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MINERAL RESOURCE ASSESSMENT — CAPE YORK PENINSULA LAND USE STRATEGY

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EXECUTIVE SUMMARY

This summary focuses on those areas within the Cape York Peninsula Land Use Strategy (CYPLUS) region regarded as having moderate to high mineral potential for various mineral commodities. It is provided as a non-technical document to assist land use planners and those without a background in the earth sciences field. The summary draws its main conclusions from the accompanying, more detailed scientific assessment of mineral resource potential for the CYPLUS region.

A qualitative assessment of the mineral resource potential of a region combines knowledge of its geology, geophysics, geochemistry, mineral deposits and mineral occurrences with current theories on mineral deposit formation and the results of exploration. This assessment has drawn on geoscientific data compiled as part of the Natural Resources Analysis Program (NRAP) of CYPLUS, and those gathered jointly under the National Geoscience Mapping Accord (NGMA) by the Geological Survey of Queensland (GSQ) of the Department of Minerals and Energy, Queensland, and the Australian Geological Survey Organisation (AGSO) of the Commonwealth Department of Primary Industries and Energy.

This assessment also draws on mineral deposit models, that is, the information which describes the essential features of a group or class of mineral deposits. The value of these models lies in their ability to apply what is known about a group of significant mineral deposits to smaller mineral occurrences so that the true character of these occurrences can be identified and their potential to constitute an ore deposit can be assessed. These models can be used to define particular tracts of land which could host deposits of a given style. The main emphasis is on those features of the deposit models that can be recognised at a regional scale, because they are the ones most likely to be recognised in the available regional data sets.

It should be noted that the assessment of mineral potential of an area applies to the foreseeable future (perhaps for the next 20 years) and should not be regarded as a "once and for all time" process. Mineral resource appraisals reflect the state of knowledge current when the appraisal is made. Assessments of mineral potential which are based on sparse geoscientific data can change significantly with the acquisition of new data. The predicted mineral potential of a region can alter in response to advances in theories of mineral occurrence, mineral exploration and mining technology, changes in commodity prices, and many other factors. Major mineral deposits continue to be found in areas throughout the world that have been repeatedly explored by competent exploration companies over many years. Notable Australian examples include the Century lead-zinc deposit in the Mount Isa region and the Kanowna Belle gold deposit near Kalgoorlie (Commonwealth Department of Primary Industries and Energy, 1993). For these reasons, access for geoscientific investigation and ongoing exploration is required if adequate assessments of mineral resource potential are to be maintained. The broad regional nature of the geological information available on Cape York Peninsula tends to restrict the level of detail given in this assessment; however, the detail provided is consistent with other natural resource data sets and is considered to be appropriate for CYPLUS.

MINING HISTORY AND ECONOMIC IMPORTANCE

Cape York Peninsula has a rich and diverse mining history dating from the discovery of gold on the Palmer River by William Hann's expedition in 1872. Population centres such as Cooktown, Coen and Weipa owe their establishment to mining. The area has produced 206Mt of bauxite, 583 481t of kaolin, 14.8Mt of silica sand, at least 47.8t of gold bullion, 16 078t of tin concentrates, 6171t of tungsten concentrates, 0.13t of molybdenite, 18 000t of copper, 1t of silver, and 4.9t of antimony concentrates. In 1992/93, the region produced $262 316 587 worth of minerals, representing 4.7% of the total mineral production of Queensland and 14.5% of non-fuel minerals. By value, this included all of Queensland's bauxite production,

98% of kaolin, 84% of silica, and 0.5% of gold production. The region is the third most important non-fuel mineral producing district in Queensland (after Mount Isa and Charters Towers). Mining is an important export earner and employer in the area. The distribution of mines and mineral occurrences within the CYPLUS region is shown in Figure 1.

GEOLOGICAL SETTING AND ASSOCIATED MINERAL RESOURCES

The CYPLUS area is covered by seven geological entities — the Cape York-Oriomo, Coen and Yambo Inliers, the Hodgkinson Province, and the Carpentaria, Karumba and Laura Basins. These areas are illustrated in Figure 2, which also shows the location of current mines and selected population centres for reference.

The Coen and Yambo Inliers contain the oldest rocks (about 1500 million years old) in the CYPLUS region and form part of an exposed north-south trending ridge. These dominantly sedimentary rocks were deformed subsequently by the effects of heat and pressure (metamorphosed) and were intruded by granitic rocks at two periods about 400 and 285 million years ago. Mineral occurrences in these areas include gold, tin, tungsten, base metals, iron and manganese.

The Cape York-Oriomo Inlier encompasses the islands of Torres Strait and the mainland near Cape York. Unlike the Coen and Yambo Inliers, the oldest exposed rocks are volcanics which were intruded by granites of roughly the same age about 295 million years ago. This area hosts gold, tin and tungsten deposits.

The Hodgkinson Province formed between 500 and 360 million years ago in the south-eastern part of the study area. It extends from Cape Melville to the south beyond Cooktown and west to Palmerville. Only the northern part of the province falls within the CYPLUS area. It comprises metamorphosed sedimentary rocks that were intruded by granites between 290 and 250 million years ago. The province contains gold, tin, tungsten, base metal, antimony and limestone deposits.

The Carpentaria and Laura Basins formed between 210 and 65 million years ago and were separated by a ridge extending between the Coen and Yambo Inliers. These basins originally may have been more extensive than the areas shown in Figure 2, covering the older Coen and Yambo Inliers and the Hodgkinson Province with a veneer of coarse terrestrial to fine marine sediment. The basins have since been partially eroded to expose the underlying rocks. Both the Laura and Carpentaria Basins contain important ground water reservoirs, and may contain petroleum. The Laura Basin also contains known coal resources.

The Karumba Basin is superimposed on the Carpentaria Basin and hosts economically important bauxite and kaolin deposits. It is also a source of ground water.

Dune fields of silica sand formed along the eastern coastal margin of the Peninsula mainly during the past 2 million years. Beach ridge deposits containing heavy minerals and silica sand occur around the east and west coasts.

MINERAL RESOURCE POTENTIAL

The assessment of mineral resource potential in the CYPLUS region has drawn on qualitative methods developed by the United States Geological Survey which describe particular areas as having low, moderate, high, or unknown potential with varying levels of certainty depending on the available information. In this summary, only those areas with moderate to high potential are highlighted, since areas with low or unknown potential will only become significant where further exploration and investigation leads to an upgrading of that potential.

Areas with moderate to high potential exist where geological, geochemical and geophysical characteristics favourable for resource accumulation are known or can reasonably be interpreted to be present. These areas include not only known mining localities, but other areas where data are adequate to demonstrate or indicate a reasonable possibility for the discovery of valuable mineral deposits.

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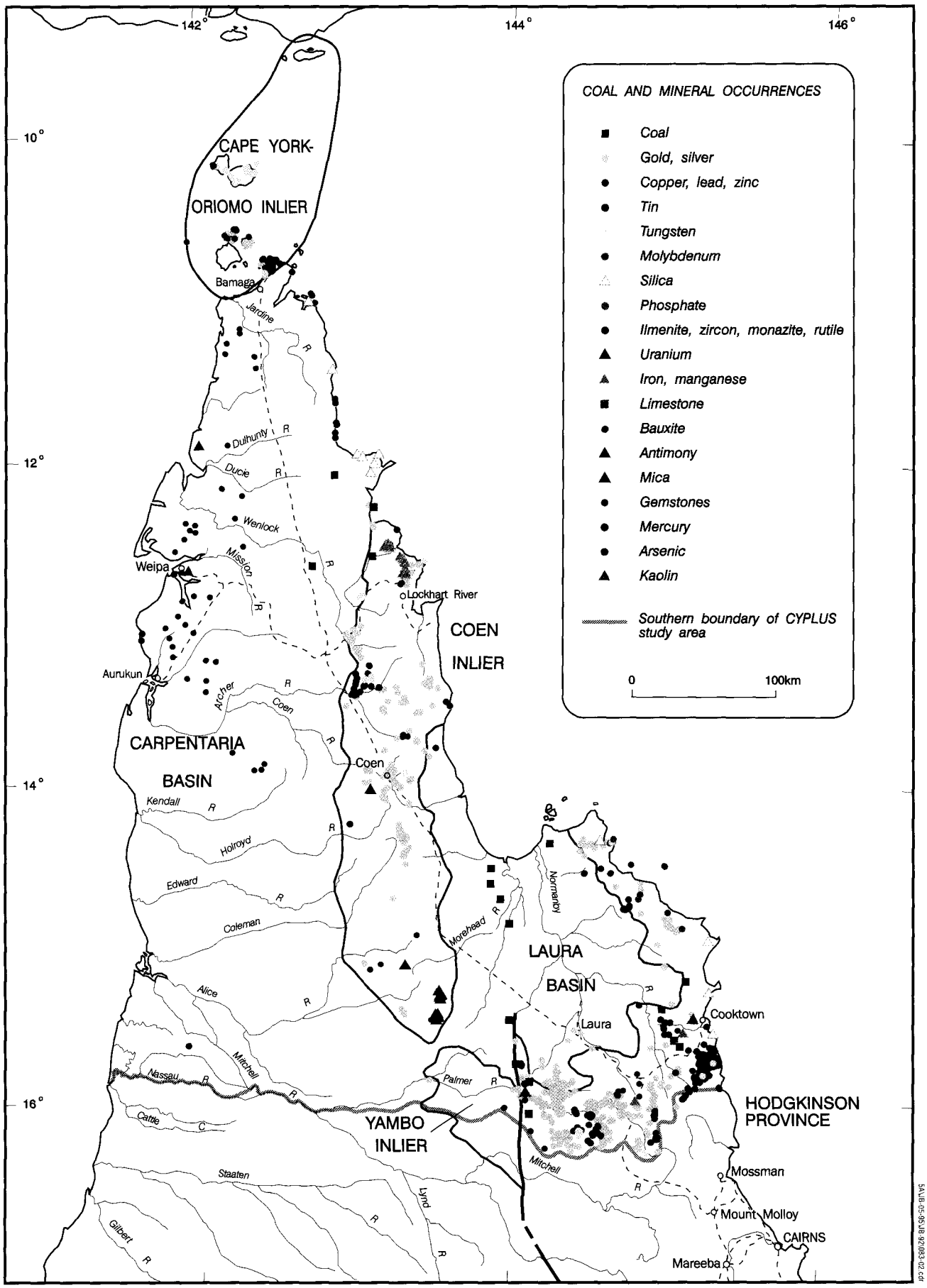

Figure 1. Distribution of mineral occurrences.

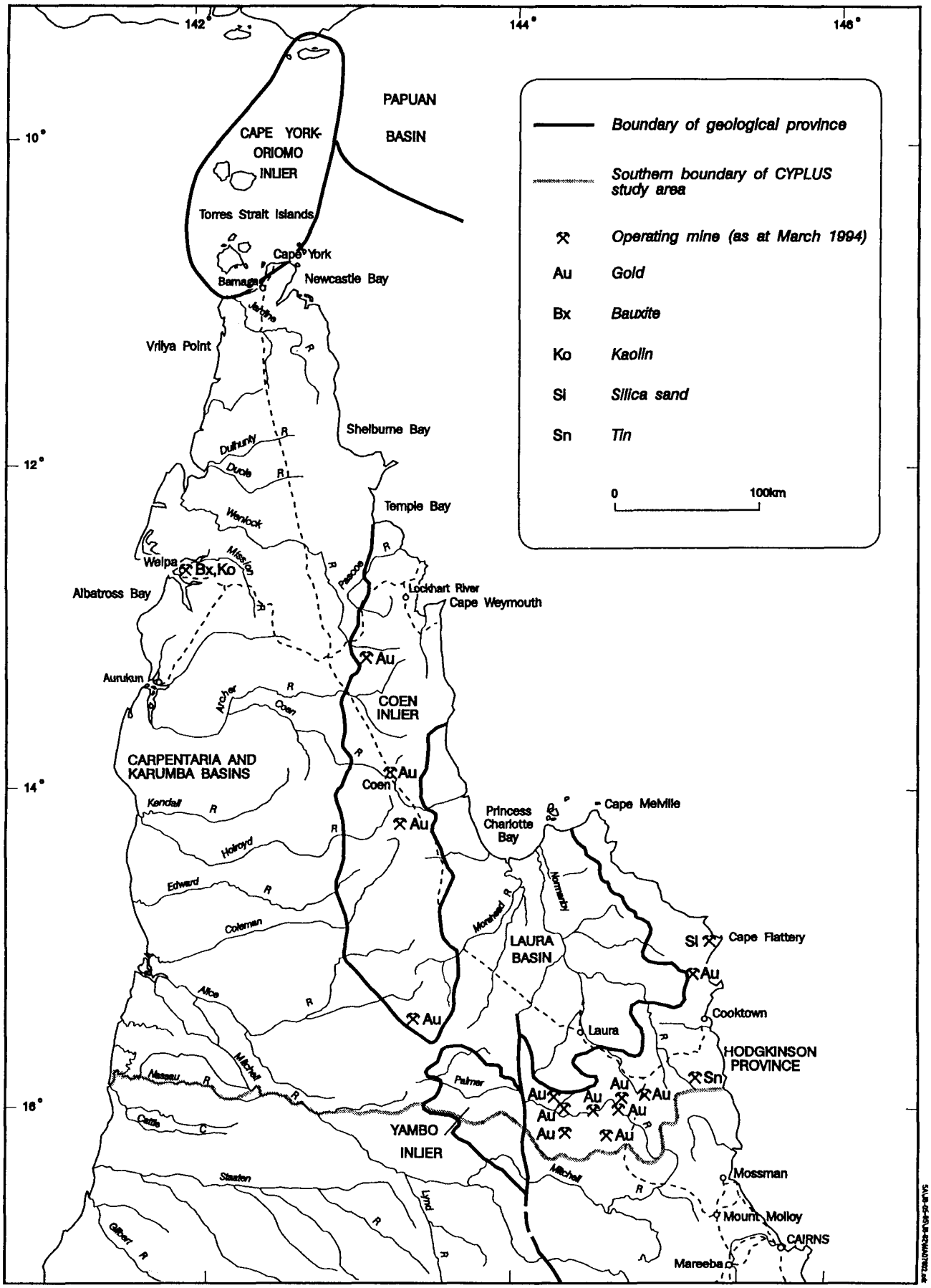

Figure 2. Geological entities and current mines.

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Areas with moderate to high potential are outlined below and in Figures 3 to 5 in terms of three broad groupings. These are areas of:

a) **major economic significance** (defined here as areas containing identified resources which currently support large-scale mining or form the resource base of current large-scale mining)

b) **possible major economic significance** (defined here as areas containing resources that could support large-scale mining, subject to further investigation and economic circumstances)

c) **minor economic significance** (defined here as areas containing or potentially containing mineral deposits which may be capable of supporting small to medium-scale mining).

a) Areas with moderate to high potential of major economic significance

These areas (Figure 3) comprise bauxite and kaolin resources held under mining lease by Comalco Aluminium Ltd and Alcan South Pacific Ltd in the Weipa area and the silica sand resources of the Cape Bedford - Cape Flattery dunefield. Comalco has total reserves of 248Mt of bauxite and 17.8Mt of kaolin and total resources of 3700Mt of bauxite and 50Mt of kaolin under mining lease. Cape Flattery Silica Mines Pty Ltd has proved reserves of 200Mt of silica sand under mining lease at Cape Flattery.

b) Areas of moderate to high potential of possible major economic significance

Known and potential deposits in these areas (Figure 4) are large enough to support large-scale mining. In most cases, economic development has not proceeded yet because of factors such as commodity prices, isolated locations, lack of markets, environmental factors, and lack of infrastructure. Deposits include bauxite resources in the Vrilya Point and Aurukun areas, silica sand dunes along the east coast from Newcastle Bay south to Shelburne Bay, heavy mineral prospects in old beach ridge systems near Colmer Point, alluvial tin deposits at Wolverton, a coking coal resource at Bathurst Range, tin vein systems at Jeannie River and Collingwood, limestone deposits near Palmerville and Kings Plains, and the Watershed tungsten prospect east of Maitland Downs. Mining of kaolin deposits at Skardon River could commence in the near future.

c) Areas of moderate to high potential of minor economic significance

Most of the deposits covered by these areas (Figure 5) are of a size and grade suited to small-scale rather than large-scale mining. Hard rock and alluvial gold deposits occur in the Cape York-Oriomo and Coen Inliers and the Hodgkinson Province. Many of these deposits, particularly those in the Hodgkinson Province, currently support small-scale gold mining. Other commodities with known and potential deposits which may be capable of supporting small to medium-scale mining include base metals, bauxite, tin, tungsten, heavy minerals and iron ore.

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The authors would like to acknowledge the valuable advice and assistance supplied by the GSQ-AGSO NGMA North Queensland Project team, especially R. Bultitude and L. Culpeper of GSQ and P. Wellman, D. Champion and B. Cruikshank of AGSO.

Mr P. Graham, Field Officer, Mareeba District Office, provided information on current mining activity in the CYPLUS study area.

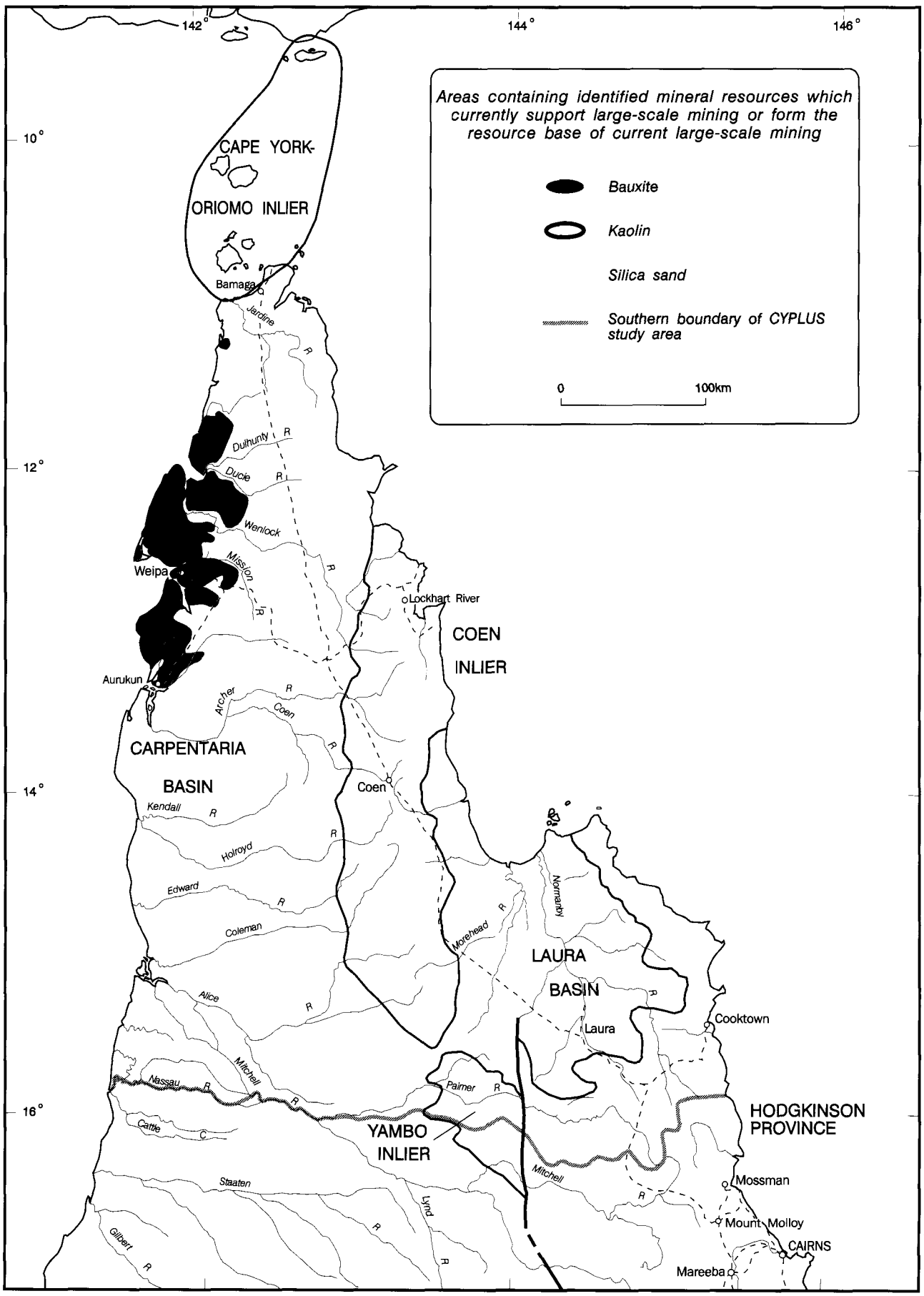

Figure 3. Known areas of major economic significance.

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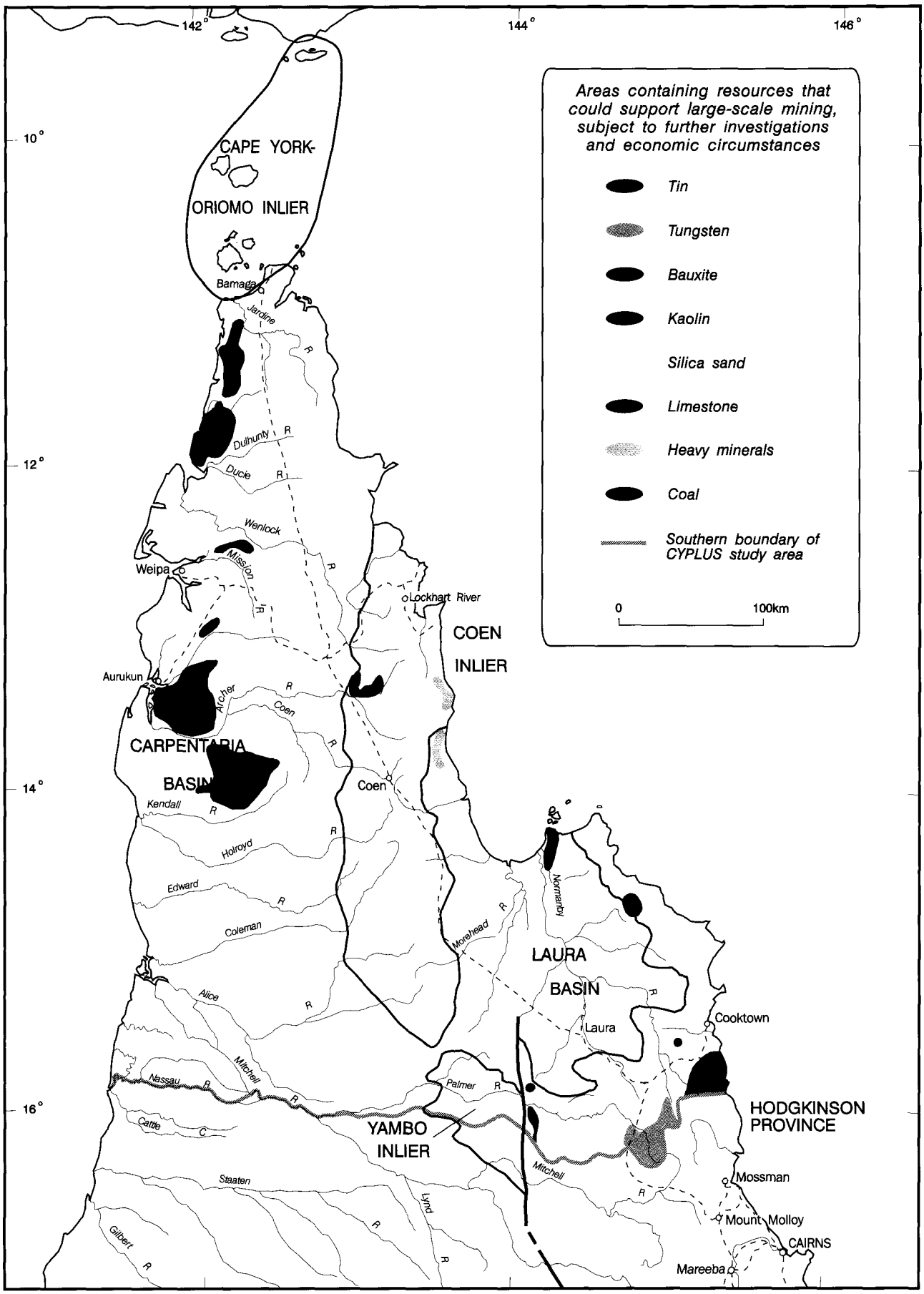

Figure 4. Known and potential areas of possible major economic significance.

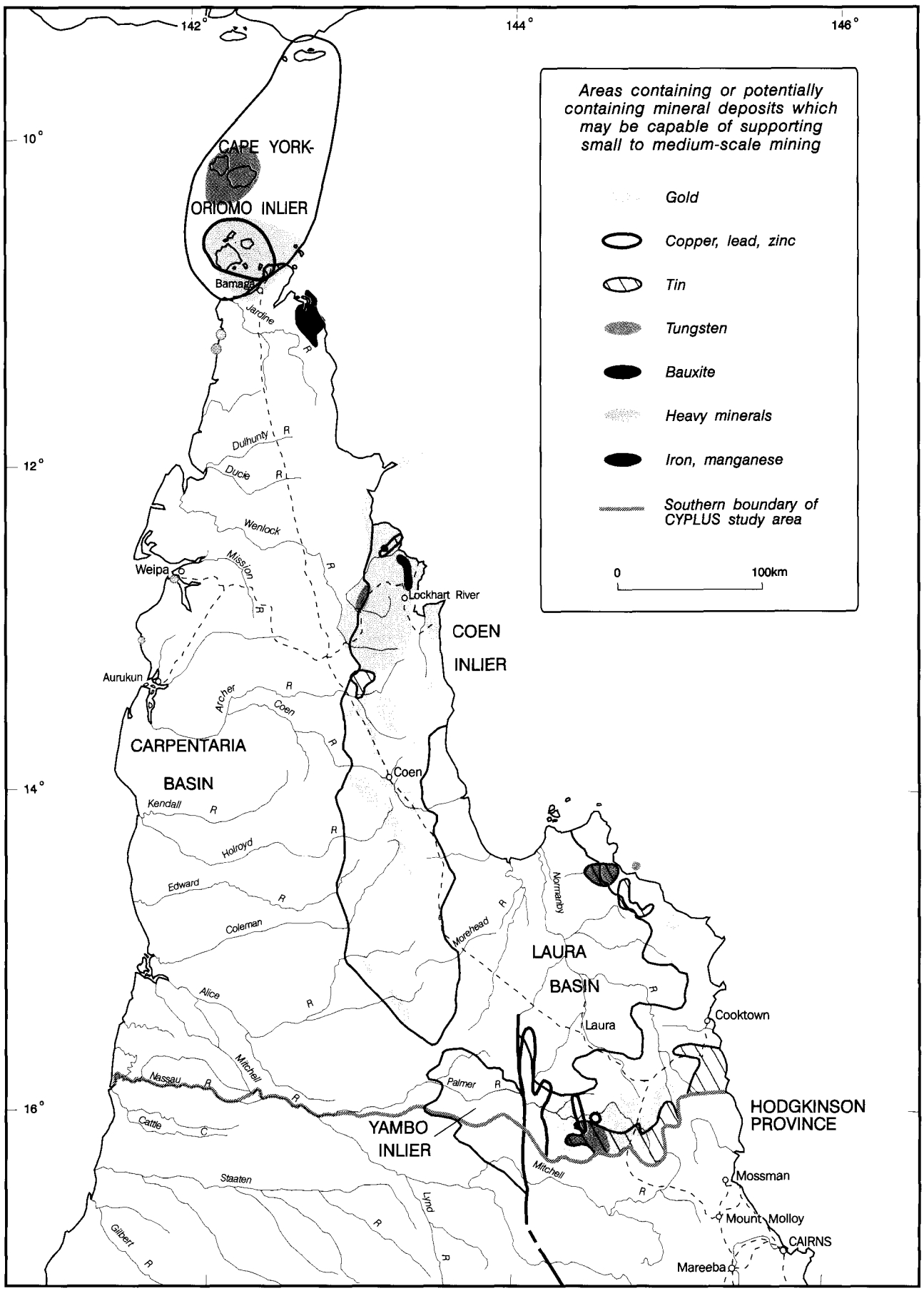

Figure 5. Known and potential areas of minor economic significance.

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INTRODUCTION

This report provides a summary of the mineral resources of Cape York Peninsula and an assessment of mineral resource potential to assist in land use decision making for the Cape York Peninsula Land Use Strategy (CYPLUS).

Mineral resource assessment information is given in terms of mineral deposit types and their geological settings. Deposit types are based on the geological characteristics of known or inferred deposits within or close to the CYPLUS area (Figure 6). The assessment also addresses the potential for undiscovered mineral and energy resources in the study area and is based on available geological, geochemical and geophysical data, together with all available information on mineral deposits and occurrences and the results of mineral exploration up until October 1993. The methodology and the data sets used in the assessment are described in the following sections.

The Cape York Peninsula Land Use Strategy (CYPLUS) is a jointly funded initiative of the Commonwealth and Queensland Governments. Its objective is to provide a basis for ecologically sustainable resource use and management in Cape York Peninsula through:

- gathering and interpreting data on the natural and cultural resources and key values of the Peninsula; and
- establishing a strategy for land use policies and decision making principles.

The strategy is being developed in three stages:

Stage I, which comprises information collection and public participation, will be completed by the end of 1994.

Stage II is the development of principles, policies and a decision-making framework and will be completed by the end of 1995.

Stage III comprises the implementation and evaluation of the framework and is ongoing.

The keystone of the strategy is the Natural Resources Analysis Program. Data are being collected on the fauna, flora, geology, mineral resources, water resources and land uses of the Peninsula and will be compiled into a Geographic Information System (GIS). Public participation is an underlying philosophy of the strategy, allowing Peninsula residents and other stakeholders to provide and obtain information and to have an effective input to the development of the strategy.

Under the auspices of the National Geoscience Mapping Accord (NGMA) North Queensland Project, the Geological Survey of Queensland (GSQ), a Division of the Queensland Department of Minerals and Energy is working jointly with AGSO (the Australian Geological Survey Organisation; formerly the Bureau of Mineral Resources, Geology and Geophysics) to update and expand knowledge of the bedrock geology, regolith, geochemistry, coastal geology, geophysics and mineral resources of the region.

MINERAL RESOURCE INVENTORY

Von Gnielinski & others (1991) prepared preliminary mineral occurrence data for AGSO from company reports covering the period 1969 to 1980. Mineral production statistics and historical data on individual mines have been compiled for the Palmer Goldfield (Burrows, 1991) and the Cooktown, Weipa and Thursday Island Mining Districts (Dugdale, 1991). Culpeper & others (1992a) prepared a summary of mineral exploration results for the period 1969 to 1990. Denaro & Culpeper (1992) have provided an overview of the known mineral resources and mineralisation styles in the area. Blake (1991) reviewed the geology and mineral and energy resources of the sedimentary basins in the area and Denaro & Shield (1993) reviewed coal and petroleum exploration within the CYPLUS area.

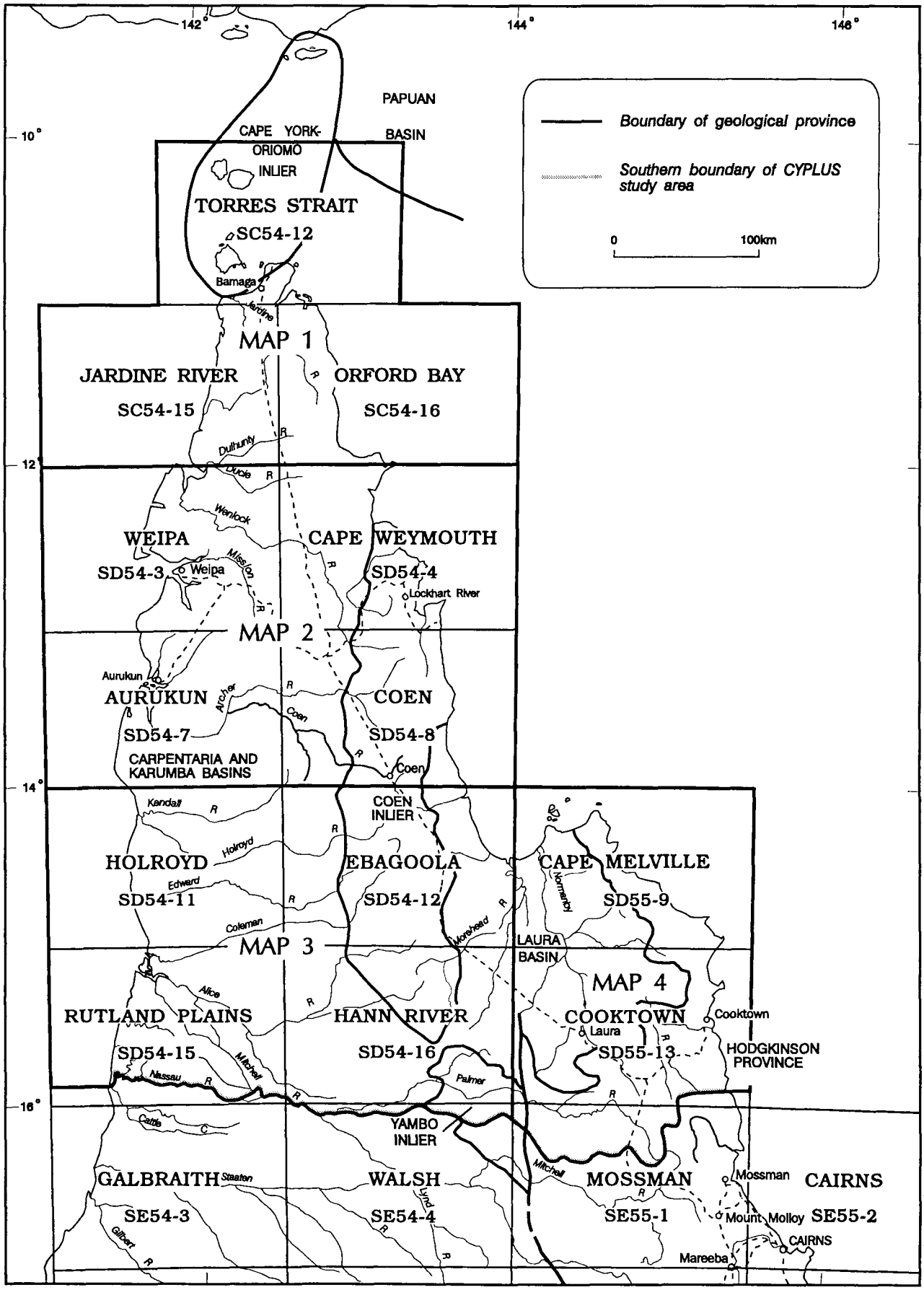

Figure 6. Location of CYPLUS study area, 1:250 000 Sheet areas and mineral resource assessment maps.

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Mineral occurrence mapping on a systematic 1:100 000 and 1:250 000 Sheet area basis commenced in 1990; Table 1 lists the relevant reports. Data are available from the Department of Minerals and Energy as hard copy reports, separate maps, and as computer databases. The results of the Mineral Resource Inventory Project of CYPLUS have been reviewed by Denaro (1994).

GEOLOGICAL MAPPING

First pass geological mapping of the Peninsula was carried out in the 1960's and 1970's (Table 2). Willmott & others (1973) summarised the geology and mineral deposits of the Coen and Yambo Inliers and Torres Strait. De Keyser & Lucas (1968) summarised the geology and mineral deposits of the Hodgkinson and Laura Basins. Smart & others (1980) have summarised the geology of the Carpentaria and Karumba Basins.

Second pass geological mapping by the GSQ commenced in the Mossman 1:250 000 Sheet area in 1984. Compilation sheets at 1:25 000 scale have been released for the Maytown, South Palmer River, Mossman, Laura, Butchers Hill, Helenvale and Cooktown 1:100 000 Sheet areas. Joint mapping with AGSO commenced in the Coen Inlier in 1990 and has resulted in the release of a new preliminary geological map for the Ebagoola 1:250 000 Sheet area (Blewett & others, 1992a) and a preliminary map commentary (Ewers & Bain, 1992). Some additional geological information has been collected for the Coen and Cape Weymouth 1:250 000 Sheet areas and a number of specialist reports have been released. Table 3 lists reports relevant to individual sheet areas. Mapping is continuing in the Red River, Walsh and Hann River 1:250 000 Sheet areas.

GEOPHYSICS

AGSO commenced collecting regional gravity data on an approximately 11km by 11km grid in 1966. Between 1969 and 1986, they carried out airborne magnetic and radiometric surveys at 1.5 to 6.0km flight line spacing and 150 to 250m terrain clearance. Since 1990, these data have been supplemented by airborne magnetic and radiometric surveys at 400m flight line spacing and 100m terrain clearance. These surveys have been funded by AGSO and the Department of Minerals and Energy. Coverage comprises the Ebagoola and Hann River 1:250 000 Sheet areas, about half of the Walsh 1:250 000 Sheet, and small parts of Cooktown and Mossman (Figure 7). Gravity and magnetic data have been interpreted by Wellman (1992a,b). Wellman (unpublished) has provided a preliminary interpretation of depth to magnetic basement for the area (Figure 8).

REGOLITH MAPPING

Regolith-landform mapping has been carried out by AGSO in the Torres Strait, Jardine River, Orford Bay, Weipa, Cape Weymouth, Aurukun, Coen, Holroyd, Ebagoola, Cape Melville, Rutland Plains, Hann River and Cooktown 1:250 000 Sheet areas. The 1993 field season has extended this work to the Mossman and Walsh 1:250 000 Sheet areas and to the Galbraith and Cairns Sheets outside the CYPLUS area.

GEOCHEMISTRY

AGSO has carried out and released regional multi-element stream sediment geochemistry over the northern Coen Inlier north of 14°S and the entire Ebagoola 1:250 000 Sheet area. The Ebagoola data set has been recently released as an atlas of geochemical images with an accompanying interpretative report (Cruikshank, 1994). Samples have been collected for the basement geology areas of the Hann River and Walsh Sheet areas (Figure 9).

PREVIOUS MINERAL RESOURCE ASSESSMENTS

Martin (1979) prepared a regional assessment of the mineral potential of Timber Reserves 141 and 165, which covered the Annan River (Cooktown) Tinfield and China Camp areas. He concluded that a considerable part of this area (most of which is now in the Wet Tropics World Heritage area) has potential for tin mining.

Table 1. Mineral occurrence reports, CYPLUS area

Sheet area(s)	Report
Torres Strait 1:250 000	Denaro (1993)
Jardine River, Orford Bay, Weipa, Cape Weymouth (part), Aurukun, Holroyd, Rutland Plains, Galbraith and Walsh 1:250 000	Culpeper (1993)
Temple Bay 1:100 000	Denaro & Morwood (1992a)
Cape Weymouth 1:100 000	Bruvel & Morwood (1992)
Wenlock 1:100 000	Denaro & Morwood (1992c)
Lockhart River and Cape Sidmouth 1:100 000	Denaro & Morwood (1992b)
Rokeby, Coen and Silver Plains 1:100 000	Denaro & others (1993)
Ebagoola 1:250 000	Culpeper & others (1992b)
Hann River 1:250 000	Culpeper & Burrows (1992)
Cape Melville 1:250 000	Denaro & others (1992)
Helenvale 1:100 000	Denaro & others (1994a)
Laura 1:100 000	Denaro & others (1994b)
Butchers Hill, Cooktown, Battle Camp and Kennedy Bend 1:100 000	Culpeper & others (1994)
Maytown 1:100 000	Lam & others (1991)
South Palmer River 1:100 000	Lam & Genn (1993)
Mossman 1:100 000	Lam (1993)

Table 2. First pass geological mapping, 1:250 000 explanatory notes series

1:250 000 Sheet Name	Explanatory notes
Torres Strait	Willmott & Powell (1977a)
Jardine River and Orford Bay	Powell & Smart (1977)
Weipa	Smart (1977a)
Cape Weymouth	Willmott & Powell (1977b)
Aurukun	Smart (1977b)
Coen	Whitaker & Gibson (1977b)
Holroyd	Grimes (1977)
Ebagoola	Whitaker & Gibson (1977a)
Cape Melville	Lucas & de Keyser (1965b)
Rutland Plains	Needham & Doutch (1973b)
Hann River	Whitaker & Grimes (1977)
Cooktown	Lucas & de Keyser (1965a)
Galbraith	Needham & Doutch (1973a)
Walsh	Grimes & Whitaker (1977)
Mossman	Amos & de Keyser (1964)

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Thirty-eight individual areas were outlined and classified into five categories according to their potential. The assessment of mineral potential was based on the actual or potential scale of mining operations, mining history, results of company exploration, and previous geological mapping.

Miezitis & McNaught (1987) prepared a report on the mineral resources and prospectivity of the then proposed Wet Tropics World Heritage area. Within the CYPLUS study area, this report covered essentially the same area as that of Martin (1979). Miezitis & McNaught (1987) described past and present known mineral

Table 3. Recent geological reports, CYPLUS area

Sheet area(s)	Reports
Coen and Cape Weymouth 1:250 000	Bain & others (1992), Black & others (1992), Blewett (1991), Blewett & Von Gnielinski (1991a, 1991b), Ewers & Cruikshank (1993), Knutson & others (1994), Trail & Blewett (1991)
Ebagoola 1:250 000	Bain & others (1992), Black & others (1992), Blewett (1991,1992), Blewett & Von Gnielinski (1991a, 1991b), Blewett & others (1992b), Bultitude & Rees (1994), Cruikshank (1994), Ewers & Bain (1992), Mackenzie & Knutson (1992), Trail & Blewett (1991), Von Gnielinski & Blewett (1992), Wellman (1992a)
Hann River 1:250 000	Bultitude & Rees (1994)
Cape Melville 1:250 000	Bultitude (1993), Bultitude & Champion (1992)
Cooktown 1:100 000	Bultitude & Champion (1992), Bultitude & Champion (1993), Bultitude & others (1991)
Helenvale and Mossman 1:100 000	Bultitude & Champion (1992), Bultitude & Champion (1993), Bultitude & others (1985), Donchak & others (1992), Law (1989)
Laura and Maytown 1:100 000	Bultitude & Champion (1992), Bultitude & Donchak (1992), Bultitude & others (1985), Bultitude & others (1993)
Butchers Hill 1:100 000	Bultitude & Champion (1992), Robertson (1993), Domagala & others (1993)
South Palmer River 1:100 000	Bultitude & Champion (1992), Bultitude & others (1985), Bultitude & others (1993), Halfpenny & Hegarty (1991)

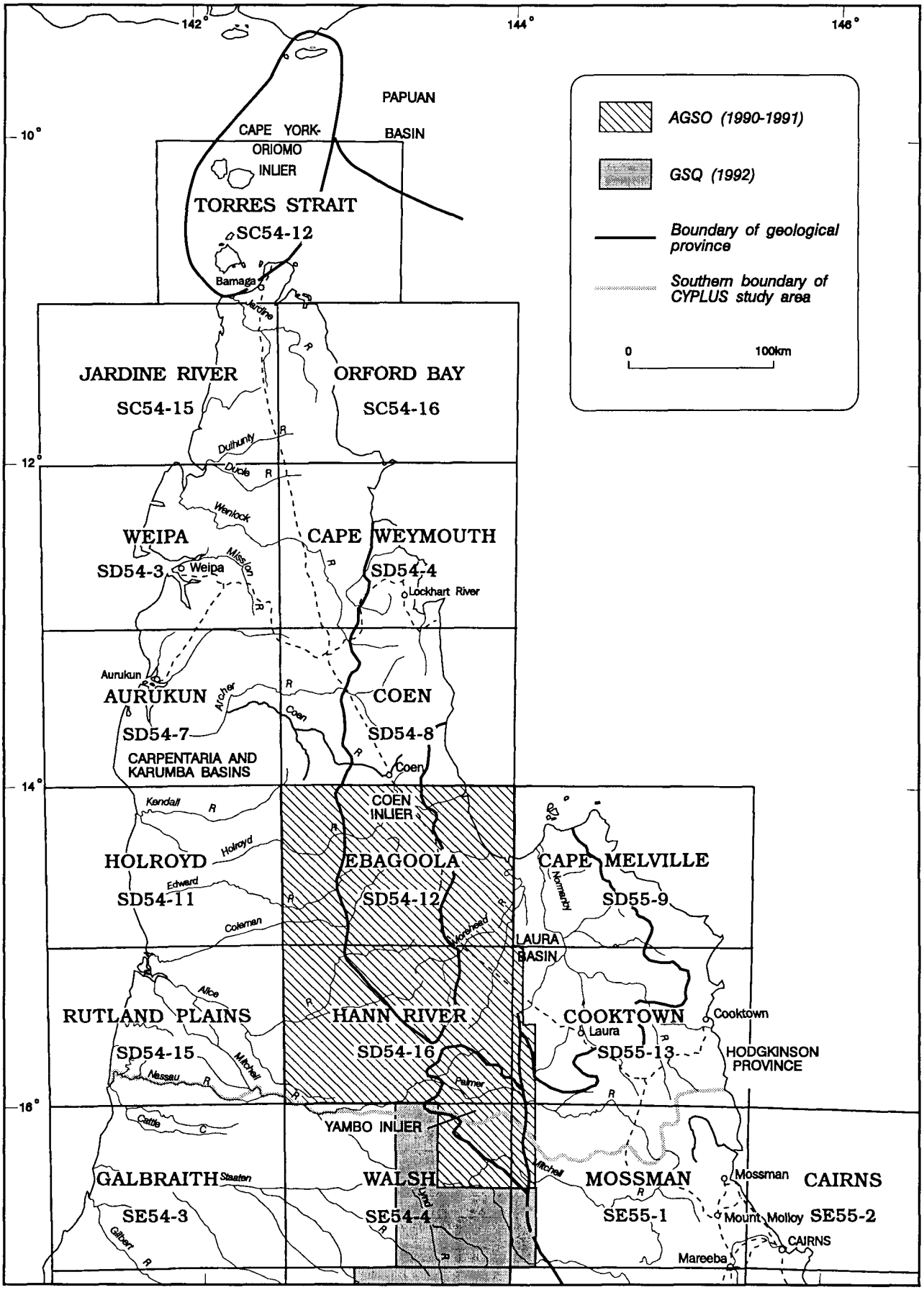

Figure 7. Aeromagnetic and radiometric surveys at 400m line spacing.

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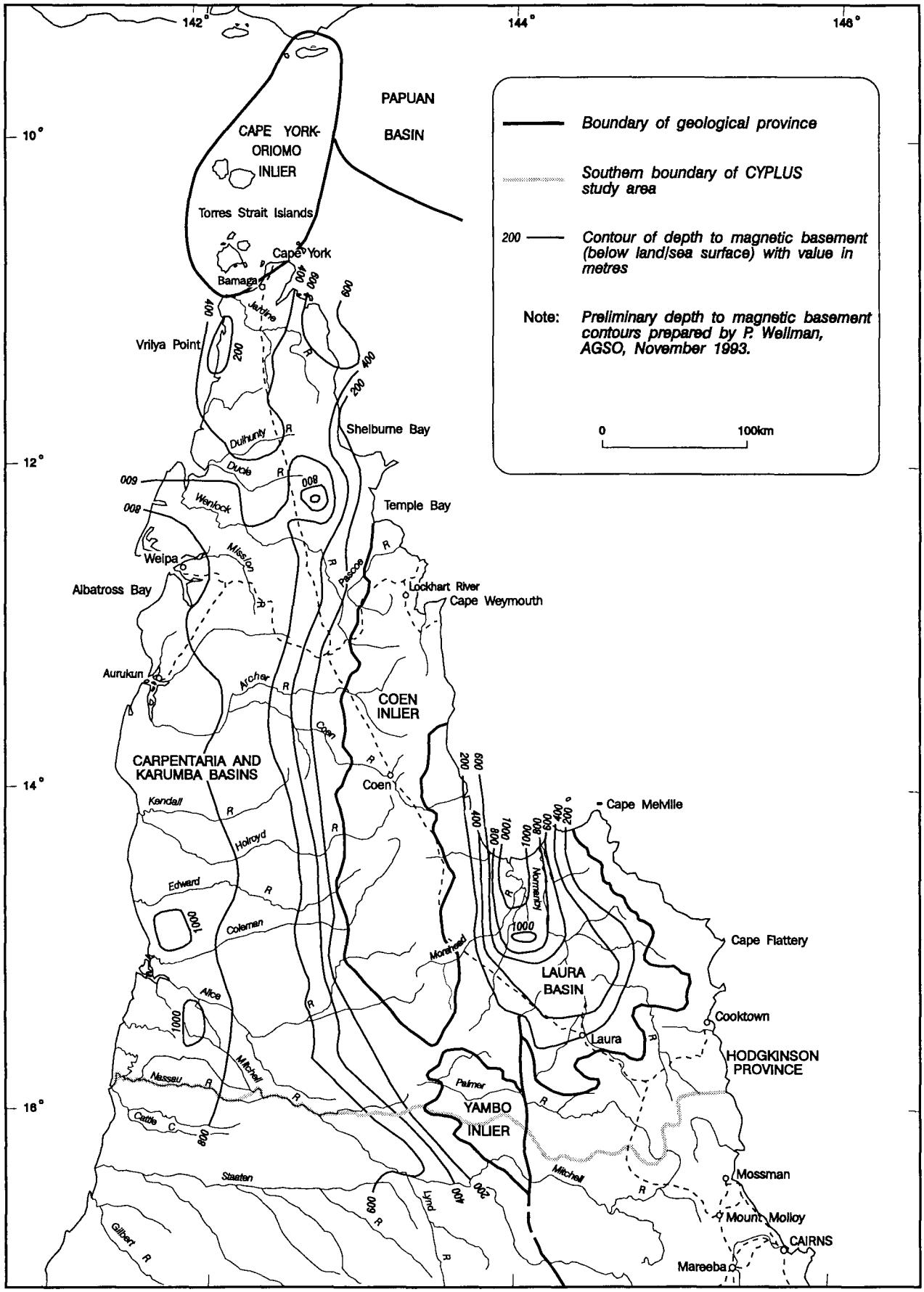

Figure 8. Preliminary contours, depth to magnetic basement.

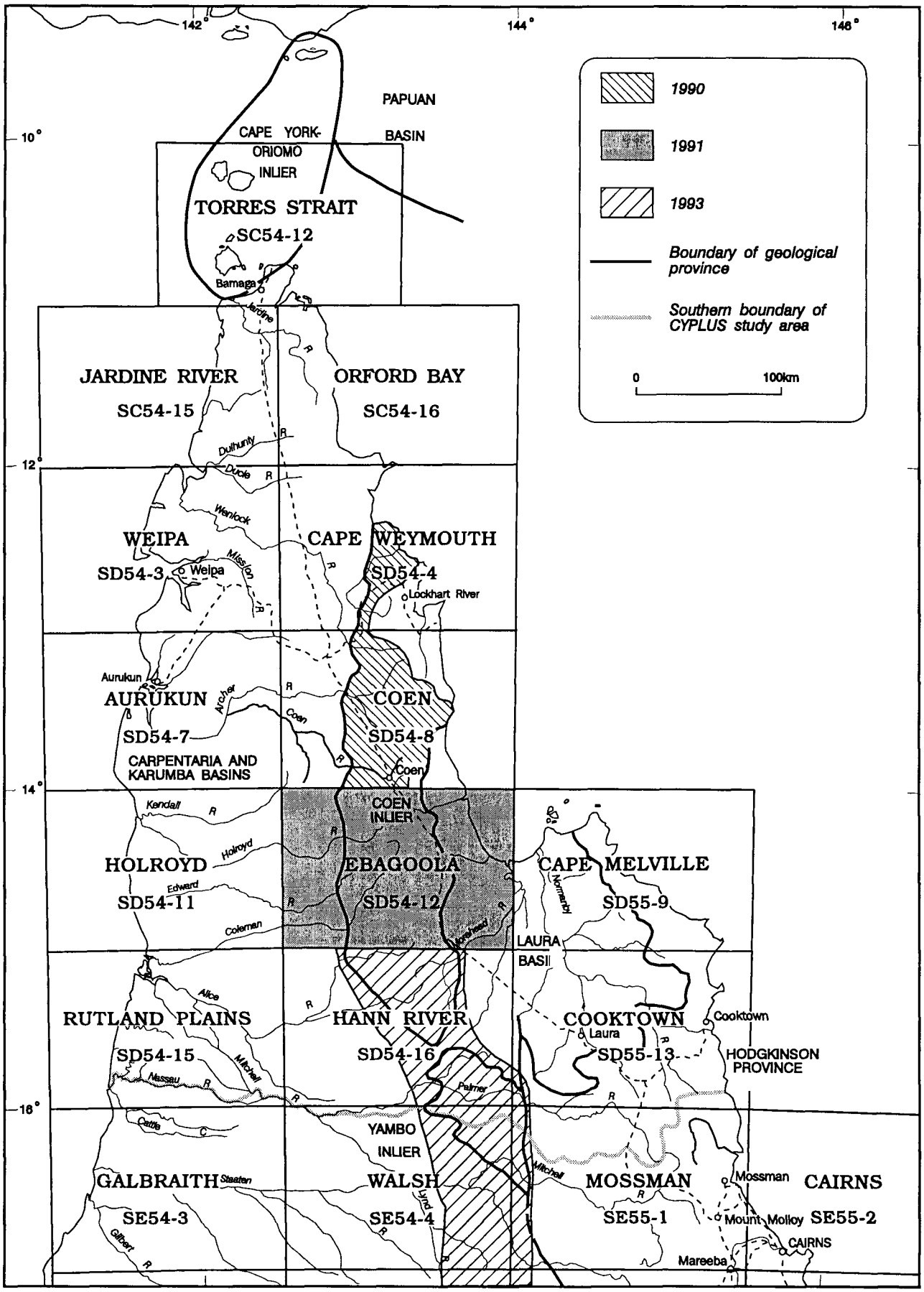

Figure 9. Regional stream sediment geochemistry surveys (AGSO).

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resources and provided a broad assessment of mineral prospectivity. An area was considered to be prospective if existing geological evidence suggested that mineral exploration might lead to the discovery of an economic mineral deposit. The terms high, moderate and low prospectivity were used, based on qualitative assessments.

As part of the National Geoscience Mapping Accord, North Queensland Project, Miezitis & Bain (1991) prepared comments on the mineral potential of Cape York Peninsula north of latitude 17° 45'S. Mineral potential was qualitatively assessed in terms of high, moderate and low potential.

White (1991) summarised the distribution of mineral deposits north of latitude 17°S and provided general comments on minerals with resource potential. Culpeper & others (1992a) and Denaro & Culpeper (1992) described the known mineral resources of the Peninsula. Ewers & Cruikshank (1993) have commented on the epithermal gold potential of the northern Coen Inlier. Knutson & others (1994) have commented on potential mineralisation associated with granites in the Coen and Cape Weymouth 1:250 000 Sheet areas.

MINERAL RESOURCE POTENTIAL CLASSIFICATION AND METHODOLOGY

An assessment of mineral resource potential is concerned with the probability of mineral occurrence, particularly mineral occurrence of sufficient size and grade to constitute an economic resource. The mineral resource potential of the CYPLUS area has been assessed using qualitative assessment methods developed by the United States Geological Survey, particularly those used by Toth & others (1993).

A qualitative assessment of the mineral potential of a region combines knowledge of its geology, geophysics, geochemistry, mineral deposits and occurrences with current theories on mineral deposit genesis and the results of any exploration (Commonwealth Department of Primary Industries and Energy, 1993). In particular, the assessment draws on the regional characteristics of mineral deposit models to establish whether or not specific mineral deposits are likely to occur.

A mineral deposit model is a description of the essential attributes or properties of a group or class of mineral deposits. The models used in this report are based primarily on those of the United States Geological Survey (Cox & Singer, 1986), supplemented by models from other sources and modified to reflect the characteristics of known mineralisation in the study area.

Various criteria can be used to assess the potential for a mineral resource. Recognition criteria are of three types:

- **diagnostic** criteria are those that are present in nearly all known deposits of a given type (for example, favourable host rock and known mineral occurrence);
- **permissive** criteria commonly, but not necessarily, suggest the presence of a given deposit type. Such criteria strengthen the possibility that a deposit of a specified type exists, but their absence does not rule out such a deposit;
- the proven absence of a diagnostic criterion can, in effect, be a **negative** criterion (for example, where a required type of host rock is known not to be present) (Gair, 1989b).

The mineral resource potential of an area is a measure of the likelihood of occurrence of mineral deposits that may be economic within the foreseeable future, that is, within the next twenty years or so. Mineral resource potential is ranked using the qualitative terms **high**, **moderate**, **low**, **nil** and **unknown**.

High mineral resource potential is assigned to areas where geological, geochemical and geophysical characteristics indicate a geological environment favourable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral deposit models indicating presence of resources, and where evidence indicates

that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area (Toth & others, 1993).

Moderate mineral resource potential is assigned to areas where geological, geochemical and geophysical characteristics indicate a geological environment favourable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and/or where an application of mineral deposit models indicates favourable ground for the specified type(s) of deposits.

Low mineral resource potential is assigned to areas where geological, geochemical and geophysical characteristics define a geological environment in which the existence of mineralisation is possible but any deposits are unlikely to be economic. This broad category covers areas with dispersed but insignificantly mineralised rock as well as areas with few or no indications of having been mineralised.

Nil mineral resource potential is a category reserved for a specific type of resource in a well-defined area. This category has not been assigned to any areas in this study because of the broad, regional scale used for the assessment.

Unknown mineral resource potential is assigned to areas where information is inadequate to assign low, moderate or high levels of resource potential. All areas without a high, moderate or low resource potential can be considered to have an unknown potential.

Levels of certainty are applied to mineral resource assessment categories in accordance with the definitions of Toth & others (1993):

A. Available information is not adequate for determination of the level of mineral resource potential.

B. Available information suggests the level of mineral resource potential.

C. Available information gives a good indication of the level of mineral resource potential.

D. Available information clearly defines the level of mineral resource potential.

Levels of certainty are shown diagrammatically on Figure 10.

Favourable geology is the most important overall condition to be satisfied in identifying an area as having mineral resource potential and encompasses all aspects of geological setting. Favourable geology is deduced from associations of mineralisation with specific rock types or other geological features such as faults.

The presence of known mineral occurrences, particularly small ones, does not automatically indicate mineral resource potential. However, mineral occurrences have a strong positive influence on the evaluation of resource potential because actual mineral occurrences support the possibility of still more (and bigger) occurrences. The absence of known mineral occurrences in parts of a rock formation that has occurrences elsewhere is not considered to be very significant because it may reflect only insufficient exploration. However, if no mineral occurrences are known anywhere in a formation, there is little basis for predicting future discoveries in that formation. In this case, mineral resource potential would be based on other considerations, such as geochemical anomalies in the formation or mineralisation occurring in similar rocks elsewhere.

Geochemical anomalies alone, except for exceptionally significant anomalies, are considered to be indicative of low potential, at best. Even in combination with favourable geology, geochemical anomalies are not as supportive of mineral resource potential as actual observed mineralisation. Geochemical or heavy mineral anomalies near known mineral occurrences in a formation reflect the obvious mineralisation and provide little more information on the mineral resource potential than is already known.

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The mineral resource potential information in this report is given in terms of mineral deposit types and their geological settings. Deposit types are based on the geological characteristics of known and inferred deposits within or close to the study area. A two-part alphabetical identifier (for example, AuA) is used in the text and on the maps to represent each deposit type. The first part of the identifier refers to the main commodity present; the second part refers to the deposit type, as specified in the text and on the maps. A third identifier, a numeric code, is assigned to specific areas with mineral resource potential. Each alphanumeric combination indicates a geographic area with a defined resource potential and level of certainty for a restricted set of commodities that occur in that deposit type.

It must be remembered that resource assessments are dynamic rather than static. As more geoscientific and exploration data become available for an area, as new concepts on mineralisation controls and ore genesis appear, as mining technology improves, and as commodity prices change, the resource potential of an area may be upgraded or downgraded.

The size classification used for this report is given in Table 4 and is based on cut off classes used by Parkinson (1988) in the Atlas of Australian Resources, and by the Canadian Geological Survey and the Northern Territory Geological Survey, with adjustments to the cut offs for gold to adequately relate the sizes of Australian gold deposits (Dash, 1991). Cut offs for kaolin have been included, taking into consideration the size of Queensland kaolin deposits. Sizes have been adjusted for lead and zinc to allow distinction of medium and large deposits in the Mount Isa area.

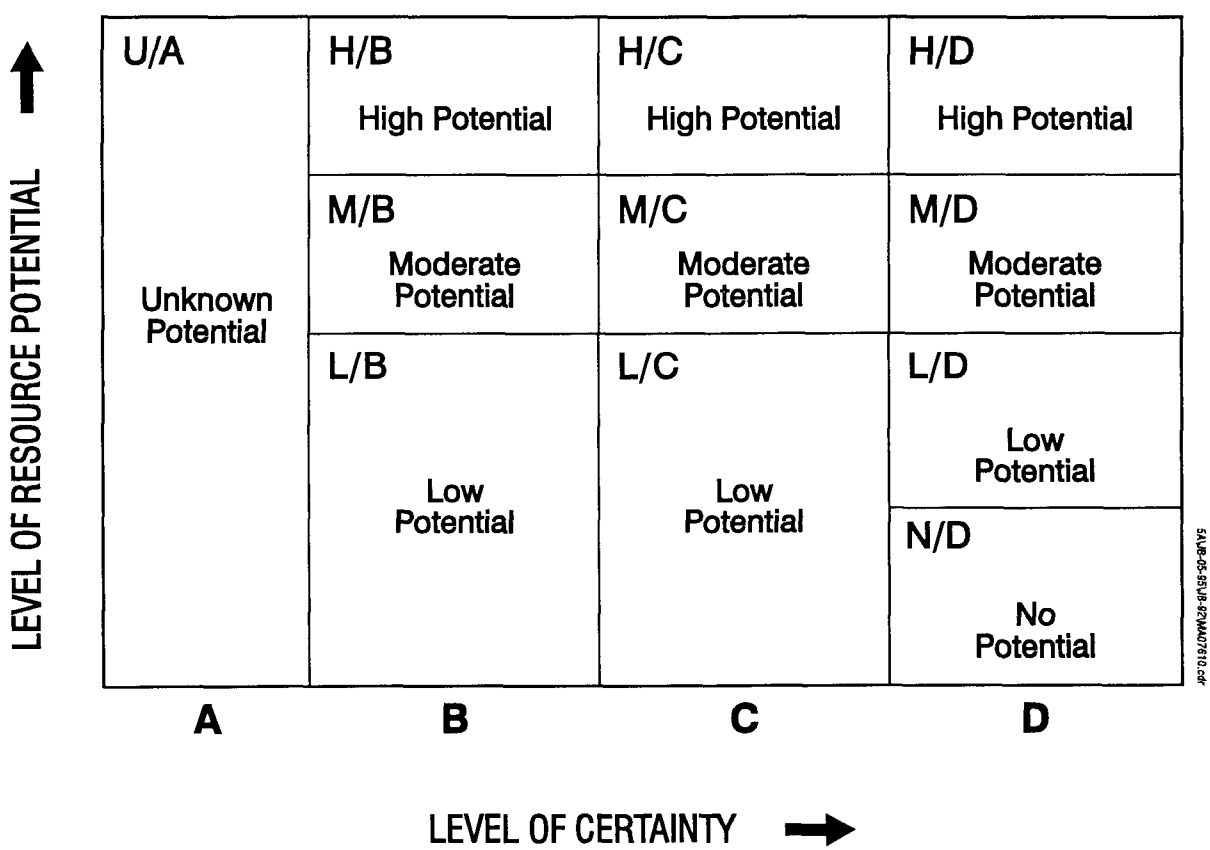

Figure 10. Levels of mineral resource potential and certainty of assessment (Toth & others, 1993).

Table 4. Size classification of deposits

Commodity	Size of deposit (tonnes)		
	Small	Medium	Large
Aluminium	<100 000 000	100 000 000 - 200 000 000	>200 000 000
Antimony	<5 000	5 000 - 50 000	>50 000
Arsenic	<5 000	5 000 - 50 000	>50 000
Asbestos	<100 000	100 000 - 10 000 000	>10 000 000
Barite	<50 000	50 000 - 5 000 000	>5 000 000
Beryllium	<10	10 - 1 000	>1 000
Bismuth	<5 000	5 000 - 50 000	>50 000
Cadmium	<5 000	5 000 - 50 000	>50 000
Chromium	<10 000	10 000 - 1 000 000	>1 000 000
Cobalt	<1 000	1 000 - 20 000	>20 000
Copper	<50 000	50 000 - 1 000 000	>1 000 000
Dolomite	<2 000 000	2 000 000 - 10 000 000	>10 000 000
Fluorite	<50 000	50 000 - 5 000 000	>5 000 000
Gold	<5	5 - 50	>50
Gypsum	<5 000 000	5 000 000 - 100 000 000	>100 000 000
Ilmenite	<5 000 000	5 000 000 - 10 000 000	>10 000 000
Iron	<5 000 000	5 000 000 - 100 000 000	>100 000 000
Kaolin	<200 000	200 000 - 20 000 000	>20 000 000
Lead	<100 000	100 000 - 2 500 000	>2 500 000
Limestone	<2 000 000	2 000 000 - 10 000 000	>10 000 000
Lithium	<10 000	10 000 - 100 000	>100 000
Magnesite	<2 000 000	2 000 000 - 10 000 000	>10 000 000
Magnesium	<100 000	100 000 - 10 000 000	>10 000 000
Manganese	<100 000	100 000 - 10 000 000	>10 000 000
Mercury	<10 000 (flasks)	10 000 - 500 000 (flasks)	>500 000 (flasks)
Molybdenum	<5 000	5 000 - 200 000	>200 000
Monazite	<20 000	20 000 - 50 000	>50 000
Nickel	<25 000	25 000 - 500 000	>500 000
Phosphate rock	<200 000	200 000 - 200 000 000	>200 000 000
Platinum, palladium	<5	5 - 50	>50
Precious gemstones	<1	1 - 10	>10
Rare earths	<1 000	1 000 - 1 000 000	>1 000 000
Rutile	<200 000	200 000 - 500 000	>500 000
Semi-precious gemstones	<10	10 - 100	>100
Silica	<1 000 000	1 000 000 - 2 500 000	>2 500 000
Silver	<500	500 - 10 000	>10 000
Talc	<1 000 000	1 000 000 - 10 000 000	>10 000 000
Tantalum	<1 000	1 000 - 100 000	>100 000
Tin	<5 000	5 000 - 100 000	>100 000
Titanium	<100 000	100 000 - 10 000 000	>10 000 000
Tungsten	<500	500 - 10 000	>10 000
Uranium	<10 000	10 000 - 40 000	>40 000
Vanadium	<500	500 - 10 000	>10 000
Zircon	<500 000	500 000 - 1 000 000	>1 000 000
Zinc	<200 000	200 000 - 5 000 000	>5 000 000

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MINING HISTORY

The early mining history of Cape York Peninsula has been summarised previously by Willmott & others (1973) and de Keyser & Lucas (1968), and in the Explanatory Notes for the relevant 1:250 000 geological sheets. Detailed information is included in the mineral occurrence reports for individual sheet areas. Production figures (Table 5) are based on those in the mineral occurrence reports and on compilations of mineral production statistics by Burrows (1991) and Dugdale (1991).

Figure 11 shows the early Gold and Mineral Fields and the recently superseded Mining Districts. Most of the study area is now within the newly expanded Mareeba Mining District. The geographical subdivisions used in this chapter are major geological provinces, which are shown on Figures 1 to 3 and are described under "REGIONAL GEOLOGY".

GOLD

Southern Coen Inlier:

John Dickie discovered gold at Ebagoola in 1900 and at Yarraden in 1901, sparking a minor gold rush, particularly from the Coen Goldfield. The **Hamilton Goldfield**, covering both areas, was gazetted in 1900. The Goldfield was at its peak between 1900 and 1905. Subsequently, production declined rapidly except for the Lukin King lode (including the Hiakai Mine), which continued sporadic production until about 1919.

The total production of the Hamilton Goldfield from 1900 to 1951 was 2291.6kg of gold, comprising 1371.6kg of reef gold from 34 196t of ore, 682.5 kg of alluvial gold, and 237.5kg of gold from the treatment of 19 256t of tailings. Alluvial mining was restricted to the Ebagoola area. The most productive reefs in the Ebagoola area were the Hamilton King, Caledonia, May Queen and Hit or Miss. Reefs in the Yarraden area included the Golden King and the Savannah.

Recently, the Golden Era Goldmine Syndicate has been working reefs and alluvial gravels at Ebagoola for specimen gold (Kay, 1990).

Gold was discovered in the upper reaches of the Alice River in 1903 by John Dickie and the **Alice River (Philp) Gold and Mineral Field** was gazetted in 1906. From 1904 to 1909, mining was virtually confined to two reefs, the Alice Queen and the Peninsula King. Other mines included the Big Blow, Eureka and Taylors Reef. Total recorded production was 101.1kg of gold from 2651t of ore and 14.0kg of alluvial gold. There has been little mining activity since 1917.

Only one reef, the Perseverance, was found in the **Potallah Creek Gold and Mineral Field**. Recorded production was 21.8kg of gold from 668t of ore and 0.16kg of alluvial gold.

Northern Coen Inlier:

Alluvial gold was discovered at **Coen** by Sefton, Watson, Verge and Goodfellow in 1876. In 1878, there was a small rush from the Palmer River but the deposits were small and the workings were abandoned in the same year. Chinese miners tried to work the ground in 1880 without success. Land was taken up for lode mining in 1885, but productive mining did not start until 1892. A 5-head battery was set up on the banks of the Coen River at its junction with Lankelly Creek. A 15-head (later reduced to 10-head) battery was erected at the Wilson Mine. The **Coen Goldfield** was proclaimed in 1892 and enlarged in 1898. From 1893 to 1899, the field produced 888.1kg of gold from 16 689t of ore. In 1900, mining at Coen came almost to a standstill when the Hamilton Goldfield was opened up, but mining continued for many years, mainly at the Great Northern Mine and by the treatment of tailings with cyanide.

The most successful mine was the Great Northern, 1.6km south-east of Coen township. It produced approximately three-quarters of the gold won from the field. Production up until 1916 was 1760kg of gold from 26 234t of ore and 412.4kg of gold from the treatment of 20 000t of tailings and mullock. Several attempts were

Table 5. Recorded mineral production, Cape York Peninsula

Gold					
Location	**Production period**	**Ore (t)**	**Tailings (t)**	**Lode gold (kg)**	**Alluvial gold (kg)**
Alice River Gold and Mineral Field	1903–1909, 1912–1916, 1936	2651		101.1	14.0
Potallah Creek Gold and Mineral Field	1902–1904, 1914, 1942, 1947	668		21.8	0.16
Hamilton Gold and Mineral Field	1900–1951	34 196	19 256	1371.6 237.5	682.5
Coen Goldfield	1876–1880 1892–1918, 1952	>29 244	20 000	2799.8 412.4	>310.0
Klondyke area	1898–1904	784		41.4	
Lochinvar Provisional Mining Field	1904	50		2.2	
Blue Mountains	1934–1945, 1948–1951	>1390		51.4	0.14
Leo Creek (Claudie Lakeland)	1896–1904, 1909–1910	595		87.5	
Rocky River Goldfield	1893–1896				38.75
Mullumbidgee	1952–1957	7		2.2	
Hayes Creek Provisional Goldfield	1909–1914, 1934, 1938–1953	529.7		28.3	0.37
Wenlock Gold and Mineral Field and adjacent area	1892–1894, 1905–1951, 1964–1965, 1977–1978	14 958.5		312.1	>1215.35
Battery Lease	1903, 1910–1913	144		6.8	
Claudie River Gold and Mineral Field	1934–1942	17 099	3220	333.1	
Possession Island Gold and Mineral Field	1897–1902, 1905, 1919	>4261		113.1	
Horn Island Gold and Mineral Field (including Hammond and Thursday Islands)	1894–1900, 1909, 1935 1988–1989	16 906		179.44 1432.0	31.07
Starcke No. 1 Goldfield (Cocoa Creek)	1892–1896	1157.2		34.5	
Starcke No. 2 Goldfield	1890–1913	5964	457	314.0 2.2	117.5
Six Mile Creek	1921, 1939–1948	111		2.69	
Palmer Goldfield (including West Normanby field)	1874–1990			4340.5	>33210
	Total:			>12 227.6	>35 619.8

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Table 5 (continued)

Tin			
Location	**Production Period**	**Lode tin (t cassiterite concentrates)**	**Alluvial tin (t cassiterite concentrates)**
Granite Creek (Coen area)	1907–1931, 1938–1940, 1977–1978		333.5
Tin Creek and First Stony Point tinfields	1900–1928, 1938–1940		14
Cape York tinfield	1950–1986	>15.6	>21.5
Barrow Point	1939		0.25
Howick Island			0.50
Cooktown Tinfield	1885–1992	272	12578
Palmer Goldfield (Granite Creek, Cannibal Creek, Mount Windsor Tableland)	1880–1884, 1900–1937, 1948, 1958, 1969, 1970	37.6	2805.5
	Total:	>325.2	>15753.25

Tungsten and molybdenum				
Location	**Production Period**	**Lode tungsten (t wolframite concentrates)**	**Lode tungsten (t scheelite)**	**Lode molybdenum (t molybdenite)**
Grand Final (12km east of Coen)	1904, 1915–1918, 1952	5.8		
	1915–1917			0.13
Bowden Mineral Field	1904–1916, 1952	70.3		
Moa Island	1938–1956	100.6		
Portlock Island	1951	0.03		
Howick Island	?1921	0.25		
Noble Island	1904–1912, 1916	18.7		
Cooktown Tinfield	1889–1902, 1919, 1921, 1955–1957	8.3		
Palmer Goldfield (Spring Creek)	1907	0.2		
	1969–1970		5966.7	
	Total:	204.18	5966.7	0.13

Copper
St George Copper mines: 1905 to 1907, 5t of 24% ore
Dianne Copper Mine: 1980 to 1983, 69 820t ore, >18 000t Cu and 1000kg Ag
Antimony
Six Mile Creek, west of Cooktown: 1944 to 1945, 7t of ~58% ore
Uncle Sandy mine, Starcke No. 2 Goldfield: 1906, 9t of 9% ore
Silica sand
Cape Flattery Silica Mine: 1968 to 1993, 14.8Mt
Bauxite
Weipa Bauxite Mine: 1960 to 1993, 206Mt
Kaolin
Weipa Bauxite Mine: 1986 to 1993, 583 481t

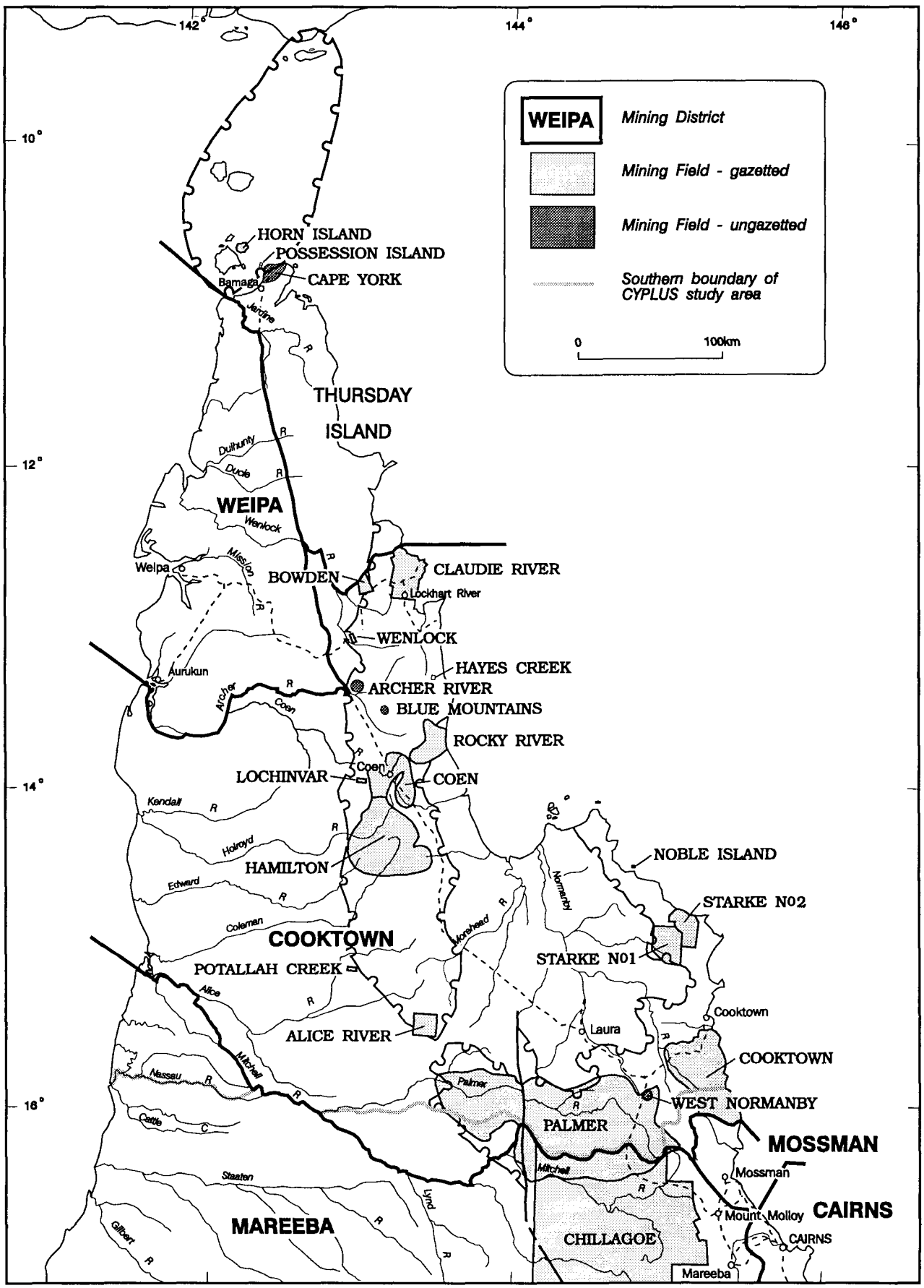

Figure 11. Historical mining districts and fields of Cape York Peninsula.

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made to reopen the mine between the First World War and 1950; the most recent attempt was by Fisher and Sons from 1946 to 1950.

Other reefs near Coen which produced gold, mainly before 1900, included the Daisy, Hanging Rock, Homeward Bound, Lankelly, Long Tunnel, Trafalgar, Wilson and reefs at the Springs (15km south-east of Coen).

Up until recently, Saracen Minerals N.L. and Wallace Mining were producing alluvial gold from Oscar Creek. They also worked old tailings dumps for their gold content. Saracen's mining plant was auctioned at Coen in October 1992.

Gold was discovered in the **Klondyke** area, 13km north-east of the Springs, by Johnson and Shield in 1887. A township was set up on Station Creek and a 5-head water-powered battery was erected. The main reef worked was the Springfield (originally called the Klondyke). In 1903, the Klondyke battery was purchased by the Coen Quartz Crushing Company and moved to Lankelly Creek near Coen. The total recorded production for the area (1898 to 1904) was 41.4kg of gold from 784t of ore.

The only information available on the **Lochinvar Provisional Goldfield**, on the headwaters of Tadpole Creek 18km south-west of Coen, is that 2.2kg of gold was produced from 50t of ore in 1904 (Annual Report of the Queensland Department of Mines, 1904). All claims on the field were deserted in this year because the ore was not rich enough to cover the cost of mining, cartage to Coen and crushing. The field was approximately one square kilometre in area and was not gazetted.

The date of the discovery of gold at the **Blue Mountains**, 40km north of Coen, is not recorded but the gold-bearing quartz reefs came to official attention in 1933 to 1934. However, Alexander and Bell were working their claim (the Golden Wasp North) from at least as early as 1931. In 1934, they sent 23.4t of ore to Charters Towers for a return of 84g/t Au. They erected a small, single head battery. Eight leases were applied for in 1935.

Blue Mountains Gold N.L. held a number of leases from 1935 to 1945 and erected a 10-head battery on the field. The company produced 20.2kg of gold from 593t of ore, mainly from the Golden Ladder and Convict. The Yarraman Mine was another major producer.

The Blue Mountains battery was owned by Fisher and Sons in 1950, but the boiler was condemned in 1951 and the battery could not be run. By 1952, the field was practically deserted. The total recorded production of the field (1934 to 1945, 1948 to 1951) was 51.4kg of gold from 1390t of ore; 0.14kg of alluvial gold was produced in 1945.

William Lakeland discovered gold on Palm Creek, in dense rainforest in the upper reaches of the **Rocky River**, in 1893. Lakeland found a little, rough "reefy" gold for 10km along the river. The gold was generally fine-grained (up to 3g) and had a high silver content. Patchy gold was found for 16 to 18km along the river. Soon, up to 50 miners were on the field; average returns were about 15g per man per day. At least a hundred miners were on the field in 1894 and two stores and two butchers' shops were erected at the main camp (Lakeland's Camp). Access to the field was by sea to a landing at the mouth of the Rocky River and a steep climb to the plateau of the McIlwraith Range.

The Rocky River Goldfield was proclaimed in August 1897. The field had an area of 464km^2 and took in the northern, western and southern watersheds of the Chester and Rocky Rivers. Apparently, the field was proclaimed to prevent the Chinese from working the 'alluvials'.

Contrary to previous reports, the field did not cover the Claudie Lakeland reef, which is to the north on Leo Creek. There is no record of any further mining being done in the field after 1897, and the exact location of the old alluvial diggings and associated reefs is not known. The total recorded alluvial gold production (1893 to 1896) was 38.8kg.

The **Claudie Lakeland** reef was discovered by W. Lakeland in 1895. It was thought to be in the Rocky River Goldfield, but the northern boundary of the field is to the

south along the divide between the Rocky River and Leo Creek. The reef is on Neville Creek, a tributary of **Leo Creek**.

Lakeland set up a 3-head, water-powered battery and reef mining began in 1896. In 1897, the battery was moved to its present site on Leo Creek. The remains of the waterwheel, gears, stamps and an old race can still be seen. The remains of a more recent iron sluice occur downstream of the battery site; the area may have been worked in the late 1930's to 1940's. There is no evidence of any workings in the alluvium of the creek and it is possible that the more recent mining operation involved the sluicing of tailings from the battery.

Most of the miners left in 1901, following the discovery of the Hamilton Goldfield. Recorded production from Lakeland's battery from 1896 to 1904 was 78.65kg of gold from 538t of ore. Almost all of this production came from the Claudie Lakeland reef.

In 1909, Evennett and party commenced work on the reef and rented Lakeland's battery. Hans Dehn and party also crushed small parcels of ore at the battery. The claims were called the Diamond King No.1 South and Diamond King PC, respectively. A production of 8.80kg of gold from 57t of ore was recorded for 1909 and 1910. The mine was apparently abandoned after 1910.

Downstream from the mine, Neville Creek and adjacent banks and gullies have been worked for alluvial gold. Numerous shallow pits and trenches have been excavated between a fairly recent camp site and a gully 50m to the north. The remains of a sluice were found in the gully. Reportedly, the gully returned $20 000 worth of gold in three months during the wet season of 1988.

Wallace Mining and Tri State Mining Ltd carried out alluvial gold mining on claims along the headwaters of **Skae Creek** in 1988.

Mullimbidgee (also referred to as Mullabidgee, Nullumbidgee, Nullabidgee, Nullubidgee and Allumbijee) was discovered and worked by members of the Creek family (for V. Moreland, Police Sergeant, Coen) soon after the Second World War. R.L. Jack had originally referred to this area as Goldhead. The total recorded production (1952 to 1957) was 2.2kg of gold from 7.0t of hand picked ore, which was treated at the Buthen Buthen battery.

Gold was reported from Hayes Creek as early as 1880 (Jack, 1922) and the area was being worked for alluvial gold in 1894. Dickie and Campbell visited the area during a prospecting expedition in 1907 and alluvial gold was worked in the same year. Preston, Dodd and Anderson took out a reward claim over the Golden Gate reef and the **Hayes Creek Provisional Goldfield** was proclaimed in 1909. The reefs are actually on Buthen Buthen Creek in the headwaters of the Nesbit River and the area has generally been referred to as Buthen Buthen to avoid confusion. Ore was produced from the Golden Gate and associated reefs from 1909 to 1914. By 1915, the field was deserted. T. Preston had a 2-head stamper battery on site in 1934. The Hayes Creek Development Company opened up the old workings in 1938 and set up a 3-head battery to provide additional crushing capacity. Recorded production for 1909, 1911 and 1914 was 11.13kg gold from >58t of ore, 1.71kg gold from cyanidation, and 0.37kg of alluvial gold.

Some prospecting continued up until 1938. From 1938 to 1942, 6kg gold was produced from 150t of ore. In the early 1950's, a small parcel of ore assayed 80 to 120g/t Au and one 4t crushing gave 0.2kg gold. Production for the field came from reefs at Buthen Buthen, the Hidden Treasure (Companimano Creek) and Woolan Munga.

In 1903, Richter, Dehn and party collected some rich stone from leaders close to the main reef on the Lone Hand PC; a crushing of 8t returned 690g of gold. This reef was on the **Battery Lease**, on Horse Creek, 56km north-north-west of Coen. In 1910, Mayers and Clausson worked the opencut. A 6-head stamper and a portable boiler were erected. A crushing of 102t returned 2.02kg of gold. Mayers abandoned the claim in 1911 because it was not payable. McEvoy and Lauder worked the August claim in 1912 and obtained 1.86kg of gold from 14.7t of ore. In 1913,

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Burgess and Ross worked the Homeward Bound claim, near the August, and a parcel of 18.8t of ore was crushed at Coen for a return of 2.22kg of gold.

William Baird made the first discovery of gold in the **Wenlock (Batavia) Gold and Mineral Field** at Retreat Creek (Bairdsville) in 1892. The field was abandoned in about 1894. Further prospecting from 1905 to 1911 disclosed several other small alluvial deposits in the general area (for example, Downs Gully, Choc-a-block Creek). The amount of alluvial gold produced from these areas up until 1910 has been estimated as 93kg.

In 1910, an Aboriginal prospector named Pluto located a shallow, narrow, but extremely rich lead of cemented wash at the base of Mesozoic sediments near the Wenlock River. The area became known as Plutoville or Top Camp and was rushed by miners from Coen and Ebagoola in 1911. The area was almost deserted by 1914, but sporadic mining activity continued until the 1920's. Total recorded production of alluvial gold was approximately 213kg. Some small reefs in the area (for example, the Golden Unit) were also worked to shallow depths.

A quartz reef called the "Main Leader" was discovered about 5km north-west of Plutoville in 1915 by Kitty Pluto (the wife of the discoverer of gold at Top Camp). The new find was called Lower Camp or Wenlock and the area was referred to as the Batavia Goldfield. The surface material and shallow alluvial ground were soon worked out and few miners were on the field from 1916 to 1922. A deep lead (the Main Lead) was found on the western side of the reef in 1922. Miners rushed to the field and the lead and reef were soon covered by numerous claims and leases. Underground workings on the Main Lead were up to 30m deep; the Main Leader was worked to depths of 100m.

Two batteries were installed at the mines during the latter part of 1932. The name of the goldfield was changed from Batavia to Wenlock in 1939. The Wenlock field was deserted during World War II. Claims along the Main Leader were amalgamated in 1946, when the main mines were the Black Cat Amalgamated (Fisher and sons), Wasp (Dickenson, Perkins and Hopkins), Black and White (Dickenson), Reform (Scrown), Golden Gate and Southern Cross (Macdonald) and Larsen's Consolidated (Zammits Prospecting Syndicate Pty Ltd). Operations ceased in 1952, partly as a result of flooding in 1950. The total production from Lower Camp was 936.6kg of alluvial gold (1184.0kg of bullion) and 297.9kg of reef gold (344.6kg of bullion).

In 1909, W. McLennan discovered an auriferous quartz lode 800m south-east of Lower Camp, but little work was done on **McLennan's Lode** until 1930, when Batavia Gold N.L. commenced prospecting and development work. W. McLennan worked the mine in 1932 and processed 46t of ore grading 60g/t gold through his one-head stamper in 1933. In 1934, Larsens Consolidated Pty Ltd erected a stone breaker, Huntington mill and Wilfrey table at the mine. In 1935, 814t of ore was produced, of which 437t was crushed for a return of 2.03kg gold. The mine was worked by opencut to a depth at which underground mining became more economical. In 1936, 500t of ore was stacked at the mill awaiting treatment. The total production of the mine is not known. The mill also treated approximately 4000t of ore carted from the Wenlock Goldfield. The production plant was moved to Wenlock in 1936 or 1937.

In 1936, H. MacDonald discovered the **White Heather** reef, 800m south of McLennan's Lode. In 1937 and 1938, 82t of ore (mainly surface stone) produced 1.5kg of Au.

Gold was first produced from the Iron Range district in 1933 and the **Claudie River Gold and Mineral Field** was proclaimed in 1936. Gold was mined at Iron Range, Scrubby Creek and Packers Creek. A stamp battery was erected at Scrubby Creek in 1935 and an Empire Mill commenced crushing in 1936 at the Gordon mine; two other batteries were erected in 1937. The Queensland Government erected a 3-head battery near the Hornet workings at Packers Creek. Total production up until 1942 was 333.1kg gold from 17 099t of ore and 3220t of tailings. Most of the production came from the Iron Range area, where the most productive reef,

Gordon's "Iron Range", produced 98.8kg. The field was closed in 1942 for the duration of the Second World War.

Between 1950 and 1953, the Cape York Development Company attempted unsuccessfully to develop a few of the mines. A small quantity of gold was being obtained from a mine at Packers Creek in 1967.

In 1980, Jahi Pty Ltd delineated proven reserves of 15 000t at 8.78ppm Au and 4250t at 8.49ppm Au in two lenticular zones at Scrubby Creek. United Reefs N.L. transported a CIP treatment plant to the site, but further exploration indicated that the mineralisation did not warrant mining.

Cape York - Oriomo Inlier:

Alluvial gold was discovered in the eastern part of Horn Island by Smyth and party in 1894; the **Horn Island Gold and Mineral Field** was proclaimed and reef mining began in the same year. Recorded production was 31.07kg of alluvial gold from 1894 to 1896 and 176.67kg of gold from 16 904t of ore from 1896 to 1900. Mining was carried out by prospectors and small syndicates; a small 5-head stamper and Berdan pans were used to treat the ore.

The Horn Island Gold Mining Company procured Smyth and party's claims in 1900 and erected a large and costly crushing plant. The company mainly worked the Band of Hope and Welcome reefs but only 25.3kg of gold was produced from 9819t of ore and operations ceased after a short time. The field was practically deserted by 1901. Cockburn and party worked the Glenmire and Monkland leases from 1904 to 1907. In 1908, the Narupai Gold Mining Company worked surface material. Sporadic production continued up until 1920. Prospecting and exploration work were carried out on the Welcome lease and minor production occurred in 1941.

Torres Strait Gold Pty Ltd explored the goldfield and opened up the **Horn Island Gold Mine** in 1987. Mining was by opencut and treatment by fine grinding, flotation and carbon-in-leach. Some alluvial gold was also recovered from gullies draining into Spring Creek. The first gold pour was in July 1988 and commercial operations commenced in January 1989. The mine closed in December 1989 due to lower than expected ore grades and the collapse of the parent companies (Augold N.L. and Giant Resources Ltd). The leases were forfeited and the Department of Minerals and Energy has decommissioned the mine and is rehabilitating the site. Total production (1988 to 1989) was 1432kg of gold bullion (52% gold). The area actually mined was only a small portion of the historic goldfield.

Gold was discovered in the north-western part of Possession Island by J. T. Embley in 1896 and the **Possession Island Gold and Mineral Field** was proclaimed. Embley held a reward claim and erected a small 5-head stamper battery with two Berdan pans. Gold production began in 1897. E.T. Cadzow took up a claim in 1902 and mining was carried out until 1906, when the leases were abandoned. Attempts to reopen the workings in 1919 and again in 1934 and 1935 were unsuccessful. Total recorded production (1897 to 1905, 1919) was 113.1kg of gold bullion from >4261t of ore. In 1903 and 1904, 54.49kg of gold bullion was produced from the Horn Island and Possession Island fields; most of this production probably came from Possession Island.

Minor amounts of gold were reportedly won on **Hammond Island** in 1907 to 1909 and on **Thursday Island** in the 1930's.

Hodgkinson Province:

In 1872, William Hann led an expedition into Cape York Peninsula to investigate the mineral and pastoral potential of the region. Frederick Warner, a surveyor, was credited with the first discovery of gold on the **Palmer River**. The reported occurrence of gold over a wide area along the Palmer attracted the attention of miners in the Georgetown area. In 1873, a group of prospectors led by James Venture Mulligan spent two and a half months prospecting along the Palmer and its tributaries, during which time 102ozs of gold was recovered. The group returned to Georgetown to report the discovery and to claim the Government reward of 1000 pounds for discovering payable gold in a new field. Their report sparked the greatest gold rush ever seen in Australia. Maytown sprang up and became the administrative centre for the whole of the Peninsula. Smaller settlements such as Lukinville, Palmerville, Echo Town, Revolver Point, German Bar, Stonyville, Byers-

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town and Uhrstown were established in outlying areas. Cooktown was established at the mouth of the Endeavour River to service the goldfield and, within months, became one of the busiest ports in Queensland.

Alluvial gold mining commenced soon after the announcement of Mulligan's find and the **Palmer Goldfield**, covering 8934km^2, was gazetted in November 1873. Alluvial deposits were mined in the North Palmer, Palmer, South Palmer and West Normanby Rivers and their tributaries, and in the headwaters of the Mosman River and Kennedy Creek. Gold was readily recovered from shallow alluvium at depths of <1m, and the average daily yield was 70g per miner. Adverse conditions, including water problems, remoteness and the high cost of cartage and supplies, prevented the rich ground from being worked out within the first year of discovery. By 1874, it was estimated that 10 000 miners were on the field. By the end of 1875 many outlying creeks and gullies were also being worked and the population was approaching 20 000. In 1877, >90% of the population was Chinese. By the end of 1883, most of the alluvial gold had been worked out and the Chinese population had dropped to about 1000. Aspects of the colourful history of the Palmer Goldfield have been recorded by Holthouse (1967).

The lodes in the Maytown district were probably mined soon after the depletion of the alluvial ground in 1875. Lode production, totalling 4340.5kg, came mainly from the Maytown and North Palmer districts and peaked in 1888/1889. Very little mining was done after 1893.

It is not known which lode was discovered first at Maytown, although in 1876 the Ida was credited as being the first mine in the district to have its ore crushed. The Louisa, Queen of the North, King of the Ranges, Albion-Caledonian, Alexandra and Rob Roy were among the earliest discoveries, followed by the Hart's Content, Recompense, Lord Nelson and others. Lodes were also mined in the North Palmer River area (Mount Atlas, Jessops Hill, Princess Midas, British Lion, Baal Gammon and Wild Irish Girl). Gold was also mined from palaeochannels in conglomerate beds at the base of the Mesozoic sequence in the Conglomerate Range area.

In 1897 and 1899, Jack reported that the production from Maytown came mainly from narrow quartz lodes grading 30 to 60g/t (1 to 2 ounces per ton). Richness rather than size appears to be a characteristic of the majority of the lodes worked. Most of the lodes were mined out above the water table within twenty years of their discovery. By the end of the 1880s, many mines were forced to close due to the high cost of deeper development. Cyanide treatment of tailings met with some success in 1898. Most miners had left the field by the end of the 1890s. From the early 1900s to the 1980s, many attempts by companies and syndicates failed to de-water and re-open the mines.

The fate of lode gold mining in the Maytown district was finally sealed by the outbreak of World War II. Between 1945 and 1989, <2kg of lode gold was produced.

The official production of that part of the Palmer Goldfield in the CYPLUS area, is estimated to be 30 709.4kg of alluvial gold and 4340.5kg of lode gold from 1874 to 1980, but the total yield was probably much higher. More than 90% of the gold came from alluvial sources along the Palmer River and its tributaries. The most productive period was between 1874 and 1882. Peak production was in 1875, when 7750kg gold was won from alluvial deposits. Alluvial gold output declined steadily from about 1000kg in 1882 to 100kg in 1890. Between 1891 to 1908, the average yield was about 50kg per year. Apart from a small revival in production, averaging about 24kg per year during the depression years from 1931 to 1934, the average yearly production to 1979 was about 1kg of gold. The last production recorded in the Annual Reports of the Department of Mines was 37kg in 1980.

In the late 1970s, a number of companies mined alluvial gold in the Palmerville, Mammoth Bend and Four Mile Bend areas on the Palmer River and on the West Normanby River.

In the early 1980s, a sharp increase in the gold price drew the attention of Australian Diversified Resources Ltd and Rimeki Pty Ltd to the area. Subsequently, these companies (in joint venture with AUR N.L.) mined McGann, Stony and Sandy

Creeks, and the gullies draining Mount Madden. Alluvial gold output increased sharply from 1985. Production by these companies was 1190kg from 1985 to 1989.

Falling tin prices in the mid 1980's compelled many alluvial tin miners to rework the Palmer River and its tributaries for gold. Early results were mixed, mainly due to competition for ground and the inefficiency of converting tin concentrators to trap the very fine-grained gold in the river wash. Lam & others (1991) estimated that >2500kg of gold was produced from the Palmer Goldfield from 1980 to 1990.

In 1986, an area from the Palmer River (including the old Maytown township) to north of the R.L. Jack memorial on top of the Conglomerate Range was proclaimed as the Palmer Goldfields Reserve. The reserve is jointly administered by the Department of Minerals and Energy and the Department of Environment and Heritage (Queensland National Parks and Wildlife Service Branch).

Alluvial gold was discovered in the **West Normanby River** around 1876 during the rush to the Palmer Goldfield. Early mining was hampered both by a lack of water and by the resistance of the indigenous inhabitants. In 1878, a ten-head stamp battery was erected at the West Normanby field. However, no official production figures were recorded for the early mining period, as the find lay outside the then boundaries of the Palmer Goldfield.

In 1884, the Palmer Goldfield boundary was altered and expanded to include the West Normanby River. Some of the leading gold mines in the West Normanby field at that time were the Monte Christo, Star of Normanby, Isabella, Edna, Emily, Poverty and Zig-zag. The Monte Christo produced 36.1kg of gold from 352t of ore in 1885 and 1886. Most of the lodes were mined to just above the water table, as the miners had no means of coping effectively with excessive ground water. By 1898, most of the miners had left the field and did not return until further discoveries were made.

The Brothers deposit was discovered around 1900 and a small quantity of gold was recovered by hand dollying of hand-picked ore. Between 1903 and 1906, approximately 18kg of gold was recorded for the West Normanby River area; the Brothers deposit would have been one of the major contributors. In 1906, a two-head Tremaine steam stamp battery was installed at the Brothers mine to service the field. The Brothers battery treated approximately 600t of ore and produced 20kg of gold between 1906 and 1916. From 1916 onwards, virtually no mining was carried out in the area, until increasing gold prices in the 1970's revived exploration interest in the field.

Recently, there has been a revival of lode gold mining in the West Normanby field.

The occurrence of gold in the McIvor River valley was known at least as early as 1878. Gold-bearing quartz reefs were discovered at **Cocoa Creek** in 1890. Six leases were being worked in 1891 but, by 1893, all except one were abandoned. The workings were on the First Call Reef. The **Starcke No. 1 Goldfield** was gazetted in 1895. Webb and party erected a 5-head battery in 1893. Stibnite lodes were found in 1893 but no antimony production was recorded. Gold production from 1892 to 1896 totalled 34.5kg from 1157.2t of ore. An English firm took over the leases in 1906 but results were disappointing and the mine was closed down. The winding gear was moved to the Starcke Consols at Munburra in 1908. An attempt was made to treat eluvial and alluvial gravels in 1987, but poor recoveries and equipment failure led to closure of the operation.

In 1921, gold was discovered south of **Six Mile Creek**, about 9km west-south-west of Cooktown. The discovery was made by C.H. Holmes and party, while searching for sandalwood, and the Mundic King prospecting area was subsequently taken up. A large outcrop of antimony ore was also discovered at the same time. A 5t trial shipment of ore sent to the Chillagoe State Smelter yielded 635g of gold. A 5-head battery from the Queen of the North mine near Maytown was installed in 1940 and the lode was worked as the R.B. Mine by Ryder-Bailey and Bott. It was also referred to as the Perseverance or Lady Annie Claim. From 1939 to 1948, 106t of ore was treated for a return of 2.05kg of gold. The lease was forfeited in 1953. During 1987 and 1988, the mine was worked intermittently on a small scale under

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tribute using a simple crusher and sluice arrangement; no production figures are available.

Cairns and Bowden discovered alluvial gold at the head of Diggings Creek (**Old Starcke Camp**) in 1890. Nuggets of up to 1.15kg were found. Although a total of 71.5kg of gold was recorded from here from 1890 to 1895, the field was never officially reported as being "payable". The alluvial workings were abandoned in 1895.

In 1896, the Webb brothers discovered payable alluvial gold in Kitty Gully, 7.5km west-north-west of Old Starcke Camp, while on a prospecting expedition subsidised by the Queensland Government. Another gold rush commenced and >70 men were on the field by mid-September. Officially, the new discovery was known as **Munburra**, and the **Starcke No. 2 Goldfield** was proclaimed in 1898. Munburra was a surveyed township site, with a Post Office, store and battery. Total recorded alluvial gold production (1896 to 1898) was 46.0kg. This figure probably includes dollied gold won from the rich caps of the reefs in the area.

The first gold-bearing quartz reef (Butchers) was found at Munburra in 1898 and a 2-stamper battery was erected in the same year. A second battery was erected in 1899 but was later removed to the Hamilton Goldfield. Because no cash reserves had been set aside, it became evident as early as 1901 that little more could be done by the individual miner and attempts were made to interest outside capitalists in the field.

Several companies, including the Queen Alexandra Company, Starcke United Gold Mining Company, Starcke Consols Syndicate and Gladstone Gold Mining Company worked the reefs up until mining ceased in about 1913. The main factors leading to the closure of the mines were poor management, the small size of the payable ore bodies, difficulties in mining below the water table, high cartage costs, and poor recovery from the battery.

The total recorded production from the Munburra reefs from 1898 to 1913 was 314kg of gold from 5964t of ore plus 2.2kg from the cyaniding of 457t of tailings in 1913. Almost half of the production (144kg of gold from 2157t of ore) came from the Last Hit reef. Other important producers were the Boomerang, Gladstone, Monte Carlo, Queen Alexandra and Rio Tinto.

Work was carried out on the Old Starcke Consols claim in 1932 to 1939 but no production was recorded. In 1980, M.P. Hoy was granted ML2874 (Cairns) over the Last Hit, Boomerang and Queen Alexandra workings and mining claims over the Rio Tinto and near the Last Hit workings. Hoy set up a one-head stamper and recovery plant near the Last Hit Mine and sank a number of new shafts. He obtained ore from the Last Hit, Boomerang and Rio Tinto reefs. In 1983, Amlex Pty Ltd subleased ML 2874 and carried out alluvial mining along Kitty Gully. R. and P. Gresinger took over the sublease and carried out some alluvial mining in 1985.

TIN

Northern Coen Inlier:

Cassiterite was first discovered in **Granite Creek** (also known as Tin Creek), near the Archer River, by Bush, Mayers, Wilson and others in about 1887. The tin price was low and the area was abandoned until 1906. A small settlement was erected in 1907. Total recorded production (1907 to 1931, 1938 to 1940) was 120t of cassiterite concentrates.

In 1977 and 1978, the Cook brothers mined alluvium in the eastern side gullies of Granite Creek under tribute to H. Kelleher. At the time, the operation was one of the largest in the Cooktown Mining District and produced 214t of cassiterite concentrates. Other leases held by Kelleher covered the bed of Granite Creek itself but the cassiterite was reportedly too fine-grained to be recovered with the existing plant.

Up until the early 1980s, very small amounts of cassiterite were recovered from **Wet Creek** by I. Pratt.

Small deposits of alluvial cassiterite have been worked in the **Tin Creek** and **First Stony Point** areas, north of the Pascoe River. Total recorded production (1900 to 1928, 1938 to 1940) was 14t of cassiterite concentrates. The Stony Point Tinfield is believed to have been first worked prior to 1887 and has been worked by gougers several times since then. R. Hudson worked the field in the 1980's with little success. Along the upper reaches of Tin Creek, four shafts and a 1.6km long race were excavated in the early days. In 1962, E. Densley held a lease over the old workings but little work was done.

Cape York - Oriomo Inlier:

Alluvial and vein cassiterite deposits were found on **Cape York** by Bromage, Holland and Miller in 1948. From 1950 to 1986, >21.5t of cassiterite concentrates was produced from alluvium and beach sands between Punsand Bay and Laradeenya Creek. Most of this production came from small rich pockets at the head of the beaches along Punsand Bay.

Following successful trial crushings at Irvinebank in 1952 of parcels of ore from Holland's Reef, in the hills south of Punsand Bay, the Queensland Department of Mines erected a small 3-head battery on Holland's lease in 1953. From 1952 to 1979, at least 15.6t of cassiterite concentrates was produced from a number of quartz lodes (Bell May, Bluff Quarry, Booty Mine, Bromage Gully, Holland's Reef (Ginger Dicks), Little Bootie, Lois' Reef, and Northern Mine (Mulhollands)).

Hodgkinson Province :

In the **Palmer Goldfield**, alluvial gold miners found cassiterite associated with gold in alluvium in **Cannibal and Granite Creeks**, south of the Palmer River, in 1873 and 1874. Mining did not commence until 1876, following a rise in the tin price in 1875. No official production records are available for the early years.

In 1879, extended areas were opened to the alluvial tin miners, resulting in a peak production of >1000t of cassiterite concentrates for the years 1880 and 1881. By the end of 1884, 2260t of concentrates had been produced. Sporadic mining was carried out along Cannibal and Granite Creeks and their tributaries from the early 1900s to the 1960s. Alluvial tin production increased significantly in the 1970s, following rising tin prices, and peaked in the mid-1980s. Granite and Cannibal Creeks were mined by Buddha Gold Pty Ltd, Frost Enterprises Pty Ltd, Mirrajong Pty Ltd and Rosella Mining Pty Ltd. Alluvium from Nine Mile and Tin Creeks was hauled to a processing plant at the Adams mine. Alluvial tin was also mined in Fiery Creek. However, the production for the area is not known because only the overall production of the Mareeba Mining District was recorded. No alluvial tin mining has been recorded from Granite and Cannibal Creeks since 1986.

Cassiterite-bearing quartz greisen lodes were discovered at Granite Creek, probably prior to 1876; 3.5t was produced in 1880. Other lode systems were soon discovered at Cannibal Creek. By 1882, Cannibal Creek became the main lode tin producing centre. However, an unexpected price collapse in 1883 forced the closure of the mines. In 1969, Frost Enterprises Pty Ltd mined the lodes at Cannibal Creek and produced 34.1t of cassiterite concentrates from 37 515t of ore. Mining ceased in 1970 because of diminishing ore grades.

In 1885, alluvial cassiterite was discovered in Wallaby Creek and the upper Annan River valley. Within a year, alluvial tin was being mined at several localities between Mount Amos and Mount Romeo, in the **Cooktown or Annan River Tinfield**, and lode mining had commenced at Mount Amos. By 1887, mining had commenced at almost all of the deposits which were to become established mining centres. Because of the mountainous terrain, only small scale mining was possible in most areas. The main mining centres were at Rossville, Helenvale, Shiptons Flat, Tabletop, Little Tableland, Big Tableland, Mount Leswell, Mount Hartley, Mount Amos, Mount Finlayson, Mount Romeo, Mount Poverty and Slatey and Granite Creeks. The main centres for lode mining were Mount Amos (Phoenician and Dreadnought mines), Big Tableland (Lion's Den mine), Mount Leswell and Collingwood.

Production reached a peak in 1888, when 1034t of cassiterite concentrates was won by 800 miners. The Cooktown Mining Field was gazetted in 1889. Dredging was attempted in 1892, but this and later attempts were unsuccessful. Most of the tin was obtained by hydraulic sluicing of alluvium, colluvium and decomposed (al-

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tered) granite. Water was obtained by elaborate systems of water races (and sometimes tunnels) tapping water from streams and dams at a high enough level above the workings to provide sufficient head pressure. The rugged, heavily forested terrain restricted the profitability of anything other than small-scale operations. The rich surface deposits were soon depleted by individuals and small parties.

The Annan River Company N.L. and others commenced large-scale sluicing operations in 1905. The largest mines were the Collingwood Face, Daly's Face and Home Rule. Annual production steadily declined and by the early 1960s averaged 20t.

In the late 1970s and early 1980s, small-scale mining again began throughout the field, together with moderately large-scale alluvial operations by Terrax Resources N.L. at Rossville and Serem Australia Pty Ltd at Lee Creek. Production rose significantly to peak at 250t in 1981. The dramatic fall in tin prices in the mid-1980s caused most tin miners to seek alternative employment.

From 1885 to 1992, the total cassiterite production from within the CYPLUS area was 12 850t, which included 272t of lode tin. There has been little tin mining carried out since the mid-1980s.

Alluvial cassiterite was discovered on the **Mount Windsor Tableland** around 1890. Mining was carried out by sluicing the large volumes of granitic alluvium in tributaries and gullies of Piccaninny Creek. The cassiterite was reported to have a high tin content and approximately 90t of cassiterite was produced from 1909 to 1932. Mining has been sporadic since 1932.

Alluvial cassiterite was also found in Campbell and Flaggy Creeks. Sixteen tonnes of cassiterite was recorded for the Campbell Creek area from 1911 to 1915 and 4t of cassiterite was reported to have been produced from the Mountaineer lease in the 1960s.

The Stephanie mine at Lang Creek was discovered by Arthur G. Hine in July 1965. Mining was carried out soon after discovery. Old workings include an opencut and an adit on top of a ridge. No official production figures are available and the mine has been idle since the 1980s.

Cassiterite was found in alluvial and colluvial deposits on **Howick Island** in 1912, but prospects at the surface did not appear promising. A production of 203kg of concentrates was reported for 1921. Idriess (1938) reported that at least 0.5t of cassiterite was produced, but these figures were not recorded in the official Warden's reports.

The **Barrow Point** area was prospected by Broken Hill Pty Company Ltd in 1937. In 1939, Thom and Wright recovered 254kg of alluvial cassiterite concentrates from creeks draining west from granite hills near Barrow Point. They were forced to cease prospecting because of a lack of fresh water and difficulty in obtaining supplies by sea.

TUNGSTEN AND MOLYBDENUM

Northern Coen Inlier:

Wolframite was discovered north of the Kennedy Road crossing of the Pascoe River by William Lakeland and William Bowden in 1892, but claims were not taken up until 1904. The **Bowden Mineral Field** was proclaimed in 1907; an influx of miners followed a rise in the wolfram price. Between 1904 and 1916, 70.1t of wolframite concentrates was produced. The only production recorded from the field since the First World War was 177.8kg of concentrates in 1952.

A small shaft on **Rocky Island** at Portland Roads is reported to have been worked for wolframite.

A small deposit of wolframite and molybdenite on the **Grand Final** lease, approximately 11km east-north-east of Coen, produced a total of 5.8t of wolframite concentrates in 1904, 1916 to 1918 and 1952. From 1915 to 1917, 130kg of molybdenite was also produced.

Cape York - Oriomo Inlier:

From 1938 to 1955, the local inhabitants mined wolframite by hand picking and gouging shoad and quartz reef deposits at three main localities (Eet Hill, Blue Mountains, and near Kubin Village) on **Moa Island**. Total recorded production was 100.6t of wolframite concentrates, most of which was obtained during the Second World War and the Korean War, when the wolframite price was high.

In 1951, 27kg of wolframite concentrates was mined on **Portlock Island**, 4.5km north-east of Moa Island.

Hodgkinson Province:

Wolframite was discovered on **Noble Island** in 1900 and Troup and party secured two leases over the deposits. Crammond and Formasini worked the deposit from 1904 to 1909. Ore was collected by picking it out of narrow veins on or near the surface. The total recorded production (1904, 1905, 1907 to 1912, 1916) was 18.7t of wolframite concentrates.

Idriess (1938) mentioned that wolframite-bearing veins occur on top of the hill on **Howick Island** and recorded that at least 250kg of wolframite was produced. However, this production was not recorded in the official Warden's reports.

Wolframite has been produced from two mines in the **Cooktown Tinfield**. H.C. Worrall worked the Bonny Boy claim at Clearwater (Romeo area) from 1955 to 1957 and produced 7.1t of wolframite concentrates. A wolframite lode was discovered at Mount Hartley in 1889 and was first worked by Symons, Fletcher and Dibney. This lode produced 1.2t of wolframite concentrates.

Approximately 15km south of Palmerville, scheelite floaters in creek beds were recorded in the early 1900's. No other discoveries were made until 1968, when Frost Enterprises Pty Ltd discovered tungsten lodes at **Spring Creek** and **Mount Hurford**. The scheelite lodes at Mount Hurford were considered to be uneconomic to mine. The Spring Creek deposit (Keddies Lode) was mined in 1969 and 1970. Production was 5966.7t of scheelite concentrates. Mining ceased in 1970 due to a low market price for tungsten ore.

COPPER

Hodgkinson Province:

Copper-stained outcrops were first worked at the **Glenroy Copper mines**, north of Palmerville, in 1906 and 1907 by Christie brothers, Hamilton, Baker and Morrison. Shallow prospecting shafts were excavated but there is no record of any production.

Copper mineralisation was discovered at the **St George Copper mines**, north of Palmerville, in 1905. The St George Copper and Coal Company prospected for copper and mercury and produced 5t of 24% copper ore from 1905 to 1907.

The **Dianne Copper Mine** deposit was probably discovered by prospectors in the early 1880's. The lode was mined from two shallow shafts and an adit but no production was recorded for this early mining period. Due to the remoteness of the deposit and high freight costs to Cooktown, the copper ore was uneconomic to mine.

Mr R. Keddie was guided to the prospect in 1958. Uranium Corporation carried out exploration work to assess the deposit in the same year; exploration results were inconclusive.

In 1968, North Broken Hill Pty Ltd carried out core drilling on behalf of the lease holders and calculated reserves of approximately 451 000t of oxidised copper ore at 0.86% copper. No mining was carried out as the reserves were below the company's target. Kennecott Exploration Pty Ltd carried out further drilling in 1969.

Mareeba Mining and Exploration Pty Ltd took out an option over the deposit and calculated reserves of 90 000t of supergene ore at 24% copper. The company acquired the deposit in 1979 and commenced developmental work. Production from 1979 to 1983 was 69 820t of direct shipping grade ore assaying 18 to 26% Cu and 359g/t Ag (Wallis, 1993b). The secondary copper ore was mined to a depth of >90m, where it gave way to primary massive sulphide ore. Most of the ore was

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not treated at the mine, but trucked by road to Cairns for direct shipment to Japan and Korea. Because of the fall in world copper prices in 1982 and depletion of reserves, Mareeba Mining decided to terminate the operation, leaving 20 000t of unrecovered ore. Plant, equipment and infrastructure were sold and removed.

ANTIMONY

Southern Coen Inlier:

John Dickie discovered an antimony deposit **near Kimba Homestead**, 30km east of the Alice River Gold and Mineral Field, in 1907. Cherry (1907) described several antimony occurrences within 2.5km of the main (Dickies No. 1 or Packsaddle 1) deposit. Old workings occur at some of the deposits but no production has been recorded.

Hodgkinson Province:

Stibnite occurs in some of the gold-quartz veins at **Cocoa Creek**, but attempts to recover the mineral were not successful.

Antimony ore was discovered in a group of gold/antimony lodes at **Six Mile Creek**, 8.0 to 9.6km west of Cooktown in 1902, but practically nothing was done at that time. Holmes' Antimony lode was worked in 1921, but there is no record of any production. The Good Luck reef was worked by Bott, Butcher and Bennett in 1942. A trial parcel of hand-dressed antimony ore was sent to Sydney but returns did not indicate very high grades. In 1944 and 1945, 7t of ore was treated in Sydney for a return of approximately 4t antimony.

In 1906, a trial shipment of 9t of 9% antimony ore was produced from the **Uncle Sandy Mine**, near Munburra in the Starcke No. 2 Goldfield.

SILICA SAND

Hodgkinson Province north of Cooktown:

The dunefields at **Cape Flattery**, north of Cooktown, were first described by Captain James Cook in 1770. Interest in the potential of the dunes as a source of silica sand was instigated by a Sydney-based consultant, F. Beggs, in 1964, after identifying potential Japanese markets. Cape Flattery Silica Mines Pty Ltd was formed and confirmed the presence of extensive deposits of high quality silica sand suitable for glass manufacturing and foundry sand. A bulk sample was sent to Japan; a contract was negotiated for the supply of 340 000t of silica sand over three years; the company obtained a number of leases from F. Beggs; and mining commenced in 1968.

Mining was originally by dredging at Mount Mitchell. The sand was beneficiated on site, trucked to a wharf at Cape Flattery, and transported by barge to ships for export. In 1987, dry mining commenced at Airport Lake. Total recorded production from 1968 to June 1993 was 14.8Mt. All production has been for export for the glass making and foundry industries.

HEAVY MINERALS

In 1992, Saracen Minerals N.L. produced 293t of ilmenite and 19t of monazite as a by-product of gold mining at **Oscar Creek**, near Coen. These minerals were sold for use in sand blasting at Weipa.

BAUXITE

The conspicuous red cliffs along the western coastline of Cape York Peninsula were first recorded by Matthew Flinders in 1802; references to laterites in the general area were made by R.L. Jack in 1880 and C.V. Jackson in 1902. The extent and economic potential of the bauxite deposits on the west coast of Cape York Peninsula were first recognised by H.J. Evans in 1955 while carrying out a regional reconnaissance for oil.

In 1957, the Queensland Government and Commonwealth Aluminium Corporation Pty Ltd signed an agreement (the Commonwealth Aluminium Corporation Pty Ltd Agreement Act of 1957) to allow the company to develop the deposits and construct the mining town of **Weipa**. Comalco Aluminium Ltd was formed in 1960 and the first commercial shipment of bauxite was made in 1963. In 1970, a bauxite calcination plant was commissioned; it is the only one of its kind in Australia.

Total bauxite production from 1960 to 1993 was 206Mt of beneficiated and calcined bauxite. Mining has been carried out on ML7024 (previously Special Bauxite Mining Lease No. 1).

KAOLIN

Kaolin was found shortly after the discovery of the **Weipa** bauxite in 1955. In the early 1970's, samples of kaolin were tested for use as a refractory calcined clay, which could be produced in the bauxite calcination kilns at Weipa. Towards the end of the 1970's, it was recognised that the kaolin had potential for use in the paper industry as a filler and for coating. A processing plant was constructed and the first kaolin mined in 1985 (Schaap, 1990). The first shipment to Japan was made in 1987/88. Total recorded production from 1986 to 1993 was 583 481t.

MICA

A small muscovite mine was worked near the **headwaters of the Morehead River**, 12.8km west-south-west of Dixie Homestead, from 1941 to 1943. In 1942, a parcel of a few hundred kilograms was made up from 3.5t of split mica and sent to Melbourne. The mine was closed by 1944.

PHOSPHATE

Cape York - Oriomo Inlier:

Small guano deposits were reportedly worked on Raine Island, Booby Island and Bramble Cay, probably in about 1878.

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CURRENT MINING ACTIVITY

The total value of mineral production from the CYPLUS study area in 1992/93 was $262 316 587; almost all of this came from Weipa and Cape Flattery. A listing of Mining Leases, Claims and Mineral Development Licences (current as at March 1994) is given in Appendix 1. Current tenure details for the CYPLUS area are available from the Mareeba District Office of the Department of Minerals and Energy.

BAUXITE

The only producing bauxite mine in the area is **Comalco Aluminium Ltd's** operation at **Weipa**, which is the largest single bauxite mining and shipping centre in the world. The metal produced around the world from Weipa bauxite each year is worth more than $4 billion (White, 1991).

The company owns and operates a smelter at Bell Bay in Tasmania, and semi-fabricating facilities in Australia, New Zealand and the United States. It has consortium interests in bauxite mining in Guinea, West Africa, in alumina refineries at Gladstone and in Sardinia (Italy), and in aluminium smelters which it manages at Boyne Island in Queensland and Tiwai Point in New Zealand. It has been carrying out a joint study with Alcan on the feasibility of a new Queensland alumina refinery based on Weipa bauxite. The recent purchase of the Gladstone power station by Comalco will lead to an expansion of the Boyne Island smelter facilities.

Bauxite mining is carried out by Comalco at Weipa and in the Andoom area, 19km north of Weipa. Approximately 70% of all bauxite mined at Weipa comes from Andoom. It is a simple opencut operation. Scrapers remove the topsoil and front-end loaders pile the ore into 150t bottom dump trailers. The ore is washed and sized at a beneficiation plant and then transported by ship to refineries in Australia and overseas. About 70% of the beneficiated bauxite is sent to the Queensland Alumina Refinery at Gladstone; the remainder is exported to Europe, USA, USSR and Japan. Future markets include Korea, where agreement has been reached to supply bauxite to a hydrate plant. The current bauxite product is obtained by blending Weipa and Andoom ore to give a composition of approximately 54.5% Al_2O_3 and 5.4% SiO_2. A low-iron variety is mined for production of calcined bauxite for synthetic corundum feed for the abrasives industry.

Total production in 1992/93 was 8 590 724t of beneficiated bauxite ($197 670 085) and 179 494t of calcined bauxite ($20 339 211). In its 1992 Annual Report, Comalco reported total bauxite reserves of 248Mt (at >50% Al_2O_3) and a total resource of 3700Mt for its ML7024 (formerly SBML1).

SILICA SAND

The **Cape Flattery Silica Mine** is owned and operated by Cape Flattery Silica Mines Pty Ltd, a wholly owned subsidiary of Mitsubishi Trading Company. Sand is end loaded onto an advancing portable conveyor belt, beneficiated in a stationary central mill by washing and heavy mineral separation, and dewatered and stockpiled using a mobile stacker cyclone. A mobile reclaimer loads stockpiled sand onto a conveyor for transport to a new wharf on the southern part of Cape Flattery headland. The wharf is capable of handling Panamax vessels of up to 70 000t capacity.

Cape Flattery Silica Mines Pty Ltd has proved reserves of 200Mt under mining lease (Cooper, 1993d); the potential resource in the area would be much greater. The optimum source of white silica sand is the bare apical mounds of elongate parabolic dunes. The grain size distribution is particularly suitable for glass manufacture and foundry moulding. Cooper & Sawers (1990) gave a chemical analysis

for export quality sand of 99.82% SiO_2, 0.01% Fe_2O_3, 0.05% Al_2O_3, 0.02% TiO_2, <0.01% CaO, <0.01% MgO and 0.10% loss on ignition.

Total production in 1992/93 was 1 801 048t, valued at $21 317 096. All production is exported to Japan, Korea, Taiwan and the Philippines for glass manufacture (60%), foundry purposes (30%) and the chemical industry (10%).

KAOLIN

Kaolin is mined by **Comalco Aluminium Ltd** at **Weipa**. Total production in 1992/93 was 131 614t of kaolin valued at $20 726 799.

The kaolin occurs in the pallid zone of the laterite profile and is mined from areas after the overlying bauxite has been removed. The deposits are discontinuous clay lenses approximately 2 to 3km long, 300m wide and 4.5m in average thickness.

The crude kaolin ore contains 80 to 90% kaolinite, 5 to 15% quartz sand, 0.1 to 0.3% hematite, 1 to 2% anatase and 1 to 3% muscovite. Accessory minerals include zircon, tourmaline, leucoxene, rutile, ilmenite, goethite, sphene, siderite, magnetite, apatite, monazite, andalusite, staurolite, spinel and halloysite (Schaap, 1990). The processing plant accepts the material as a slurry from a classification plant near the mine stockpile. After electromagnetic separation of iron impurities, a kaolin cake is produced by extraction of the residual water. This cake is dried to coarse kaolin beads by blasts of hot air. The beads are then exported, mainly to Japan.

The deposit has proved and probable reserves of 17.8Mt, with a further 5.7Mt of possible ore available. Total resources may be as high as 50Mt (Cooper, 1993c).

GOLD

There are no large gold mines or prospects in the study area, but numerous small alluvial operations are current. Total production of gold bullion (alluvial and lode) in 1992/93 was 155kg valued at $2 223 934.

Small to medium-scale alluvial gold mining is being carried out along the Palmer River and its tributaries from the Strathleven area upstream to the headwaters of the Palmer and South Palmer Rivers.

As well as alluvial mining, underground mining of auriferous quartz veins is being carried out in the West Normanby River area.

Small-scale gold mining is also carried out in the old Starcke Nos 1 and 2 Goldfields, and the Ebagoola, Coen and Alice River Goldfields.

BUILDING STONE

A number of small-scale **slate quarries** or pits have been developed between the St George and Palmer Rivers on Maitland Downs Station. Most of these quarries are worked intermittently due to poor access in the wet season. The larger operators include Mr R.D. Joseph, River of Gold Slate Company, Rogina Stone and Slate, and Palmer River Slate. The slate has a phyllitic sheen and is brown to dark grey; yellow to red colouration is common in the more highly weathered surface deposits. The stone is marketed in the Cairns area as random and crazy pavers and for landscaping (Trezise, 1990). High overheads associated with remote location and generally lower quality stone reduce its competitiveness with many cheaper imported slates. Total production in 1992/93 was 55t of slate valued at $39 462.

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TIN

The study area has been an important producer of tin and contains a number of significant tin deposits. The main impediment to development of these deposits is the continuing depressed state of the tin market. Total production in 1991/92 was 0.106t valued at $465. No tin concentrates were produced in 1992/93.

Small-scale mining is still carried out intermittently at Mount Poverty and at Nolan Creek near Rossville.

RECENT EXPLORATION

The results of company exploration in the CYPLUS area have been described in detail by Culpeper & others (1992a) and are given in the mineral occurrence reports for individual Sheet areas. Denaro & Shield (1993) have summarised the results of coal and petroleum exploration.

Prior to 1969, company exploration focused mainly on heavy minerals along the coastline, alluvial gold and heavy minerals in the drainage systems, bauxite on the west coast, and silica sand in the Cape Flattery area. In the early 1970's, investigation of the bauxite deposits continued. Exploration was also carried out for base metal deposits in the southern Coen Inlier and for alluvial gold and tin. Much of the exploration of the late 1970's was for gold, uranium and base metal deposits in the Proterozoic inliers, although the search for alluvial tin, gold and heavy mineral deposits continued.

In the early 1980s, exploration was directed towards alluvial and lode deposits of gold and tin. In the late 1980s, almost all exploration was for gold; some exploration was for heavy minerals (for their rare earth elements content), silica sand at Cape Flattery and Shelburne Bay, and kaolin on the west coast.

Recently, exploration focused on the base metal potential of the Coen and Yambo Inliers. Exploration has also been carried out for hard rock gold deposits in the Coen and Ebagoola Goldfields, for alluvial gold in the Palmer Goldfield, and for heavy minerals at Colmer Point.

Company exploration has led directly to the delineation of bauxite deposits on the west coast, silica sand at Cape Flattery and Shelburne Bay, kaolin deposits at Weipa and Skardon River, coking coal at Bathurst Range, heavy minerals at Colmer Point, alluvial tin resources at Granite Creek (north of Coen), lode tin deposits at Jeannie River and Collingwood, copper at the Dianne Copper Mine, tungsten at Spring Creek, and numerous small alluvial gold, tin and heavy mineral resources.

Table 6 lists exploration tenures current as at February 1994. Up-to-date information on tenures in the area is available from the Mareeba and Brisbane District offices of the Department of Minerals and Energy.

Table 6. Exploration tenures, Cape York Peninsula, February 1994

Tenure	Holder	Location	Date Granted
EPC 463	Bathurst Coal and Power Ltd	Bathurst Range	22/09/86
EPM 4068	Venture Exploration N.L.	Skardon River area	12/08/85
EPM 5767	Peko Exploration Ltd	Rocky River - Colmer Point area	23/02/89
EPM 5772	Peko Exploration Ltd	Massy Creek area	24/02/89
EPM 5830	Peko Exploration Ltd	Chester River - Scrubby Creek area	03/04/89
EPM 6470	Huw Mercer Evans	Ebagoola Goldfield	02/04/90
EPM 7108	CRA Exploration Pty Ltd	Crosbie Creek - Coleman River, Lukin River area	10/01/91
EPM 7109	CRA Exploration Pty Ltd	Little Coleman River area	17/04/91
EPM 7118	Saracen Minerals N.L.	Coen Goldfield	03/09/91
EPM 7144	Peko Exploration Ltd	Chester River area	26/04/90
EPM 7286	CRA Exploration Pty ltd	Crosbie Creek - Coleman River area	04/01/91
EPM 7428	Comalco Aluminium Ltd	Pennefather River - Wenlock River area	14/11/91
EPM 7430	Comalco Aluminium Ltd	Pennefather River - Pine River area	14/11/91
EPM 7488	CRA Exploration Pty Ltd	Lukin River area	17/07/90
EPM 7566	Cyprus Gold Australia Corporation	Southwestern edge of Coen Inlier	22/02/91
EPM 7596	CRA Exploration Pty Ltd	Geikie Creek - Granite Creek area	24/01/91
EPM 7614	Jeffrey John Anderson	McLennan's Lode	14/06/91
EPM 7654	Peko Exploration Ltd	Temple Bay	24/01/91
EPM 7887	Dalrymple Resources N.L.	Dianne Copper Mine area	12/07/91
EPM 7951	Peko-Wallsend Operations Ltd	Cape Direction	14/12/92
EPM 8162	Combined Mining and Milling N.L.	Archer River - Granite Creek area	22/10/91
EPM 8417	Reef Mineral Resources Pty Ltd	Palmer River (Fox Creek - Fernhill Creek area)	03/10/91
EPM 8597	Lone Star Exploration N.L.	Archer River - Granite Creek area	28/02/92
EPM 8634	Starcke Gold Pty Ltd	Starke No. 2 Goldfield	31/03/92
EPM 8682	CRA Exploration Pty Ltd	Scrubby Creek - Nineteen Mile Creek area	13/02/92

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Table 6. (continued)

Tenure	Holder	Location	Date granted
EPM 8683	CRA Exploration Pty Ltd	Balclutha Creek - TerribleCreek area	13/02/92
EPM 8684	CRA Exploration Pty Ltd	Coleman River area	13/02/92
EPM 8690	CRA Exploration Pty Ltd	Annie River - Balclutha Creek area	28/02/92
EPM 8810	CRA Exploration Pty Ltd	Stewart River area, Coen Goldfield	15/06/92
EPM 8811	CRA Exploration Pty Ltd	Lukin River - Spion Kop area	19/05/92
EPM 8820	Bruce Resources N.L.	Sandy Creek - Cannibal Creek area	15/06/92
EPM 8885	Red Dome Pty Ltd	Skae Creek - Attack Creek area	05/04/93
EPM 8953	CRA Exploration Pty Ltd	Saltwater Creek - Coleman River area	11/09/92
EPM 9000	Edmund Henry Jennings	Spear Creek	14/09/92
EPM 9019	CRA Exploration Pty Ltd	Fish Creek area	15/09/92
EPM 9020	CRA Exploration Pty Ltd	Hann River - Jedda Creek area	15/09/92
EPM 9055	CRA Exploration Pty Ltd	Coleman River area	26/10/93
EPM 9073	Red Dome Pty Ltd	Mullimbidgee	14/12/92
EPM 9353	John Edward Kingsley	Maytown area	19/05/93
EPM 9375	CRA Exploration Pty Ltd	Lukin River area	14/05/93
EPM 9432	Graham Edward Elmes	West Normanby Goldfield	08/07/93
EPM 9444	Odin Australia Ltd	North Palmer River area	04/11/93
EPM 9517	Carpentaria Gold Pty Ltd	Mount Croll	04/11/93
EPM 9573	CRA Exploration Pty Ltd	Holroyd River - Lukin River area	04/08/93
EPM 9606	Edmund Henry Jennings	Palmer River - Spear Creek area	06/09/93
EPM 9650	Neil Francis Stuart	Granite Normanby River	04/11/93
EPM 9672	Artuka Pty Ltd	Northeast of Coen	06/12/93
EPM 9687	Savage Resources Ltd	Lakeland Downs area	02/12/93
EPM 9720	Savage Resources Ltd	Lakeland Downs - Laura River	03/12/93
EPM 9721	Savage Resources Ltd	Lakeland Downs area	02/12/93
EPM 9766	Savage Resources Ltd	Headwaters of the North Palmer River	02/12/93
EPM 9768	Savage Resources Ltd	MacDonalds Hill area, Lakeland Downs	02/12/93
EPM 9848	R.E. Palmer	Doughboy Creek	17/01/94
EPM 9936	K.A. White	Mt Eykin - Mt Pike area, West Normanby	23/02/94

REGIONAL GEOLOGY

Cape York Peninsula consists of a stable shield of Proterozoic metamorphic and Palaeozoic granitic rocks (the Coen and Yambo Inliers) overlain by gently dipping Mesozoic and Cainozoic sedimentary rocks of the Carpentaria, Laura and Karumba Basins (Figure 12).

The Coen and Yambo Inliers are separated from folded Palaeozoic sediments of the Hodgkinson Province by the Palmerville Fault. The Coen Inlier and Hodgkinson Province have been intruded by late Palaeozoic granitic rocks with associated acid volcanics.

Late Palaeozoic granitic and acid volcanic rocks form the Cape York - Oriomo Inlier, which extends from Cape York across Torres Strait to Papua New Guinea.

The predominant structural trend in Cape York Peninsula is northerly. The inliers, igneous belts and sedimentary basins are all elongated in this direction.

PROTEROZOIC METAMORPHIC ROCKS

Yambo Inlier:

Metamorphic rocks of the Yambo Inlier belong to the **Dargalong Metamorphics**, which also crop out in the Dargalong Province, to the south. The main rock types are biotite-plagioclase-quartz gneiss, quartzite and amphibolite in the east, and plagioclase-muscovite-biotite-quartz schist, muscovite-quartz schist and quartzite in the west. A few small lenses of amphibole- and diopside-bearing gneiss are interbanded with the gneiss. Mafic granulites occur in places (Bultitude & Rees, 1994). The Yambo Inlier is cut by the southern boundary of the CYPLUS area.

Coen Inlier:

The oldest rocks exposed in the Coen Inlier are remnants of a sequence of Proterozoic metamorphic rocks which occur between plutons of the mid-Palaeozoic Cape York Peninsula Batholith. The metamorphic rocks have been subdivided into the Coen Metamorphics, Holroyd Metamorphics and Sefton Metamorphics (Willmott & others, 1973). Metamorphic grade is in the greenschist and amphibolite facies. Retrogressive metamorphism up to amphibolite facies is widespread.

The **Coen Metamorphics** comprise biotite-muscovite-quartz schist, quartzite, biotite-quartz-feldspar gneiss, garnet-amphibole-quartz-feldspar gneiss, amphibolite, and a few lenses of calc-silicate rocks. The Coen Metamorphics are metamorphosed in the amphibolite facies. In the Ebagoola 1:250 000 Sheet area, the Coen Metamorphics have recently been subdivided into four units and redefined as the **Coen Metamorphic Group** (Ewers & Bain, 1992). Extension of the mapping of the subdivisions into other sheet areas has not yet been completed. The Coen Metamorphic Group is defined as the central, north-south striking belt of metamorphic rocks bounded by the Coen Shear Zone on the east and the Ebagoola Shear Zone (Ebagoola 1:250 000 Sheet area) on the west. Belts of metamorphic rocks to the east and north-east of Coen, which were previously included in the Coen Metamorphics, have been redefined by Ewers & Bain (1992) as the poorly exposed **Newberry Metamorphic Group**.

The **Holroyd Metamorphics** comprise muscovite-quartz schist and phyllite, quartzite, biotite-muscovite-quartz schist, biotite-quartz-feldspar gneiss, feldspathic schist, slate, meta-sandstone and meta-dolerite. In places, the schist contains sillimanite, andalusite, staurolite, garnet, graphite or tourmaline. The unit is metamorphosed in the lower greenschist to amphibolite facies. The Holroyd Metamorphics in the Ebagoola 1:250 000 Sheet area have been subdivided into twelve units and redefined as the **Holroyd Group** and the **Edward River Metamorphic Group** (Ewers & Bain, 1992).

The **Sefton Metamorphics** crop out in the north-east of the Coen Inlier. They are fine-grained muscovite-quartz schist, phyllite, quartzite, and minor amphibolite. In the Iron Range area, schist and quartzite are interbanded with hematite-quartz schist, magnetite quartzite, greenstone, marble and calc-silicate rocks. In the

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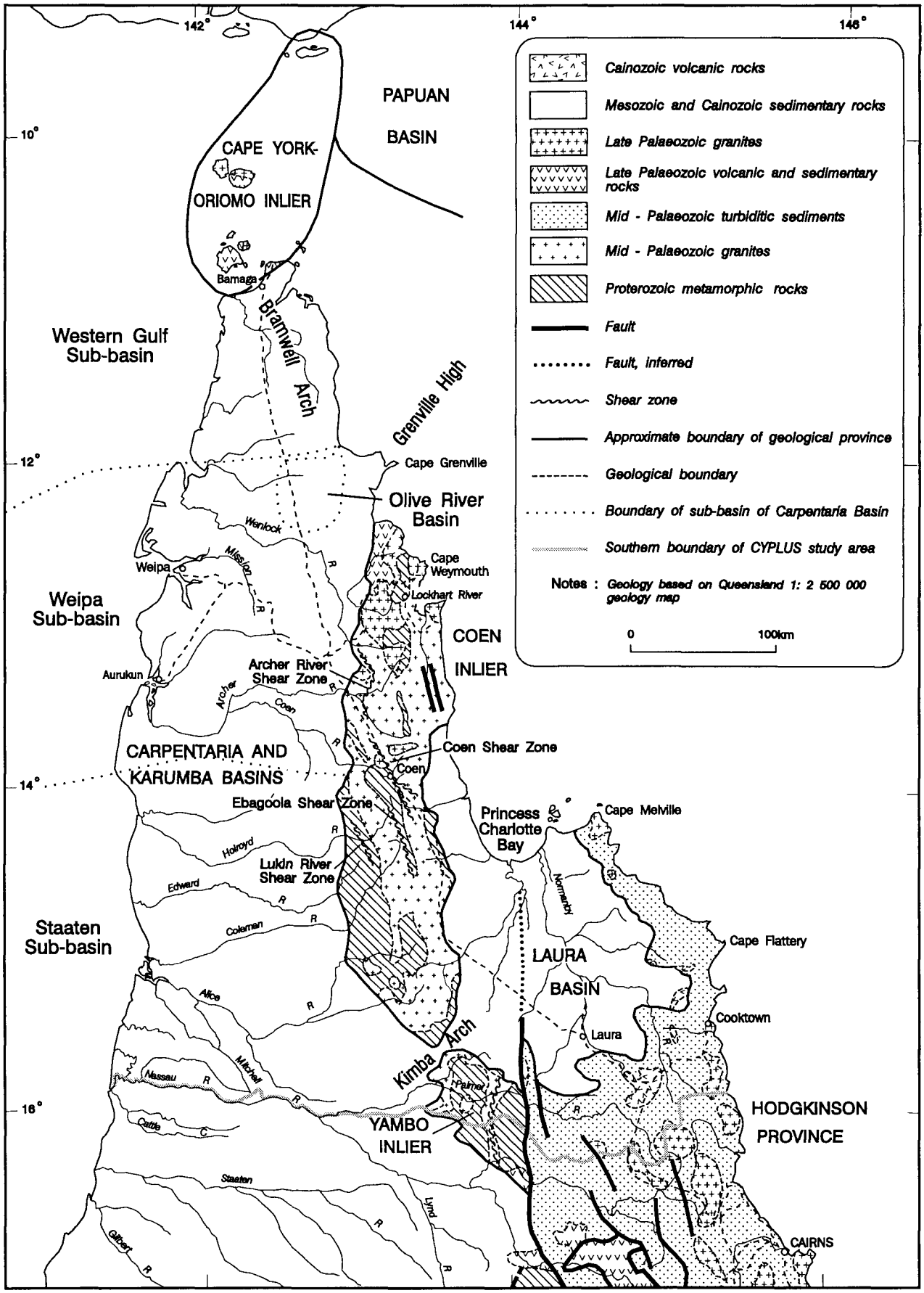

Figure 12. Regional geology.

Temple Bay area, muscovite-quartz schist grades into schistose limestone; calc-silicate rocks are also present.

Recent studies by AGSO (Bain & others, 1992) have indicated that the metamorphic rocks of the Coen Inlier may be substantially younger (late Precambrian or early Palaeozoic) than those of the Georgetown Inlier to the south and may have been derived from them. The Coen Inlier is characterised by a metamorphic, magmatic and deformational climax that occurred at about 400Ma, resulting in complex second-generation structures, amphibolite-grade metamorphism and S- and I-type granitic magmatism. Mafic granulites in the eastern part of the Coen Inlier record a high-grade (granulite facies) metamorphic event or events (Bultitude & Rees, 1994).

Three superimposed metamorphic events, roughly synchronous with the first three of four regional deformation events, have been recognised (Ewers & Bain, 1992). The metamorphic grade increases to the east and south from low in the greenschist facies to high in the amphibolite facies.

Layering generally dips steeply and has a regional north to north-north-west trend. Schistosity and foliation are generally parallel to subparallel to the trend of layering, but schistosity in the Holroyd Metamorphics is locally obliquely inclined to layering.

In the psammopelitic rocks, four metamorphic zones have been recognised: the chlorite and biotite zones of the greenschist facies, and the andalusite and sillimanite zones of the amphibolite facies. All four zones are represented in the Holroyd Metamorphics but only the sillimanite zone is represented in the Coen Metamorphics.

PROTEROZOIC IGNEOUS ROCKS

Dykes and irregular bodies of dolerite intrude the Dargalong Metamorphics in the western part of the Yambo Inlier. Samples have yielded K-Ar whole rock age dates of 1345 $\pm$ 33 and 1829 $\pm$ 45Ma (Cooper & others, 1975). However, recent geological mapping by the GSQ and AGSO has indicated that dolerites in the Yambo Inlier range from amphibolite (metamorphosed dolerite) to unaltered dolerite with primary minerals and textures intact. It is likely that the unaltered dolerites are late Palaeozoic in age.

CAPE YORK PENINSULA BATHOLITH

The north-trending Cape York Peninsula Batholith crops out extensively through the Coen and Yambo Inliers. It has been divided into three major petrographic-geochemical groups (supersuites) by MacKenzie & Knutson (1992) and Knutson & others (1994). These supersuites are the I-type Flyspeck Supersuite and Blue Mountains Supersuite and the S-type Kintore Supersuite. The main geochemical differences between the supersuites are higher aluminium saturation index (ASI) and K_2O/Na_2O in the S-types; all the granites are very iron-poor and strongly reduced (MacKenzie & Knutson, 1992).

These supersuites are of Late Silurian to Early Devonian age (pooled U-Pb zircon age of 407Ma; Black & others, 1992) and have been emplaced at moderately deep crustal levels, as indicated by the abundance of pegmatites and a close association with migmatites.

The batholith was intruded into metamorphic rocks of the Coen and Yambo Inliers. Emplacement took place during the peak of metamorphism, probably via dilational jogs in major north-north-westerly trending sinistral transpressional shear zones such as the Ebagoola and Coen Shear Zones (MacKenzie & Knutson, 1992). The Flyspeck Supersuite was emplaced first, then moved aside as emplacement of the S-type granites followed.

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Most of the granites show some evidence of deformation, ranging from a weak foliation to intense mylonitisation, particularly adjacent to regional shear zones. Xenoliths of metamorphic country rocks, alignment of phenocrysts and some compositional banding are fairly common near contacts. The granites themselves commonly appear to grade into one another, and from relatively mafic to more felsic compositions.

Flyspeck Supersuite: In the Ebagoola 1:250 000 Sheet area, the I-type Flyspeck Supersuite consists of the Flyspeck Granodiorite, Glen Garland Granodiorite, Peringa Tonalite, Artemis Granodiorite, Tea Tree Granodiorite, Two Rail Monzogranite, Carleton Monzogranite and Kirkwood Monzogranite. It includes all of the rocks previously mapped as Flyspeck Granodiorite by Willmott & others (1973).

The main rock types are hornblende-biotite, biotite-hornblende, allanite-biotite and allanite-hornblende-biotite granodiorite, biotite-hornblende tonalite, biotite, allanite-biotite and hornblende-biotite monzogranite to granite, and biotite granite.

Blue Mountains Supersuite: The Blue Mountains Supersuite comprises the Blue Mountains Suite and the Morris Adamellite. These granites crop out in the Coen 1:250 000 Sheet area. The main rock types are hornblende-biotite granite, biotite-hornblende granite, felsic biotite microgranite, biotite-muscovite granite, hornblende-biotite granodiorite and porphyritic biotite granite.

Kintore Supersuite: The S-type Kintore Supersuite is the dominant component of the Cape York Peninsula Batholith, comprising approximately 70% of the total exposed area of granitic rocks (Ewers & Bain, 1992). It has been subdivided into the Ebagoola and Lankelly Suites on the basis of textural and subtle geochemical differences, and is essentially equivalent to the Kintore Adamellite, Aralba Adamellite and Lankelly Adamellite of Willmott & others (1973).

The **Ebagoola Suite** comprises the Kintore, Barwon, Leconsfield, Warner, Lindalong, Burns, Heneage, Tadpole and Ebagoola Granites in the Ebagoola 1:250 000 Sheet area. The main lithology is biotite-muscovite granite. These rocks are variably porphyritic. Some biotite-muscovite-garnet granite, muscovite leucogranite, biotite-muscovite leucogranite, muscovite pegmatite, biotite-muscovite pegmatite, and muscovite aplite also occur.

The **Lankelly Suite** comprises the Lankelly and Kendle River Granites in the Ebagoola 1:250 000 Sheet area. The main rock types are porphyritic muscovite-biotite to biotite granite. The Lankelly Suite essentially corresponds to the Lankelly Adamellite.

The Kintore Supersuite also includes the McIlwraith Granite and Buthen Buthen Granite.

Shear zones: Major shear zones extend across the Yambo Inlier and in both the granitic and metamorphic rocks of the Coen Inlier. These zones occur as discrete, north-west and north trending, *en echelon* belts up to 3km wide and 20km long; minor shearing is widespread throughout the Inliers.

The Coen Shear Zone, which separates the Lankelly Granite from the Coen Metamorphics, may continue north under alluvium to connect with the Archer River Shear Zone. A sinistral west-over-east sense of shear has been inferred for both zones (Blewett & von Gnielinski, 1991a). The overall shear sense is oblique slip. Shearing may have begun before the granites of the Kintore Supersuite had completely crystallised and continued after consolidation of the rocks.

HODGKINSON PROVINCE

The Hodgkinson Province is an elongate, deformed flysch terrane which comprises terrigenous clastic-volcanic-limestone shallow water assemblages in the west (Palmer River Formation, Mountain Creek Conglomerate, Van Dyke Litharenite, Mulgrave Formation, Chillagoe Formation) and finer grained, deep-sea sequences

in the east (Hodgkinson Formation). Metamorphic grade is typically very low to prehnite-pumpellyite subfacies, except in the south-east where the grade is greenschist facies. Multiple deformation in the province has resulted in dominantly north-west structural trends with steep dips. The Province is separated from the Yambo Inlier in the west by the Palmerville Fault, and only the northern part of the province is within the CYPLUS area.

The **Palmerville Fault** is a reverse fault which probably formed the western limit of the Hodgkinson Province in Silurian times. It was active in the Permian, and movement continued into the Early Cretaceous and probably into the Tertiary. It is one of the main structures controlling the development of the Laura Basin.

The **Palmer River Formation** is regarded as the oldest unit in the Hodgkinson Province and is most probably Early Ordovician (Bultitude & Donchak, 1992). The main lithology is fine to medium-grained quartzose arenite.

The Palmer River Formation is faulted against or unconformably overlain by the Late Ordovician **Mountain Creek Conglomerate**. This unit contains abundant volcanic detritus, but also contains numerous clasts of quartzose arenite identical to arenites in the Palmer River Formation.

The **Van Dyke Litharenite** is the only other unit in the western part of the province that contains significant amounts of volcanic detritus. It is a probable time equivalent of the Mountain Creek Conglomerate, with which it appears to interfinger (Bultitude & Donchak, 1992). It also contains clasts apparently derived from the Palmer River Formation.

The **Mulgrave Formation** consists mainly of quartzose arenite similar to that in the Palmer River Formation, but is characterised by a more diverse range of rock types (metabasalt, chert, shale, mudstone, siltstone, conglomerate). It is tentatively regarded as Late Ordovician (Bultitude & Donchak, 1992).

The Early Silurian to Early Devonian **Chillagoe Formation** comprises interlayered metabasalt, limestone, chert, greywacke, mudstone and conglomerate. Metabasalt is the dominant lithology in the study area. The formation is fault-bounded.

The Devonian **Hodgkinson Formation** comprises arenite, siltstone and mudstone, with intercalations of chert, basic volcanic rocks, conglomerate and minor limestone lenses. Melange or "broken-formation" zones are common in many areas. The arenites are mainly quartz-intermediate greywackes, sourced from high-grade metamorphic and plutonic rocks. Isolated volcaniclastic arenite lenses found in the eastern part of the Helenvale 1:100 000 Sheet area may indicate the proximity of an eastern, contemporaneous volcanic arc, the remnants of which may now lie beneath the Coral Sea (Donchak & others, 1992).

Bultitude & Donchak (1992) defined four members (the Kitoba member, OK member, Larramore metabasalt member and Quadroy Conglomerate) in the Maytown area. The Hodgkinson Formation has been subdivided into several informal units, depending on the abundance of fine-grained or coarse-grained sequences, in the eastern part of the Province.

Sedimentation within the Hodgkinson Province ceased in the latest Devonian or earliest Carboniferous when eastward-directed thrusting is thought to have closed the basin (Donchak & others, 1992). Tectonism resulted in the imbrication of the sediments into a number of westward-younging thrust slices. The dominant regional north-north-west trending slaty cleavage within the Hodgkinson Formation is thought to have been produced by subsequent tectonism.

The Hodgkinson Province has been multiply and complexly deformed. Up to five major deformations have been recognised in the region. The main lithological units are fault bounded in most places and their internal stratigraphy is extensively disrupted by numerous thrust faults which trend parallel or subparallel to the strike of the beds. Bedding is predominantly steeply dipping to subvertical.

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The sedimentary rocks of the Hodgkinson Formation have been intruded by late Palaeozoic granitic rocks of the North Queensland Volcanic and Plutonic Province.

NORTH QUEENSLAND VOLCANIC AND PLUTONIC PROVINCE

The North Queensland Volcanic and Plutonic Province is a major, post-orogenic igneous province which extends as far south as Townsville. It comprises late Palaeozoic granitic intrusions and subaerial volcanics. The volcanics are commonly interbedded with fluviatile or lacustrine sediments. The units described below occur within the CYPLUS area.

Late Palaeozoic volcanic and sedimentary rocks:

The Early Carboniferous **Pascoe River beds** crop out in the valleys of the Pascoe River and its tributaries in the northern part of the Coen Inlier. Rock types comprise sandstone, arkose, greywacke, siltstone and shale, with minor coal, conglomerate and chert. The beds appear to be entirely freshwater (Carr, 1975a).

There are three recognisable units in the sequence. In ascending order, these are: carbonaceous shale and coal; arkose and greywacke; and silicified siltstone, chert and greywacke. Tuff and tuffaceous sandstone also occur, indicating contemporaneous volcanism.

The regional structural trend is north-north-west, and the Pascoe River beds have been folded along axes parallel to this trend. Dips range from 10° to 60° and minor faulting is common.

The **Olive River Basin** is a small, oval, intracratonic depression in the Weipa subbasin of the Carpentaria Basin. Drillholes have intersected Carboniferous, Permian and Mesozoic sedimentary rocks.

The pre-Mesozoic sediments are interpreted to be dominantly deltaic and were deposited in graben structures. The Carboniferous rocks comprise clayey quartzose sandstone with minor interbedded siltstone and are considered to be equivalent to the Pascoe River beds.

Late Permian sediments comprise carbonaceous siltstone and shale, quartzose sandstone, and minor coal (Wells, 1989a). A major fault on the eastern side of the basin appears to have controlled deposition in the Permian.

During the late Palaeozoic, **acid volcanic rocks** erupted over an area of approximately 200km^2 near Iron Range and at Cape Grenville in the northern Coen Inlier, and in Torres Strait. They consist predominantly of acid welded tuff, with some rhyolite and intermediate flows.

Volcanic rocks crop out in three separate areas in the Iron Range district and were probably erupted from separate, contemporaneous centres. The units are the **Janet Ranges Volcanics**, **Kangaroo River Volcanics** and **Cape Grenville Volcanics**.

Rhyolitic welded tuff predominates; other rock types include rhyolite, breccia, agglomerate, rhyodacitic and dacitic welded tuff, andesite and metabasalt. The volcanics are possibly genetically related to and have been intruded by the Early Permian, high-level Weymouth Granite.

The **Torres Strait Volcanics** crop out on many of the Torres Strait Islands and on the mainland at Cape York. They were erupted from a number of centres and have been subdivided into four members — the Eborac Ignimbrite, Endeavour Strait Ignimbrite, Goods Island Ignimbrite and Muralug Ignimbrite. Each member consists mainly of a number of sheets of welded ash-flow tuff of similar composition; there is a compositional variation from member to member. The volcanics are altered and mineralised, probably as a result of late-stage hydrothermal activity related to associated intrusive rocks.

The volcanics are intruded by the Late Carboniferous Badu Granite and are thought to be no older than Carboniferous.

The Late Permian **Little River Coal Measures** crop out in a narrow, 20km long, structurally complex, down-faulted graben structure along part of the Palmerville Fault System, east of the Yambo Inlier. The extent of the Permian sediments is defined by the Palmerville Fault in the west and the Fairlight Fault in the east.

Rock types include thick-bedded, medium to coarse, feldspathic and lithic sandstone, grey silty shale with interbeds of dark impure limestone, fine sandstone, and coal (Carr, 1975b). The coal seams are up to 7m thick, but are steeply dipping and faulted (Wells, 1989b).

The unit has undergone significant deformation during the Mesozoic and Cainozoic. Movements along the Palmerville Fault zone have resulted in chaotic folding and faulting of the sequence, especially in thin-bedded sequences, and account for the steep dips and numerous younging reversals. Strata strike north-north-westerly. The true stratigraphic thickness is not known but is probably <1000m (Bultitude & Donchak, 1992).

The Little River Coal Measures are faulted against the Dargalong Metamorphics to the west and the Palmer River, Mulgrave and Chillagoe Formations to the east. Presumably, the coal measures unconformably overlie these units at depth.

The Permian **Normanby Formation** occurs as several, small, north-north-east trending faulted outliers on the extreme south-eastern edge of the Laura Basin (Carr, 1975b) and unconformably overlies the Hodgkinson Formation. The formation comprises approximately 1000m of thin-bedded micaceous sandstone, thick-bedded coarse to fine-grained feldspathic sandstone, dark silty calcareous shale, thick beds of pebble conglomerate, and impure limestone beds (Wells, 1989b). At least 30m of impure coal occurs in the western (?upper) part of the formation. Thick flows of fine-grained rhyolite, thin beds of lapilli tuff, and volcanic breccia are common in the central and eastern (?lower) part of the northern and southern outliers. Significant areas of mafic to intermediate volcanics also occur. The formation is essentially unmetamorphosed. The volcanics are commonly extensively altered.

The formation is bounded by well-defined faults against the Hodgkinson Formation and is overlain by unfaulted Jurassic sandstone. The coal is folded, crushed and faulted. Folds plunge gently or moderately steeply. Beds are mainly steeply dipping to subvertical and the rocks are extensively cleaved or foliated. Strata are cut by numerous steep strike faults and several, steep, north-easterly trending cross-faults.

The formation was deposited in a series of linear, fault-bounded rift basins produced by regional crustal extension (Donchak & others, 1992). The mafic/felsic nature of the volcanism which accompanied sedimentation is typical of extensional tectonic regimes.

Moderately to steeply dipping sediments, comprising hard tuffaceous sandstone and siltstone, with interbeds of shale and minor coal, have been intersected in petroleum exploration, coal exploration and stratigraphic drillholes in the Laura Basin (Carr, 1975b). *Glossopteris indica*, which occurs in both the Little River Coal Measures and the Normanby Formation, has been recorded from some drillholes. Seismic exploration has indicated a thick sedimentary sequence, including Permian rocks, which occurs in zones striking north-north-west. These beds may be co-extensive with both the Normanby Formation and the Little River Coal Measures (Wells, 1989b).

Late Palaeozoic intrusive rocks:

Late Palaeozoic granitic rocks crop out in the Cape York-Oriomo Inlier, Coen Inlier and Hodgkinson Province. These granitoids have been dated isotopically as Late Carboniferous to Late Permian. Granites intruding the Cape York-Oriomo and Coen Inliers are I-types. Those intruding the Hodgkinson Province include both S- and I-types. In some places, they intrude acid volcanic rocks and have the characteristics of high-level granites.

The Late Carboniferous **Badu Granite** intrudes the Torres Strait Volcanics. The main rock types are leucocratic biotite granite, porphyritic biotite granite and adamel-

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lite, and hornblende-biotite adamellite and granodiorite. Intrusions of porphyritic microgranite are probably contemporaneous with the Badu Granite.

The Permian **Weymouth Supersuite** includes the Weymouth Suite (Weymouth Granite and Portland Roads Granite), Wolverton Adamellite and Twin Humps Adamellite (Knutson & others, 1994). The Weymouth Suite intrudes Proterozoic metamorphics, mid-Palaeozoic granites and late Palaeozoic volcanic rocks in the Iron Range district. Rock types include porphyritic allanite-hornblende-biotite granite, allanite-hornblende-biotite granodiorite, biotite (± allanite) granite, and some microgranite and leucocratic granite. Dolerite intruding the Kangaroo River Volcanics to the south of Temple Bay may be associated with the Weymouth Granite (Willmott & others, 1973).

The Wolverton Adamellite intrudes mid-Palaeozoic granites in the Granite Creek area north of Coen and comprises leucocratic biotite adamellite and granite, and some microgranite and aplite.

The Wigan Adamellite comprises leucocratic biotite ± hornblende granite and some leucocratic muscovite granite, muscovite granite pegmatite, and aplite. It intrudes the Flyspeck Adamellite. Both mid-Palaeozoic and late Palaeozoic granites may be present in the area mapped as Wigan Adamellite (Knutson & others, 1994).

The Twin Humps Adamellite intrudes mid-Palaeozoic granites near Coen. The main lithology is a porphyritic hornblende-biotite leucogranite.

The Late Carboniferous to Early Permian **Lindsay Flat Microgranite** comprises two small stocks of porphyritic biotite microgranite in the Ebagoola 1:250 000 Sheet area (Ewers & Bain, 1992). Aeromagnetic data suggest that the two stocks merge into a single body at a few hundred metres depth. The Lindsay Flat Microgranite may be genetically related to spatially associated dykes of porphyritic rhyolite.

Numerous, small **acid to intermediate dykes**, some of which are up to 30m thick and several kilometres long, intrude the Coen Inlier. The dykes are mainly rhyolitic to rhyodacitic in composition, but some are andesitic to doleritic. All are moderately to intensely altered. Most are east-north-east trending, parallel to a well-developed regional fracture pattern. Some are subparallel to north-north-westerly trending major shear zones. Locally, the dykes are strongly foliated and lineated. They are probably Late Carboniferous to Early Permian (Ewers & Bain, 1992). Rhyolite also forms small plugs (for example, Spion Kop) in the Ebagoola area.

Early to Late Permian granites have intruded the eastern part of the Hodgkinson Province. Bultitude & Champion (1992) have redefined these batholiths and granitic complexes, which show a pronounced north-westerly to north-north-westerly alignment, parallel or subparallel to the regional trends of bedding and major structural elements in the Hodgkinson Formation. Most of the plutons are high-level contact aureole types, characterised by the presence of miarolitic cavities and/or granophyric intergrowths and relatively narrow, low-grade, contact metamorphic aureoles. Contacts with the country rocks are almost invariably steep.

The granites are concentrated mainly in two belts. The western belt was formerly mapped mainly as Mareeba Granite and the eastern belt mainly as Finlayson Granite. Both belts contain S- and I-types, but S-types predominate.

Granites of the **Cooktown Supersuite** form most of the Finlayson Batholith. They crop out over approximately 250km^2, mainly in a north-north-west trending belt extending for 80km between China Camp and Cooktown. The granites have been grouped into 8 suites (Bultitude & Champion, 1992). Named suites are the Big Tableland (Big Tableland Granite), Collingwood (Collingwood Granite), Cooktown (Charlotte, Cooktown and Finch Bay Granites), Mount Hartley (Mount Hartley Granite and Mount Leswell Microgranite), Mount Poverty (Finlayson and Mount Poverty Granites), Roaring Meg (China Camp and Roaring Meg Granites), and Waterfall (Waterfall Granite) Suites. Unassigned granites include the Phoenician, Lizard Island, Mount Finnegan, Boolbun, Barrow Point, Ninian Bay and Starcke Granites and Mrs Watsons Bay Microgranite.

Most of the plutons are granites, although there are some adamellites. Porphyritic varieties are common. Associated microgranites are typically finer grained than the granites they intrude. The mineralogical characteristics, particularly the widespread occurrence of cordierite, and the local abundance of gneissic enclaves indicate that the Cooktown Supersuite contains S-type granites. Most, and possibly all, of the granites are Late Permian.

Granites of the **Whypalla Supersuite** form a north-westerly trending belt to the west and south-west of the Cooktown Supersuite. This supersuite corresponds mainly to the Mareeba and Cannibal Creek Granites. Within the CYPLUS area, named suites are the Cannibal Creek (Cannibal Creek Granite), Mount Pike (Bullhead and Mount Pike Granites), Kelly Saint George (Kelly Saint George and Nangee Granites), and Whypalla (Koobaba, Mount Windsor and Whypalla Granites) Suites.

These granites appear to have been emplaced at levels comparable to or slightly deeper than those of the Cooktown Supersuite and are epizonal to mesozonal. They are cut by scattered dykes and pods of microgranite.

The units consist predominantly of (muscovite-) biotite adamellite, with rare granite and granodiorite. Most plutons have finer grained (chilled) margins. The granites of the Whypalla Supersuite are S-types. Their geochemical characteristics are consistent with derivation from an immature, relatively Ca-rich supracrustal source.

The I-type **Yates Supersuite** includes the most mafic of the intrusions in the eastern Hodgkinson Province. It includes the Keating (Keating Granodiorite), Puckley (Leichhardt Pocket and Puckley Granites), Trevethan (Black Mountain and Trevethan Granites) and Mount Yates (Mount Yates Granodiorite) Suites, and the unassigned Bunk Creek and Hopevale Granites. Many of these units were previously mapped as part of the Finlayson or Mareeba Granites.

The plutons appear to be epizonal or possibly mesozonal intrusions. No miarolitic cavities have been detected, but narrow, low-grade, contact metamorphic aureoles occur around most units.

The main rock types are hornblende-biotite granodiorite and adamellite, together with subordinate biotite granodiorite and adamellite and rare biotite granite and tonalite or diorite.

The Early Permian **Cape Melville Supersuite** consists of four units, the Cape Melville Granite being by far the most extensive. Other units are the Saint Pauls Microgranite, Altanmoui Granite and Cape Bowen Granite. These units were previously mapped as the Altanmoui Granite.

The main lithology is a medium to coarse-grained (hornblende-) biotite adamellite. Vughy pegmatite pods and lenses occur in the Altanmoui Granite. This and other features are consistent with emplacement at relatively high levels in the crust, comparable to the levels deduced for the Cooktown and Whypalla Supersuites. The Cape Melville Supersuite has the chemical and mineralogical characteristics of I-type granites.

The **Wakooka Granite** forms a small stock which was formerly mapped as part of the Altanmoui Granite. It is a medium-grained, moderately porphyritic biotite adamellite. The presence of miarolitic cavities indicates that the unit was emplaced at a relatively high level in the crust. Bultitude & Champion (1992) did not classify the Wakooka Granite as an S- or I-type because it is in contact with and probably intruded by an S-type microgranite, despite having chemical characteristics similar to the I-type Cape Melville Supersuite.

A widespread major deformation event post-dated the emplacement of granites in the Hodgkinson Province (Bultitude & Champion, 1992). It pre-dated the essentially undeformed Middle Jurassic to Early Cretaceous Laura Basin sequence and most probably occurred in the very Late Permian or Early Triassic. Shearing is evident in the Permian Normanby Formation, but is indistinguishable from earlier broken formation fabrics in the Hodgkinson Formation (Domagala & others, 1993). This event appears to be restricted to the coastal zone and is probably related to the intense Russell–Mulgrave Shear Zone farther south in the Cairns region.

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Scattered, north-westerly to north-north-westerly trending **mafic and felsic dykes** occur throughout the Hodgkinson Province. Rock types include porphyritic microgranite, dolerite, rhyolite, basalt, andesite, and diorite. These dykes are probably very Late Permian.

MESOZOIC SEDIMENTARY BASINS

Within the study area, Jurassic and Cretaceous rocks occur in two interconnected downwarps — the Carpentaria and Laura Basins — and are >1km thick under the Gulf of Carpentaria. The sequence rests mainly on Proterozoic and Palaeozoic metamorphic and igneous rocks. Locally, the Carpentaria Basin conceals a small area of Carboniferous to Triassic rocks — the Olive River Basin. The Mesozoic rocks are extensively blanketed by Cainozoic sediments.

Structurally, the basins are simple. They are intracratonic and structures are the result of blockfaulting or draping over basement blocks. The parallel evolution of the basins began in the Late Triassic as a result of broad epeirogenic downwarping and block-faulting within the Australian craton.

Jurassic rocks crop out round the margins of the basins and form fair to good scarp exposures in mesas and river valleys. The Cretaceous rocks are poorly exposed as scattered rubbly outcrops characteristic of the interior plains.

Carpentaria Basin:

The Carpentaria Basin lies between the Proterozoic rocks of the Coen, Yambo and Georgetown Inliers in the east and the McArthur Basin, Nicholson Basin and Mount Isa Inlier in the south-west. The northern and western extents of the basin below the Gulf of Carpentaria and the Arafura Sea are not well known.

To the north-east, the basin sequence merges with and thickens into the Papuan Basin over a broad, poorly defined structure — the Bramwell Arch. To the east, the basin is connected with the Laura Basin via the Kimba Arch, over which the earliest Cretaceous rocks are continuous.

The Carpentaria Basin has been divided into four sub-basins, three of which (the Weipa, Staaten, and Western Gulf sub-basins) are within the CYPLUS area (Figure 6).

Sedimentation began in the north and south-west parts of the basin during Middle to Late Jurassic times with the deposition of the Garraway Sandstone and the Eulo Queen Group.

The fluvial **Garraway Sandstone** is restricted to the northern part of the basin, particularly in the Weipa sub-basin. It comprises a fining upwards sequence of quartzose conglomerate, sandstone, siltstone and claystone.

Deposition of the fluvial **Eulo Queen Group** in the southern part of the basin was synchronous with that of the Garraway Sandstone. The Eulo Queen Group comprises planar and trough cross-bedded quartzose sandstone, with graded and reverse graded conglomerate beds near the base of the unit, and interbedded clayey quartzose sandstone, siltstone and minor mudstone towards the top.

The overlying, Late Jurassic to Early Cretaceous **Gilbert River Formation** was deposited throughout the basin and is interpreted as a transitional unit. Deposition began with fluvial sediments at the base, changing to a near-shore marine environment at the top. The formation is dominated by clayey quartzose sandstone. Towards the top of the formation, the sandstone becomes finer, siltstone becomes more common, and glauconite occurs.

The wholly marine, Early Cretaceous **Rolling Downs Group**, which overlies the Gilbert River Formation, is dominated by fine-grained sediments. It has been divided into the Wallumbilla Formation, Toolebuc Formation, Allaru Mudstone and Normanton Formation.

The **Wallumbilla Formation** was first deposited in the north of the Carpentaria Basin as lithic glauconitic sandstone. Marine siltstone and mudstone were later deposited throughout the basin.

The **Toolebuc Formation** conformably overlies the Wallumbilla Formation. It consists of interbedded organic-rich mudstone and fossiliferous limestone.

The **Allaru Mudstone** comprises siltstone and mudstone and conformably overlies the Toolebuc Formation. It is interpreted as a shallow marine sequence.

The **Normanton Formation** conformably overlies the Allaru Mudstone and consists of glauconitic sandstone and siltstone. It represents a continuation of near-shore deposition associated with infilling of a shallow sea, the final phase of Late Cretaceous sedimentation within the basin.

Olive River Basin:

The marine **Helby beds** and the fluvial **Garraway Sandstone** were deposited in the Olive River Basin in Early to Late Jurassic times. A Middle Jurassic marine transgression resulted in the Helby beds overlying the Garraway Sandstone over much of the basin's extent.

The Garraway Sandstone comprises micaceous sandstone, with very minor siltstone. The Helby beds comprise sandstone with siltstone laminae. The base of the Helby beds, where it overlies the Garraway Sandstone, is a distinctive khaki-green sandstone which represents the change from fluvial to marine deposition.

The **Gilbert River Formation** passes laterally into the Helby beds to the north. The lower part of the formation was deposited in a fluvial environment, but the unit grades upwards into a marginal marine environment. Deposition of the Helby beds and the Gilbert River Formation ceased in the Early Cretaceous; both formations are conformably overlain by the marine **Rolling Downs Group**.

Laura Basin:

Located on the eastern side of Cape York Peninsula, the Laura Basin is an intracratonic, northerly-trending basin which covers an approximate area of 16 000km^2 offshore and 18 000km^2 onshore (Smart & Rasidi, 1979). The maximum thickness of Jurassic and Cretaceous sediments is 1100m and these sediments are overlain by a thin veneer of Late Tertiary and Quaternary strata. The offshore extent of the basin, through Princess Charlotte Bay, extends to the edge of the continental shelf.

The Laura Basin overlies some small grabens containing Permian rocks, but mainly covers mid-Palaeozoic sedimentary rocks and late Palaeozoic granitoids of the Hodgkinson Province. The Hodgkinson Province forms the southern and eastern boundaries and the Coen Inlier forms the western boundary. The northern limit of the Laura Basin is the offshore Grenville High, across which Cretaceous rocks are continuous with the Papuan Basin. To the south-west, the Laura Basin is also continuous with the Carpentaria Basin across the Kimba Arch.

Deposition in the Laura Basin began with the Middle to Late Jurassic, fluvial to marginal marine **Dalrymple Sandstone**. This formation is lithostratigraphically equivalent to beds underlying the Gilbert River Formation in the Carpentaria Basin. It consists of conglomerate, sandstone, and minor siltstone, mudstone and shale. In most places, the basal bed is a massive conglomerate or conglomeratic sandstone of fluvial origin. Impure coal and carbonaceous shales occur locally and appear to be restricted to the lower part of the succession, just above the basal beds.

The Late Jurassic to Early Cretaceous **Gilbert River Formation** overlies the Dalrymple Sandstone. The contact is generally conformable, but is disconformable or unconformable in places. The formation ranges from fluvial at the base to marginal marine at the top where glauconite occurs. Deposition was continuous across the Kimba Arch to the south-west in the Late Jurassic. The formation comprises quartzose sandstone with subordinate interbedded conglomerate, siltstone and mudstone. Thin coal layers occur in some shaley beds.

The marine **Rolling Downs Group** conformably overlies the Gilbert River Formation. This group generally consists of a dark grey mudstone and siltstone sequence, with very fine-grained sandstone laminae and lenses.

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CAINOZOIC IGNEOUS ROCKS

The Pleistocene **Maer Volcanics** form the Murray, Dernley and Stephens Islands in Torres Strait. Most of the islands consist of pyroclastic cones, some with restricted basaltic lava flows. A few smaller islands are basalt only.

The **Silver Plains Nephelinite** comprises basanitic nephelinite and crops out near Balclutha Creek, 17km inland from the western shore of Princess Charlotte Bay. Field relationships suggest that it comprises two or three flow units.

Basaltic lavas of the **McIvor River Basalt Province** (Bultitude & others, 1991) overlie nearly horizontal Mesozoic sediments and alluvium in restricted areas at the head of the Starcke River, in the Morgan - McIvor River valley, and west of Hopevale. This province consists predominantly of valley-fill basaltic lava flows and only very minor pyroclastic deposits. Most of the lava flows emanated from two small shield volcanoes (Mount Webb and Mount Ray).

Volcanic activity in the **Piebald Basalt Province**, in the Cooktown area, was characterised by numerous pyroclastic and composite vent-type eruptions. A number of vents have been recognised, including Mount Rose, Post Office Hill, Mount Piebald, Rootseys Knob, Bald Hills and Blackfellows Lookout.

Limited K-Ar age dating suggests that most of the lavas are late Pliocene to Pleistocene.

The **McLean Basalt** is named after Mount McLean, a modified cone located 5km south of Lakeland Downs. These basalts are amygdaloidal to vesicular lava flows with coarser pyroclastic deposits occurring close to vents (Donchak & others, 1992). Vents include Mount McLean, The Brothers, Bob's Hut, Mount Earl, Mount Sellheim, Hoskin's Vent and Mount Murray (Robertson, 1993). Most of the cones are of the scoria type; composite cones are relatively uncommon. Maar-type structures have been mapped at Tom's Hollow and Bull Hollow; other, smaller maar-type structures are known to occur in the area (Domagala & others, 1993). K-Ar age dating has indicted two periods of cone-building volcanic activity — one in the late Miocene and one in the early Pliocene. Basalt associated with the maar structure at Tom's Hollow has yielded a very early Pliocene age, suggesting that a period of explosive activity occurred between the two cone building episodes.

CAINOZOIC SEDIMENTS

Grimes (1980) divided Cainozoic deposits of Cape York Peninsula into two zones, separated along the drainage divide.

Deposits in the **Carpentaria Region** lie within the **Karumba Basin**, an epicratonic basin superimposed on the Mesozoic Carpentaria Basin. Grimes (1980) postulated that the basin developed in three major cycles, each comprising an initial phase of tectonism with active erosion and deposition, followed by a phase of planation and the formation of deeply weathered land surfaces. The geology of the Karumba Basin is summarised here in accordance with the description given by Grimes (1980). However, recent studies by Pain & Ollier (1992) indicate that there is no evidence of a genetic relationship between the occurrence of ferricrete and deep weathering and that the formation of extensive erosional surfaces completely covered by ferricrete is unlikely.

During the Early to Middle Tertiary **Bulimba Cycle**, the Bulimba Formation accumulated and the Aurukun Surface was formed. This cycle was initiated by uplift of the eastern margin of the Karumba Basin in Late Cretaceous or Early Tertiary times. The main unit of the cycle is the **Bulimba Formation**, which is a widespread fluvial deposit of interbedded clayey sandstone, conglomerate and sandy claystone. The **Louisa Formation**, a small unit of silicified sandstone and conglomerate in the eastern part of the basin, is thought to be a facies of the Bulimba Formation. The **Floraville Formation** in the south-west of the basin is lithologically similar to and probably contemporaneous with the Bulimba Formation.

The **Aurukun Surface** formed as a depositional surface on the Bulimba Formation and other sediments and as an erosional planation surface around the basin margins. It was deeply weathered towards the end of the cycle and laterites formed over most of the area. Local silicification occurred in southern parts of the surface.

The Middle Tertiary to Pliocene **Wyaaba Cycle** was apparently initiated by Oligocene earth movements. The **Wyaaba beds** are the main onshore deposits and comprise fluvial clayey sandstone and sandy claystone. Marine deposits occur near the present coastline and much of the offshore extent of the Wyaaba beds may also be marine. The **Falloch beds** are lithologically similar to the Wyaaba beds.

The Pliocene **Kendall Surface** formed and was deeply weathered towards the end of the Wyaaba Cycle. Weathering produced laterite and local silicification and also upgraded the older laterites of the Aurukun Surface to bauxite in the Weipa area.

Basaltic volcanism occurred around several centres in the south-east of the Karumba Basin towards the end of the Wyaaba Cycle and during much of the following Claraville Cycle.

The **Claraville Cycle** commenced with uplift in Pliocene times and is still continuing. Several stages of upwarp, as well as eustatic and climatic fluctuations have occurred during the cycle.

Five stages of fan deposition have been recognised in the Gilbert and Mitchell Rivers area. Each stage is related to a phase of erosion in its provenance area.

The coastal deposits of the Karumba Plain consist of lines of sandy beach ridges separated by mudflats. The beach ridges are of two ages. An older set of Pleistocene ridges appears to date from the last interglacial high sea-level; a younger set is related to Holocene sea-levels.

The **Northern Coastal Region** includes the eastern coastal plains of Cape York Peninsula and onshore Cainozoic sediments superimposed on the Laura Basin. Offshore deposits include the continental shelf, south-western part of the Papuan Basin, the offshore continuation of the Laura Basin, and the Coral Sea Plateau.

In the **Laura Basin** area, the **Fairview Gravel** formed in the first, Early Tertiary cycle of activity. This unit is probably a correlative of the Bulimba Formation of the Karumba Basin and is now exposed as thin mesa cappings of conglomerate and quartzose sandstone that have been lateritised and silicified (Aurukun Surface).

The second, Middle to Late Tertiary cycle of activity was initiated by uplift along the present axis of the Great Dividing Range. The main sedimentary units deposited were the **Lilyvale beds** (clayey quartzose sand, gravel and sandy clay) and the **Yam Creek beds**. These units were lateritised during the formation of the Kendall Surface.

The third cycle commenced with further upwarp of the Great Dividing Range in the Pliocene. Deposition occurred along most of the **coastal plain**. There were up to five phases of alluvial deposition, the sequences probably being controlled by continuing episodes of uplift, sea-level changes and climatic fluctuations.

Older units were lateritised and silicified to some degree. Contemporaneous basaltic volcanism occurred near Cooktown. Quaternary fluvial and coastal deposits have continued to form up to the present day.

Reworked quartz sand dunefields on the east coast of Cape York Peninsula may have formed in a number of stages during times of low or fluctuating sea-level. The dunefields formed because of a local abundance of sand and exposure to strong onshore winds. Transgression of a rising sea in Pleistocene interglacial periods eroded frontal dunes and created a sand source by recycling the existing dunes (Cooper & Sawers, 1990).

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GEOLOGICAL HISTORY

The oldest exposed rocks in the study area are the metamorphic rocks of the Coen and Yambo Inliers. These rocks formed from mudstone, sandstone, basic volcanics and limestone deposited in a shallow water, relatively stable (shelf) basinal environment in the Proterozoic (probably <1500 million years ago) (Ewers & Bain, 1992). During or after deposition of the sediments, mafic to intermediate sills (greenstone) were intruded into parts of the sedimentary sequence. Subsequent deformation and metamorphism resulted in the closure of the basin, and the formation of indurated sandstone and siltstone, slate, phyllite, schist, amphibolite, gneiss and marble.

About 400 million years ago, during the peak of a second major metamorphic event, the Proterozoic rocks were extensively intruded by the granitic rocks of the Cape York Peninsula Batholith over a distance of at least 420km, from the Yambo Inlier in the south to Weymouth Bay in the north. These granites were emplaced at relatively deep levels in the earth's crust and the surrounding rocks were regionally metamorphosed and, in places, hydrothermally altered and partially melted (migmatised). Granite emplacement was accompanied by regional shearing and the emplacement of gold-bearing quartz veins (Ewers & Bain, 1992).

Sedimentation in the Hodgkinson Basin, on the eastern side of the Yambo Inlier, commenced in the Ordovician (~500 to 440 million years ago), centred on pre-existing weaknesses in the Proterozoic crust. A back arc setting in a marginal sea related to subduction has been postulated (Bultitude & others, 1993) for the Hodgkinson Basin. Volcanism with accompanying quartzose flysch sedimentation ceased at the beginning of the Silurian, probably due to "stepping" of the subduction zone farther to the east.

In the Early Silurian (~420 million years ago), the Palmerville Fault system formed a hinge zone between the exposed Proterozoic craton and a subsiding depositional area to the east. Siliciclastic and carbonate sediments of the Chillagoe Formation were deposited in a relatively stable, shallow marine rift basin close to the fault (Bultitude & others, 1993). Sedimentation was accompanied by voluminous eruptions of mafic lava, and fossiliferous limestones formed on volcanic highs (Arnold & Fawckner, 1980). Base metal deposits with volcanogenic affinities are locally associated with the sediments and intercalated mafic volcanics.

The rate of subsidence increased markedly in the Early to Middle Devonian (~410 to 375 million years ago). The stable Chillagoe Formation basin evolved into a large, deep marine basin, and a very thick sequence of predominantly turbidity-current deposits (Hodgkinson Formation) accumulated. This deposition is thought to have occurred in an environment of crustal extension behind an active subduction zone at the rifted margin of the craton, far to the east (Bultitude & Donchak, 1992). The Hodgkinson Formation consists mainly of greywacke with minor interlayered chert and basalt, as well as a few small limestone lenses. The uplifted Proterozoic western margin was the major source of the siliciclastic sediments. Flysch-type deposition continued into at least the Late Devonian (~375 to 360 million years ago).

In the Early Carboniferous (~360 to 325 million years ago), freshwater sediments were deposited in small basins in the northern part of the Coen Inlier (Pascoe River beds) and farther north in the Olive River Basin. These sediments comprise sandstone, arkose, greywacke, siltstone and shale, with some coal, conglomerate and chert.

In the Late Devonian or Early Carboniferous, sedimentation in the south ceased when eastward-directed thrusting closed the Hodgkinson Basin and the succession was strongly folded and faulted. The tectonism resulted in the imbrication of the succession into numerous westward-younging thrust slices (Donchak & others, 1992). The region gradually emerged above sea level, most probably in the Early Carboniferous. Gold-bearing quartz veins formed during metamorphism and dewatering of the sediment pile.

The Proterozoic and early to mid-Palaeozoic rocks were eroded in the Late Carboniferous to Permian and the landscape became subdued. Sediments were

deposited in lakes and in shallow, fault-bounded marine rift basins formed by regional crustal extension. Acid volcanism occurred in places. Coal occurs in the sediments of the Little River Coal Measures, Normanby Formation and the Olive River Basin.

In the Late Carboniferous to Early Permian (~300 to 270 million years ago), post-orogenic, high-level granitic batholiths were emplaced in the north of the Coen Inlier and in the Cape York - Oriomo Inlier. Co-magmatic volcanic rocks were erupted near Iron Range, Cape Grenville and in Torres Strait (Willmott & others, 1973). Minor volcanic activity also occurred in the far east of the Hodgkinson Province, south of Cooktown. These volcanics are mainly rhyolitic to dacitic flows and tuffs. The emplacement of the granites and volcanics was accompanied by localised gold, tin and tungsten mineralisation.

Extensive granite emplacement also occurred in the eastern part of the Hodgkinson Province in the Early to Late Permian (~290 to 250 million years ago). Early Permian andesitic to rhyolitic volcanics (Normanby Formation) are also present in the Cooktown area. Most of the granites are high-level types and are cut by acid and rare basic dykes. They are associated with tin and tungsten mineralisation.

In the Late Permian to Early Triassic (~250 million years ago), a widespread, major deformational event characterised by the development of extensive shear zones affected rocks in the coastal zone of the Hodgkinson Province. This shearing post-dated the granites (Donchak & others, 1992).

In the Middle to Late Jurassic (~185 to 140 million years ago), fluviatile quartzose sand was deposited in structurally controlled erosion depressions on an erosion surface of mainly deformed Proterozoic rocks, west of the Coen and Yambo Inliers. This was the start of deposition of the sediments of the Carpentaria Basin. The region was covered by a blanket of continental and marine sands (Gilbert River Formation) in the Late Jurassic to Early Cretaceous. Shallow marine sediments of the Helby beds accumulated in the north.

In the Middle Jurassic to Early Cretaceous, much of the previously uplifted Hodgkinson Province (and Yambo Inlier) sagged, especially adjacent to the Palmerville Fault, to form a depression in which the fluviatile-lacustrine to shallow marine sediments of the Laura Basin were deposited (Bultitude & Donchak, 1992).

Sedimentation continued in the Early Cretaceous (~140 to 95 million years ago), when a very large, shallow, epicontinental sea covered both basins. The Jurassic sediments contain coal measures and the sedimentary sequences are an important source of ground water in Cape York Peninsula.

Following emergence at the end of the Cretaceous (~65 million years ago), the Mesozoic sediments were partly eroded and older rocks exposed in the Tertiary (~65 to 1.65 million years ago). Uplift in the east raised the basement rocks in the centre of the Peninsula to their present elevation. Uplift occurred in stages and fluviatile sand, gravel and clay deposits were deposited in broad downwarps in the Laura Basin. Broad downwarping of the Carpentaria Basin formed a new, shallow basin (the Karumba Basin) in which fluviatile sand, gravel and clay were deposited (Bultitude & others, 1993).

The sediments of the Karumba Basin reflect several cycles of uplift, erosion and deposition, each followed by deep weathering of the stabilised land surfaces. The bauxite deposits of the Weipa Peninsula formed during these deep weathering events.

Uplift of the Hodgkinson and Laura Basins was accompanied by faulting and localised basaltic volcanism. Numerous volcanic vents have been recognised in the Cooktown - Lakeland Downs - McIvor River area. The basalt flows and pyroclastics of the McIvor River Basalt Province, Piebald Basalt Province and McLean Basalt were erupted in the Miocene to Pleistocene (~6 to 1 million years ago).

Erosion and deposition in the Quaternary (1.65 million years ago to present) led to the formation of alluvial deposits along the major river systems, estuarine and deltaic deposits at the mouths of the major rivers, and the formation of beach ridges and sand dunes along the shoreline. These sediments are sources of alluvial gold, tin and heavy minerals. The sand dunes are a source of silica sand.

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KNOWN MINERALISATION AND RESOURCES

Figure 13 shows the location of mineral deposits in the CYPLUS area which have known production or resources. Production and resource figures are given in Table 7. Table 8 lists mineral deposit types on an age/structural province basis.

GOLD

Within the study area, gold deposits fall into a number of broad categories.

- Proterozoic, metamorphosed stratabound/stratiform deposits occur in the Coen Inlier. Both syngenetic and epigenetic mineralisation occur.
- Mesothermal, shear zone-hosted gold-quartz vein mineralisation may be related to the intrusion of the Silurian to Devonian granites of the Cape York Peninsula Batholith and/or to associated metamorphism.
- Gold mineralisation occurs associated with chert/quartzite lenses in the Hodgkinson Formation.
- Breccia, vein and stockwork deposits are related to Carboniferous to Permian granites and subvolcanic complexes with dykes, plugs, stocks and breccias of rhyolitic to trachytic composition.
- Mesothermal, syntectonic "slate belt" type gold-quartz veins in the Hodgkinson Province are also of Carboniferous to Permian age.
- Gold occurs in quartz veins of possible epithermal affinity in late Palaeozoic volcanic-sedimentary units.
- Mesozoic and Tertiary palaeochannel (deep lead) and Recent alluvial and eluvial placer gold deposits.

The general distribution of the deposit types is shown on Figure 14.

Cape York - Oriomo Inlier:

Gold-base metal sulphide-quartz veins and stockworks occur in welded tuff and porphyritic granite on Horn, Possession, Hammond and Thursday Islands in the southern Torres Strait area. The main focus of exploration has been the Horn Island Goldfield, where Torres Strait Gold Pty Ltd delineated indicated and inferred resources of 2.35Mt at an average grade of 2.37ppm Au in the 1980s (Levy & Storey, 1990).

The gold is restricted to quartz-carbonate reefs in altered porphyritic granite and microgranite; very little gold occurs in unveined granite. The main alteration products are green sericite, chlorite and illite occurring in narrow zones around veins and as more pervasive zones enclosing stockworks. Sulphide minerals include pyrite, galena, sphalerite, chalcopyrite and arsenopyrite, and commonly form up to 20% of ore shoots. Individual veins range from 0.3 to 10m wide. The veins are tensional features, with well-developed comb quartz, laminated quartz and breccia textures. Much of the silica is cryptocrystalline and fluorite occurs in some veins. Gold is free in the oxidised zone, but closely associated with galena in the primary ore. These deposits fall into the porphyry-related vein and stockworks category of Morrison (1988).

Elsewhere on Horn Island, and on Possession Island, gold occurs in quartz-base metal sulphide veins in silicified, brecciated and sericitised volcanic rocks of the Torres Strait Volcanics.

Coen Inlier:

Metamorphosed stratabound/stratiform massive and disseminated base metal sulphide-silver-gold deposits occur in the Proterozoic Holroyd Metamorphics in the Potallah Creek area. They have been investigated mainly as potential base metal resources, but drilling has indicated that the Gossan Prospect grades 19.7 to 94ppm Ag and 0.2 to 0.6ppm Au.

In the Iron Range area, gold mineralisation occurs as two distinct styles (**metamorphosed stratabound/stratiform gold-iron-manganese deposits** and **associated**

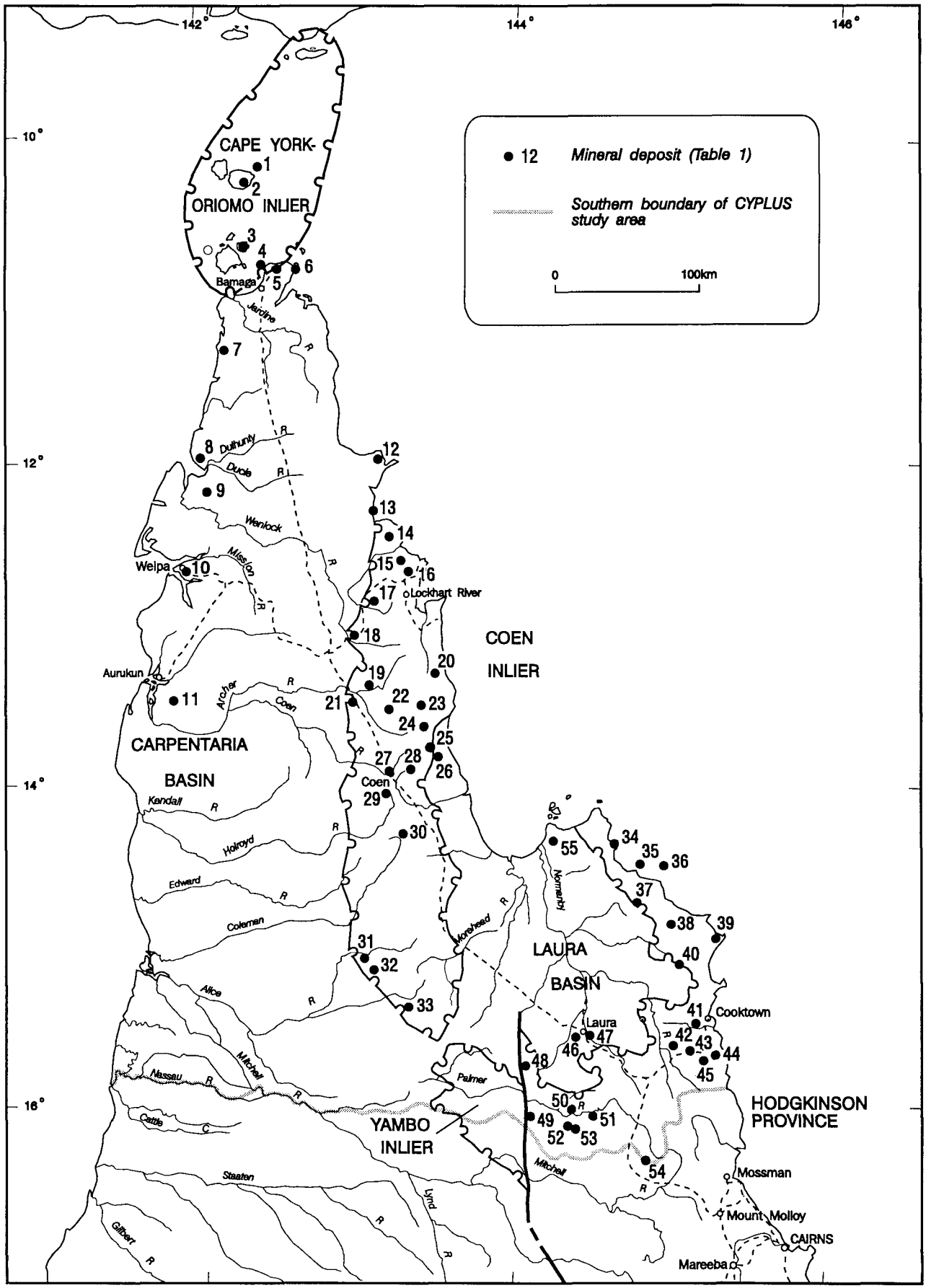

Figure 13. Distribution of mineral deposits with known production or resources.

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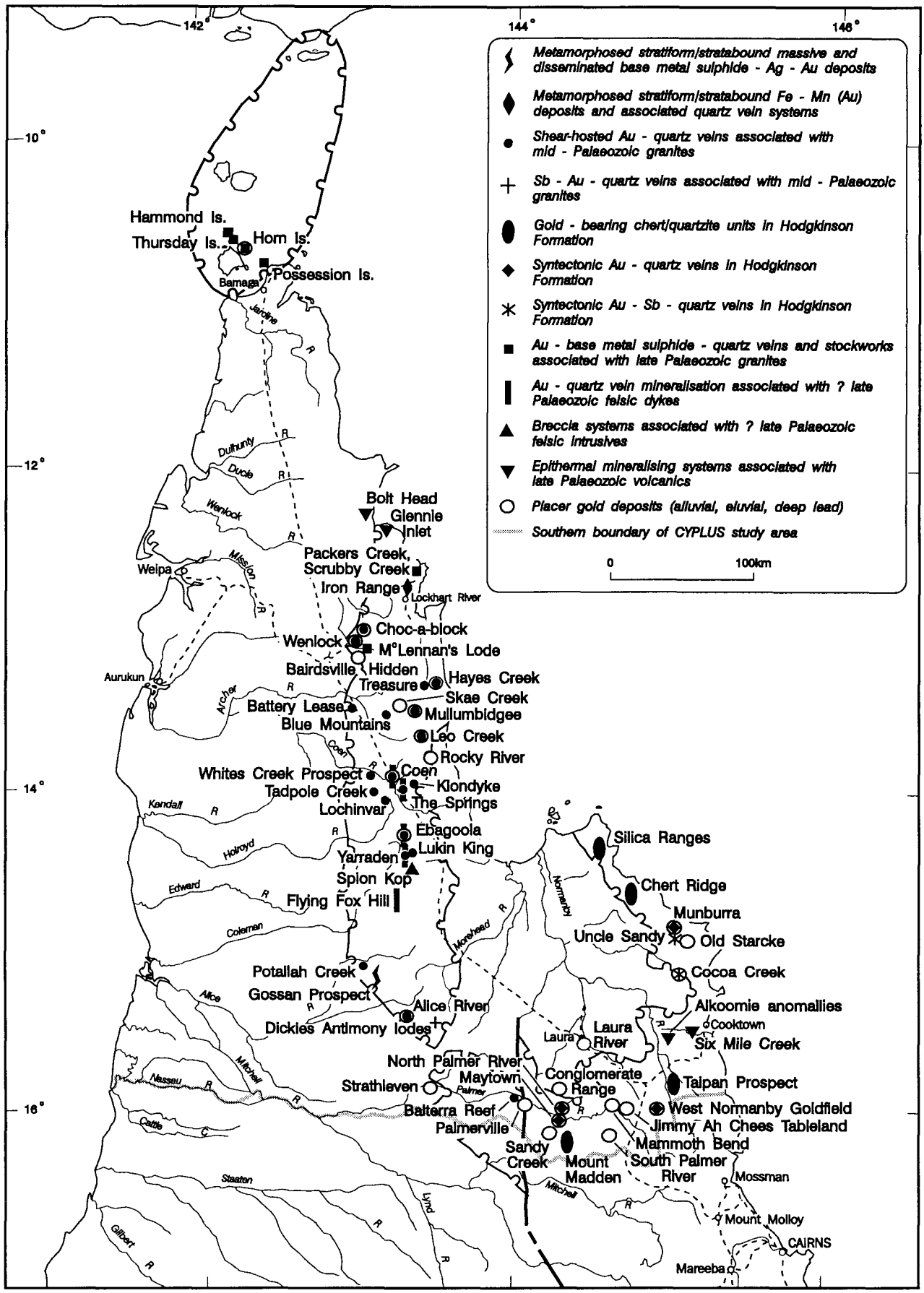

Figure 14. Distribution of gold and antimony deposits.

Table 7. Mineral deposits with known production or resources

Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
1	Portlock Island	Quartz lodes in Carboniferous acid volcanics and related porphyritic granite	30kg wolframite, 1951	
2	Moa Island	Quartz lodes in Carboniferous acid volcanics and related porphyritic granite	About 101t wolframite, 1938–1956	
3	Horn Island Goldfield	Au-base metal sulphide-quartz veins and stockworks in Carboniferous acid volcanics and related porphyritic granite; alluvial placer	About 1643kg of gold bullion, 1894–1909, 1935, 1988–1989	Inferred resource: 2.35Mt @ 2.37ppm Au
4	Possession Island Goldfield	Au-base metal sulphide-quartz veins and stockworks in Carboniferous acid volcanics and related porphyritic granite; alluvial placer	About 113kg of gold bullion, 1897–1919	
5	Cape York Tinfield	Quartz veins and sheeted quartz veins in Carboniferous acid volcanics and associated intrusive porphyries; alluvial stream and beach placers	About 37t cassiterite, 1950–1986	Northern Mine: 200t @ 7.2% recoverable Sn Fourteen Acre Mine: 1000t @ 0.7% recoverable Sn Booty and Maula Creeks: 448 000m^3 of alluvium @ 310g/m^3 cassiterite Lady Luck lease: 660 000m^3 of beach sands @ 193g/m^3 cassiterite
6	Turtle Head Island–Escape River	Lateritic bauxite developed on Cretaceous to Tertiary sediments; Quaternary sand dunes		230Mt bauxite; >30Mt silica sand
7	Vrilya Point	Lateritic bauxite developed on Cretaceous to Tertiary sediments		100Mt bauxite @ 44 to 45% total Al_2O_3 and 7% reactive silica
8	Skardon River	Kaolin in pallid zone of lateritic profile developed on Cretaceous to Tertiary sediments		27Mt kaolin; silica resources confidential
9	Alcan South Pacific Ltd lease (ML 7031)	Lateritic bauxite developed on Cretaceous to Tertiary sediments		75Mt bauxite
10	Weipa Bauxite Mine	Lateritic bauxite developed on Cretaceous to Tertiary sediments; kaolin in pallid zone of laterite profile	206Mt bauxite, 583 481t kaolin, 1960–1993	Resource: 3 700Mt bauxite, 50Mt kaolin Reserves: 248Mt bauxite, 17.8Mt kaolin

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Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
11	Aluminium Pechiney Holdings Pty Ltd lease (ML 7032)	Lateritic bauxite developed on Cretaceous to Tertiary sediments		300Mt bauxite
12	Shelburne Bay	Silica sand dunes		Resources: 143Mt silica sand Reserves: 40Mt silica sand
13	Bolt Head	Limestone in Proterozoic metamorphic rocks		25 000t
14	Tin Creek and First Stony Point Tinfields	Alluvial placers	About 14t cassiterite, 1900–1940	
15	Iron Range	Metamorphosed, stratabound/stratiform iron-manganese deposits in Proterozoic metamorphic rocks		1.0Mt @ 54 to 62% iron and manganese, 300 000t @ 45 to 55% combined iron and manganese
16	Claudie River Gold and Mineral Field	Stratabound Au-Fe-Mn deposits and associated quartz veins in Proterozoic metamorphic rocks; quartz veins in Permian granite; alluvial placers	About 333kg of gold bullion, 1934–1942	
17	Bowden Mineral Field	Quartz veins in Proterozoic metamorphic rocks and related to Permian granite	About 71t wolframite, 1904–1916, 1952	
18	Wenlock Goldfield	Quartz reefs in shear zones in Silurian-Devonian granites and along granite-metamorphic contact; quartz veins in Permian granite; alluvial placers (including deep leads at base of Mesozoic sequence)	About 1528kg of gold bullion, 1892–1951, 1964–1978	
19	Granite Creek (near Coen)	Alluvial placers	About 334t cassiterite, 1907–1940, 1977–1978	4.1Mm^3 of alluvium @ 1.13kg/m^3 cassiterite
20	Hayes Creek Goldfield	Quartz reefs in shear zones in Silurian-Devonian granite; alluvial placers	About 29kg of gold bullion, 1909–1914, 1834–1953	5 000m^3 alluvial wash @ up to 0.33g/m^3 Au
21	Battery lease	Quartz reefs in shear zones in Proterozoic metamorphic rocks, close to the contact with Silurian-Devonian granite	About 6.8kg of gold bullion, 1903–1913	
22	Blue Mountains	Quartz reefs in shear zones in Silurian-Devonian I-type granite; alluvial placers	About 52kg of gold bullion, 1934–1951	
23	Mullimbidgee	Quartz reefs in shear zones in Silurian-Devonian granite; alluvial placers	About 2.2kg of gold bullion, 1952–1957	

Table 7 (continued)

Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
24	Leo Creek	Quartz reefs in shear zones in Silurian-Devonian granites and along granite-metamorphic contact; alluvial placers	About 88kg of gold bullion, 1896-1910	
25	Rocky River Goldfield	Quartz reefs in shear zones in Silurian-Devonian granites and along granite-metamorphic contact; alluvial placers	About 39kg of gold bullion, 1893-1896	
26	Colmer Point	Sand dunes (palaeo-beach ridge deposits)		192Mt silica; heavy mineral resources confidential
27	Coen Goldfield	Quartz reefs in shear zones in Proterozoic metamorphic rocks and Silurian-Devonian granites and along granite-metamorphic contact; gold associated with Carboniferous-Permian porphyritic rhyolite dykes; alluvial placers	About 3564kg of gold bullion, 1876-1918, 1952	
28	Grand Final	Quartz vein in a Silurian-Devonian granite	5.8t wolframite and 130kg molybdenite, 1904-1918, 1952	
29	Lochinvar Provisional Goldfield	Quartz reefs in shear zones in Silurian-Devonian granite; alluvial placers	About 2.2kg of gold bullion, 1904	
30	Hamilton Goldfield	Quartz reefs in shear zones in Proterozoic metamorphic rocks and Silurian-Devonian granites and along granite-metamorphic contact; gold associated with Carboniferous-Permian porphyritic dykes, breccia and intrusions; alluvial placers	About 2292kg of gold bullion, 1900-1951	
31	Potaliah Creek Goldfield	Quartz reefs in shear zones in Proterozoic metamorphic rocks, close to the contact with Silurian-Devonian granite; alluvial placers	About 22kg of gold bullion, 1902-1914, 1942-1947	

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Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
32	Gossan Prospect	Stratiform polymetallic massive sulphide in black shale and basic igneous rocks of a Proterozoic metamorphic formation		50 000t @ 10% combined Cu, Pb and Zn sulphides
33	Alice River Goldfield	Quartz reefs in shear zones in Silurian-Devonian granite; alluvial placers	About 115kg of gold bullion, 1903-1916, 1936	
34	Barrow Point	Alluvial placer	0.25t cassiterite, 1939	
35	Noble Island	Quartz vein stockwork in Devonian metasediments and related to Permian granite	About 19t wolframite, 1904-1916	
36	Howick Island	Quartz veins in Permian granite; alluvial placer	0.5t cassiterite and 250kg wolframite, 1921	
37	Jeannie River Prospect	Complex tin-sulphide lodes in Devonian metasediments intruded by Permian granite		6.7Mt @ 0.8% Sn
38	Starke No. 2 Goldfield	Syntectonic/synmetamorphic Au-quartz and Au-Sb-quartz veins in Devonian metasediments; alluvial placers	About 434kg of gold bullion, 1890-1913	
39	Cape Flattery Silica Mine	Silica sand dunes	14.8Mt silica sand, 1968-1993	Reserves: 200Mt silica sand
40	Starcke No. 1 Goldfield	Syntectonic/synmetamorphic Au-quartz and Au-Sb-quartz veins in Devonian metasediments; alluvial placers	About 35kg of gold bullion, 9t of 9% Sb ore, 1892-1896	
41	Six Mile Creek	?Epithermal quartz veins in Permian intermediate volcanics and sediments	About 2.7kg of gold bullion, 7t of 58% Sb ore, 1921, 1939-1948	
42	Melody Rocks	Limestone in Devonian metasedimentary sequence		>100Mt of high to chemical grade limestone
43	Kings Plains Prospect	Alluvial placer		87Mm^3 of alluvium @ 130g/m^3 cassiterite, 77g/m^3 cutoff (including 42Mm^3 @ 160g/m^3 cassiterite)
44	Collingwood Tin Prospect	Cassiterite in siliceous sheeted veins, albitic veins and greisen associated with Permian granite		3 106 980t @ 0.90% Sn (including 2 027 609t @ 1.00% Sn)

Table 7 (continued)

Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
45	Cooktown Tinfield	Quartz-tourmaline lodes and sheeted veins, greisen veins, and greisen and argillic alteration zones in Permian granites; alluvial placers	About 12 850t cassiterite, 8.3t wolframite, 1885–1992	Sandhills Prospect: 14 963 loose m^3 of greisen @ 0.74kg/m^3 cassiterite and 28 416 loose m^3 @ 0.66kg/m^3 cassiterite Lee Creek: 2.1Mm^3 of alluvium @ 383g/m^3 cassiterite (0.9Mm^3 of wash @ 759g/m^3 cassiterite) Mungumby Creek: 595 125m^3 of alluvium @ 0.20kg/m^3 cassiterite (434 760m^3 @ 0.43kg/m^3 cassiterite) Mount Hartley Creek: 381 440m^3 of alluvium @ 0.18kg/m^3 cassiterite Grasstree Pocket: 1Mt of slopewash and colluvium @ 138g/t cassiterite Just In Time claim: 96 449m^3 of eluvium @ 0.55kg/m^3 cassiterite, 0.2kg/m^3 cutoff
46	Mosman River	Alluvial placer		232 000m^3 of alluvium @ 0.19g/m^3 Au(+Pt+Pd), 0.1g/m^3 cutoff
47	Laura River	Alluvial placer		1.3Mm^3 of alluvium @ 4.2ppm Au(+Pt+Pd)
48	St George Copper Mines	Secondary copper and mercury mineralisation in shears in Devonian basic volcanic rocks	5t of 24% Cu ore, 1905–1907	
49	Mitchell-Palmer Rivers	Limestone in Silurian–Devonian metasedimentary sequence		~1500Mt limestone
50	Palmer Goldfield (including the West Normanby Goldfield)	Syntectonic/synmetamorphic Au-quartz and Au-Sb-quartz veins in Devonian metasediments; gold-bearing chert-quartzite units; alluvial placers (including deep leads at base of Mesozoic sequence)	About 37 551kg of gold bullion, 1874–1990	Fernhill Bend: 1 653 000m^3 of alluvium @ 337mg/m^3 Au Palmerville crossing: 1 119 000m^3 of alluvium @ 395mg/m^3 Au Glenroy Creek–Palmer River: 35 000m^3 of alluvium @ 255mg/m^3 Au West Normanby River: 596 000m^3 of alluvium @ 0.4g/m^3 Au + 470 000m^3 @ 0.2g/m^3 Au West Normanby River–Granite Normanby River junction: 600 000m^3 of alluvium @ 0.26g/m^3 Au

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Deposit number	Name	Type and age of deposit	Recorded production and years of main production	Resources and reserves
51	Dianne Copper Mine	Volcanic-associated massive sulphides in Devonian metasediments	69 820t of ore (18 000t Cu and 1000kg Ag), 1980–1983	
52	Cannibal and Granite Creeks	Quartz-greisen lodes in Devonian metasediments and Permian granite; alluvial placers	About 2843 t cassiterite, 1880-1970	
53	Spring Creek	Quartz-greisen veins in tourmalinised Devonian metasediments above a subsurface Permian granite	About 5967t scheelite and 0.2t wolframite, 1907, 1969–1970	
54	Watershed Prospect	Quartz veins and disseminated scheelite in Devonian calc-silicate rocks and Permian granite		14Mt @ 0.3% WO_3
55	Bathurst Range	Jurassic coking coal		157Mt of medium to low volatile, bituminous coking coal with a moderately high sulphur content

Table 8. Mineral deposit types by age and structural province

Age	Coen Inlier	Yambo Inlier	Cape York – Oriomo Inlier	Hodgkinson Province	Carpentaria Basin	Laura Basin	Karumba Basin
Proterozoic	• Enriched iron formation (Fe/Mn) • Iron formation-hosted Au • Stratabound base metal sulphides • Limestone						
mid-Palaeozoic (Silurian – Devonian)	• Mesothermal Au-quartz veins and Sb-Au-quartz veins	• ?Mesothermal Au- quartz veins		• High Ca limestone • Volcanogenic massive sulphides • Chert-hosted Au • Basalt-hosted Cu			
late Palaeozoic (Carboniferous – Permian)	• Coal • Porphyry-hosted Au-base metal sulphide-quartz veins and stockworks • Porphyry-related Au-breccia deposits • Sn and W veins • ?Epithermal Au		• Porphyry-hosted Au-base metal sulphide-quartz veins and stockworks • Sn and W veins	• Coal • Mesothermal Au- quartz and Sb- Au-quartz veins • Sn and W veins • Sn greisens • W skarns • ?Epithermal Au			
Mesozoic					• Coal • Deep-lead placer Au	• Coal • Deep-lead placer Au	
Cainozoic	• Si sand dunes • Alluvial placer heavy minerals • Alluvial placer Au • Alluvial placer Sn	• Alluvial placer heavy minerals • Alluvial placer Au	• Alluvial placer Au • Alluvial placer Sn	• Si sand dunes • Alluvial placer Au • Alluvial placer Sn • Alluvial placer heavy minerals	• Si sand dunes	• Shoreline placer heavy minerals • Alluvial placer heavy minerals • Alluvial placer Au	• Lateritic bauxite • Lateritic kaolin • Shoreline placer heavy minerals • Alluvial placer heavy minerals • Alluvial placer Au

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vein systems) in banded iron formation of the Sefton Metamorphics. At the Northern Queen, A.I.F. and Peninsula Hope deposits, higher grade gold (>10ppm) is associated with quartz-sulphide veins and siliceous, silicate-pyrite-rich rocks of a banded iron formation which comprises mixed silicate, silica, sulphide, oxide and carbonate facies. Elsewhere in this area, the banded iron formation contains traces of gold (0.2 to 2.0ppm).

At the Johnstons, Gordons and Ironclad deposits, epigenetic quartz-sulphide veins and stockworks occur proximal to the contact of banded iron formation and schist. They may have formed by structural remobilisation of stratabound mineralisation along a high angle overthrust.

Most of the gold production from the Coen Inlier has come from **gold-quartz veins in and adjacent to regional shear zones** which extend for tens of kilometres in Silurian to Devonian granites and adjacent Proterozoic metamorphic rocks. Bain & others (1990) considered that the mineralisation is probably related to the emplacement of Silurian to Devonian I-type granites. However, it should be noted that mineralisation occurs in both S- and I-types and that the S-types are considered to be later than the I-types (MacKenzie & Knutson, 1992). Therefore, the gold mineralisation is more likely to be related to mid-Palaeozoic deformation and/or to late Palaeozoic I-type magmatism.

Miezitis & Bain (1991) described the mineralisation as mesothermal quartz veins of the Charters Towers type (plutonic vein category of Morrison (1988)). However, Morrison (1988) considered the veins of the Coen and Hamilton goldfields to be related to Carboniferous porphyries rather than the Silurian to Devonian granites. On the basis of mineralisation characteristics (particularly sulphide mineralisation), these deposits have been classified as mesothermal quartz veins in this report. However, it is possible that the mineralisation is late Palaeozoic.

Within the study area, this style of mineralisation occurs in the Alice River, Potallah Creek, Ebagoola, Lukin King, Yarraden, Springs, Lochinvar, Coen, Klondyke, Leo Creek, Blue Mountains, Hayes Creek, Wenlock and Mullumbidgee areas. Mineralisation at Blue Mountains may be a special type related specifically to the I-type Blue Mountains Granite (Knutson & others, 1994). In the Yarraden to Coen area, some gold remobilisation may have been associated with emplacement of ?late Palaeozoic rhyolite dykes within the regional shear zones.

The deposits occur as simple or compound quartz reefs in fissures and as lenticular, en echelon and anastomosing quartz bodies along shears. Individual reefs are up to 2m wide, several hundred metres long and steeply dipping. Massive euhedral and comb quartz is cut by veinlets and infilled with later generations of vugh-forming quartz. Wall rock alteration comprises sericite ± carbonate ± pyrite ± chlorite selvedges up to 2 or 3 times the vein width and is most prominent in the granites. Brecciation and silicification are characteristic of the major producing mine — the Great Northern, at Coen. Some reefs have graphitic selvedges adjacent to ore shoots.

Mineralisation comprises a simple pyrite ± arsenopyrite ± base metal sulphide assemblage. Free gold generally occurs adjacent to sulphides; the gold has a gold:silver ratio of approximately 3:1. Mineralisation is generally restricted to short, rich shoots containing crosscutting generations of quartz and rarely occurs in primary quartz or wall rocks. Economic ore shoots tend to occur at inflection points along the shear zones. The best grades are in narrow leaders on the footwall and/or hanging wall. Veins mined in the past were very high grade (up to 300g/t and generally 30 to 60g/t). Stockwork and spur vein systems adjacent to the reefs are not well developed and generally grade up to 8g/t Au. Altered granite generally assays <2.5g/t Au. No opencut resources have been proven yet, despite extensive exploration in the Coen and Ebagoola areas. Remaining underground resources at known mines are probably limited and would support small-scale mining operations only.

The veins probably formed from hydrothermal fluids during brittle reactivation of faults and mylonite zones. The ore fluids were possibly of magmatic derivation,

originating from deep crustal levels. Graphitic wall rock zones may have controlled deposition of gold in some of the ore shoots.

Porphyritic rhyolite and rhyodacite dykes of probable Carboniferous to Permian age are common in the area from Yarraden to Coen. Some dykes are pyritic, silicified and brecciated, and carry low-grade gold mineralisation. Mineralisation, in the form of gold-bearing quartz-calcite-fluorite-pyrite veins, occurs in shears marginal to the dykes and in parallel and feather shears. Minor arsenopyrite, galena and sphalerite also occur in the veins.

In the Coen and Hamilton Goldfields, the dykes occur associated with shear-hosted gold-quartz veins and may have remobilised gold from that mineralising event.

At Flying Fox Hill, quartz vein mineralisation with up to 0.3ppm Au is associated with porphyritic rhyodacite. Many companies have postulated an epithermal origin for veins associated with the dykes but, so far, exploration for large tonnage epithermal systems has been unsuccessful.

The style of mineralisation is described as 'porphyry-related vein and stockwork deposits' by Morrison (1988) and is widespread in north Queensland. The common association is with porphyry dykes in reactivated shear zones or in complex fault and fracture sets formed in a regional stress field during intrusion. Significant occurrences are associated with dykes of rhyolitic to trachytic composition, related to Permo-Carboniferous subvolcanic complexes. Fissure, rather than shear, lodes predominate in most deposits and individual veins have sharp walls and minor wallrock inclusions. The veins are dominated by fine, clear, elongate, euhedral quartz growing in combs, lining vughs, or as cockade overgrowths. Carbonate is a common associate and sulphides (Fe, Cu, Pb, Zn) typically constitute up to 20% of ore shoots.

In north Queensland, **porphyry-related breccia deposits** are associated with Permo-Carboniferous subvolcanic complexes with dykes, plugs, stocks and breccias of rhyolitic to trachytic composition. There are numerous breccia bodies in north-east Queensland but only a handful contain significant gold mineralisation (Morrison, 1988).

Within the study area, the only known definite deposit of this type is at Spion Kop, south of Ebagoola. Mineralisation and weak argillic alteration closely follow the contact of a 300m diameter rhyolite pipe intruding Flyspeck Granodiorite. Breccias along the contact zone comprise clasts of rhyolite, granite and greisen in a rhyolitic, silica and greisen matrix. The breccias contain arsenopyrite and up to 2.4ppm Au. Gold mineralisation is associated with sulphide (pyrite + minor arsenopyrite)- quartz veins and with fractures in the granite. Past mining concentrated on an arsenopyrite-rich felsite breccia lode which assayed approximately 30g/t Au.

Mineralisation at Spion Kop is also associated with north-trending felsite dykes in the area. A high temperature, intrusive contact breccia environment is indicated. Low temperature mineralising systems are entirely absent.

At Scrubby Creek and Packers Creek, near Iron Range, **gold-pyrite-arsenopyrite veins** occur in the late Palaeozoic Weymouth Granite. In 1980, Jahi Pty Ltd delineated proved reserves of 15 000t at 8.78ppm Au and 4250t at 8.49ppm Au in two lenticular zones at Scrubby Creek. However, further investigations by United Reefs N.L. indicated that grades were 2 to 3ppm.

Gold mineralisation at McLennan's Lode and the White Heather, south-east of the Wenlock Goldfield, comprises **quartz veins in shear zones** in the late Palaeozoic Wigan Adamellite. Associated sulphides include pyrite, arsenopyrite, galena and chalcopyrite. The main mineralised zones are silicified breccia zones (fragments and blocks of lode quartz in silicified and sericitised granite) in dykes of fine-grained granite. The gold is generally very fine-grained; lode samples assayed 4.5 to 9.9g/t Au.

Potential **epithermal gold mineralising systems** occur in the Bolt Head area, at Temple Bay. Drilling by Queensland Metals Corporation N.L. did not detect any

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anomalous gold but distinct Hg, As and Sb bedrock anomalies were intersected. Quartz-pyrite-arsenopyrite veins in narrow, linear breccia zones in ignimbrite and silicified tuff of the Kangaroo River Volcanics at Glennie Inlet assayed up to 0.55ppm Au. The rocks are anomalous in Hg, As and Au. Ewers & Cruickshank (1993) have reported that an area of regional ^{18}O depletion (indicative of epithermal gold potential) occurs in the Temple Bay - Pascoe River area.

Gold-bearing deep-leads occur in gutters at the base of the Gilbert River Formation at Bairdsville, Top Camp and Lower Camp in the Wenlock Gold and Mineral Field. The gold-bearing wash is well-cemented and comprises well-rounded cobbles of quartz and basement rocks in a medium to coarse-grained clayey quartzose matrix.

Subeconomic grades of alluvial gold have been found in basal units of the Tertiary Lilyvale beds and Falloch beds in the Nesbit River valley and the Larsen's Creek area.

Alluvial and eluvial gold deposits shedding from lode deposits have been mined in many areas. Production has come from the Alice River, Ebagoola, Coen, Hayes Creek, Wenlock and Rocky River goldfields. Colours of gold have been reported from alluvium in most rivers and major creeks draining the Coen Inlier.

Tri-State Mining Ltd investigated the alluvial potential of Skae and Whites Creeks, north-north-east of Coen, in the 1980's and delineated inferred resources of 56.25kg Au in Whites Creek and 89.5kg Au in Skae Creek. The Skae Creek alluvium was mined in 1988.

Augold N.L. estimated that 5000m^3 of wash in a 1m thick section in Buthen Creek, immediately downstream of the main lode workings in the Hayes Creek Goldfield, grades up to 0.33g/m^3.

In 1985, Alberta Mines N.L. investigated the alluvial gold potential of the Rocky River, east-north-east of Coen. Stream bed gravels returned 18.83 to 21.53g/m^3 along a 2.2km length of the river. However, bulk samples assayed only 0.23g/m^3 in the stream bed and much lower in terraces and flats. The high initial results were probably caused by biased sampling due to large boulders. Alberta Mining concluded that the deposits were too low grade for economic mining.

Leo Creek, where it drains the Claudie Lakeland reef, and creeks draining the Mullumbidgee reefs are considered to be highly prospective for small alluvial gold deposits. Minor illegal mining has been carried out at Leo Creek in the past and stream bed alluvium and residual soils on the banks produce good colours of gold when panned.

Yambo Inlier:

A mineralisation style similar to that at Coen and Ebagoola occurs at the Balterra Reef, west of Palmerville. N.A. Adam reported rock chip assay results of up to 292g/t Au for a 400m strike length of a zone of **hematitic, gossanous and quartz-veined and brecciated granitic gneiss** of the Dargalong Metamorphics. Costean samples assayed up to 7.14g/t Au. Samples collected in 1993 assayed up to 6.1g/t Au and 4.8g/t Ag. Samples from gossanous quartz reefs in the Fox and Fish Creek areas, west of Palmerville, assayed up to 3.6g/t Au and 1.8g/t Ag.

Stream bed and palaeochannel alluvial deposits in the Palmer River, near Strathleven, have been investigated in the past, but reported grades (<0.2g/m^3) are too low for economic mining. The gold is very fine-grained and flaky.

A number of high-level alluvial terraces along the Palmer River in the Palmerville area have been investigated. Dillingham Constructions Pty Ltd identified inferred resources of 1 653 000m^3 at an average grade of 337mg/m^3 at Fernhill Bend; 1 119 000m^3 at an average grade of 395mg/m^3 at the Palmerville Crossing; and 35 000m^3 at 255mg/m^3 for an area of wash adjacent to the intersection of Glenroy Creek with the Palmer River.

Hodgkinson Province:

Gold-bearing chert/quartzite units have been found in a number of places in the Hodgkinson Formation, for example, Mount Madden, Mount Buchanan, Mount Jessop, Jessops Hill, Mount Bennett and Mount Eykin. They are associated with basic volcanic flows. The chert and volcanics contain sulphide-bearing silica veins

as fracture fills associated with folding. Up to 5% pyrite and arsenopyrite is disseminated in the chert and volcanics. Overall gold grades are generally low (<6g/t), although veins grading of the order of 30g/t were mined at Mount Buchanan and Mount Madden. The highest gold contents are associated with fold noses and faults.

R.B. Mining Pty Ltd interpreted the deposits at Mount Madden to be exhalative chert beds within a series of finely laminated volcanic flows. Western Mining Corporation Ltd interpreted the same deposits as zones of intense surficial silicification of carbonaceous phyllite and quartz-sericite units. The gold was remobilised and concentrated in fold noses and faults during folding events.

Cambrian Resources N.L. delineated a belt of basic volcanics and exhalative cherts in the Mammoth Bend area of the Palmer River. Extensive, stratabound gossans are associated with the cherts. Rock chip samples assayed up to 2.74ppm Au.

Auriferous, gossanous, quartz-veined chert lenses have also been found in the West Normanby Goldfield. The largest is a breccia stockwork at Mount Eyekin. Samples assayed up to 2.56ppm Au.

Substantial outcrops of hematitic chert and breccia in the Starcke No. 1 Goldfield assayed up to 2.55ppm Au. Shear zones associated with the chert contain quartz and pyrite, and primary hematite veins occur in the chert. The breccias are also anomalous in arsenic, antimony, selenium and silver.

Numerous chert lenses, some of possible exhalative origin, crop out as prominent ridges in the Hodgkinson Formation between Cooktown and Bathurst Bay. The cherts are locally altered basic volcanic and sedimentary rocks, with some primary/syngenetic chert, generally occurring as large boudins in deformed metasedimentary rocks. Alteration minerals comprise epidote and chlorite, and magnetite is visible in hand specimen. Quartz veins and limonite-stained fractures are common. Several companies have investigated chert ridges at the Lagoon Prospect, Brown's Peak, Four Kilometre Hill, Chert Ridge, and in the "Silica Ranges" area, between Barrow Point and Bathurst Bay. Visible gold was reported to occur in one core hole at Chert Ridge and fine-grained gold was found in pan concentrates from creeks in the Bathurst Bay area. Rock chip samples have returned maximum assay results of 1.52ppm Au for chert and 3.67ppm Au for ferruginous breccia. Aluminous, hydrous phosphate minerals occur in discordant veinlets associated with some of the deposits.

The Ginger Pig Prospect, in the headwaters of the Granite Normanby River, may be an associated deposit type. This prospect is a garnet-cummingtonite-sulphide chert unit associated with meta-basalt. Sulphides comprise <5% by volume and include pyrrhotite, pyrite, and traces of chalcopyrite, galena and arsenopyrite. Rock chip samples from the mineralised zone assayed up to 4.10g/t Au. The probable metasomatism in the Ginger Pig area suggests the presence of a nearby intrusive body, possibly at depth below the deposit (Donchak & others, 1992).

The Sporing Creek Prospect is a gold-anomalous, siliceous magnetite-garnet-amphibole-sulphide unit closely associated with extremely altered microdolerite or basalt flows of the Hodgkinson Formation. This unit appears to be a distal, siliceous Fe-Mn-Mg-rich deposit of volcanic exhalative origin. Sulphides are minor (<5%) and comprise pyrrhotite (partly altered to pyrite), minor chalcopyrite, and traces of galena and arsenopyrite.

Anomalous gold (up to 0.64ppm) is associated with a pyritic-hematitic chert unit striking parallel to and on the western side of a fault separating the Hodgkinson Formation and the Normanby Formation at the Taipan Prospect, near the East Normanby River. Stream sediment sampling indicated anomalous gold associated with pyritic chert, carbonate-altered spilite and fine-grained carbonaceous sediments of the Hodgkinson Formation. Low-order gold (up to 0.80ppm) occurs in fault-bounded silicification zones in spilites.

North-west of Kings Plains Station, gold occurs in a silicified, brecciated fault zone (the "Dingo Shear") which is in the Hodgkinson Formation and is parallel to the

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contact with the Normanby Formation. Gold is restricted to the fault zone, which assays up to 1.12ppm Au.

Gold has been mined from **syntectonic/synmetamorphic Au-quartz and Au-Sb-quartz veins** in the Hodgkinson Formation in the Palmer Goldfield, West Normanby Goldfield and Starcke Nos 1 and 2 Goldfields. This mineralisation style is the "slate belt veins" described by Morrison (1988).

The veins occur in late brittle to brittle-ductile shear zones crosscutting previous deformations. They show evidence of incremental quartz deposition and multiple shear movement. The main quartz textures (buck, ribbon, breccia and assimilation) are characteristic of the mesothermal environment. Ore shoots are a complex mixture of quartz and gouge. The total sulphide content is generally low (<5%) and comprises pyrite, arsenopyrite, pyrrhotite and stibnite; base metal sulphides are present as accessory minerals only. The gold is free, typically of high fineness (+900) and occurs as small irregular masses and discrete grains in quartz and intermixed with pyrite and arsenopyrite. Grades mined averaged 30 to 60g/t Au.

The veins pinch, swell and branch and occur as groups of en echelon veins localised in secondary brittle shears associated with larger, often regionally significant, shear and melange zones. Gold is unevenly distributed and is generally concentrated in shoots associated with dilation zones, which are caused by changes in strike, splays, lithologic contacts and fissure intersections. At Munburra, the veins are spatially related to felsite porphyry dykes. Wall rocks, particularly adjacent to gold-bearing shoots, may have narrow sericitic alteration selvedges. Brecciated margins are common.

In the Hodgkinson Goldfield (Mossman 1:250 000 Sheet area), the calculated oxygen isotopic composition of the gold-bearing fluids is 10 $\pm$ 2 per mil, which overlaps the fields for metamorphic and primary magmatic fluids (Golding & others, 1990). The calculated hydrogen isotopic composition for the hydrothermal fluids is -100 $\pm$ 20 per mil at 300 $\pm$ 50°C. Fluid inclusion studies, together with shear zone characteristics, indicate that the veins in the Hodgkinson Goldfield formed at 270 to 350°C (assuming a fluid pressure of ~1Kbar).

In summary, Golding & others (1990) postulated that the veins were deposited during regional tectonism and channelled to dilational sites in shear zones. The stable isotope characteristics of these mesothermal auriferous fluids mainly reflect extensive fluid-rock interaction, either at source or within fluid conduits.

Morrison (1988) reported that muscovite alteration from veins in the Hodgkinson Goldfield gave a K-Ar age of Late Carboniferous. Peters (1987) suggested that the veins formed during Permian tectonism, following injection of dolerite dykes and sills and localised east-west shearing during the Early Carboniferous. The Permian tectonism was a melange-forming event, with localised high heat flows and intrusion of regional plutons (with associated Sn and W mineralisation).

Gold-bearing veins of this type form by dissolution or leaching processes in large source regions, followed by fluid transport over significant distances and precipitation in appropriate sites that are small compared with the source regions (Cox & others, 1987). Focussing of fluid flow occurs in or adjacent to high permeability fault or shear zones. Thrust surfaces, in particular, have been recognised as very important sites for channelling of fluid flow and may affectively tap fluids migrating from the underlying thrust plate. Veins are commonly developed in restricted areas in structurally-controlled sites such as around shear and fault zones, in particularly competent rock units, or in particular parts of folds.

So far, exploration for bulk-tonnage, low-grade stockwork deposits centred on these vein systems has been unsuccessful. Mineralisation occurs in rich shoots of limited extent and wall rocks and crosscutting veinlets are too low-grade to constitute a mineable resource.

Gold-quartz vein mineralisation at Six Mile Creek, 9km west-south-west of Cooktown, occurs in sheared and highly altered acid to intermediate volcanics and intercalated silty to sandy sediments of the Permian Normanby Formation and may be related to Permian granites in the area. Mineralisation comprises **gold-stibnite-**

quartz vein stockworks and breccia in shear zones. Textures are indicative of an epithermal origin (Truelove, 1986). Best drilling intersections in the area were 2m at 0.20g/t Au for quartz veins in the oxidised zone and 2m at 0.59g/t Au for a zone of intense sericite-silica alteration.

A number of **gold-mercury geochemical anomalies** have been delineated as forming a southern extension of a regional shear zone which includes the Six Mile mineralisation. These include the Ratso, Glassblower, Alkoomie, Liontamer, Festus, Gonzo and Jasper anomalies in the Kings Plains - Alkoomie area. Samples assayed up to 27.5ppm Hg and 230ppb Au for stream sediments, 24ppm Hg for rock chips, and 3ppm Au for pan concentrates. The anomalies are in the Normanby Formation and in the Hodgkinson Formation close to faulted contacts with the Normanby Formation. There is some evidence for a subsurface intrusion in the area. These prospects may represent the upper part of an epithermal system with potential to host a significant gold deposit at depth.

Gold-bearing alluvial leads occur below Tertiary basalt in the Jimmy Ah Chees Tableland and Little Palmer River areas of the Palmer Goldfield.

Alluvial and eluvial gold deposits shedding from lode deposits have been mined in many areas. Production has come from the Palmer, West Normanby and Starcke Nos 1 and 2 goldfields. Colours of gold have been reported from alluvium in most rivers and major creeks draining the Hodgkinson Province.

The Palmer River and its tributaries carry extensive deposits of auriferous alluvium. Three main types of Cainozoic alluvium/eluvium have been recognised as being associated with present-day drainage systems (Lam & others, 1991). These are:

1. Recent wash occurring within flow channels and under active sand banks.
2. Old wash lying outside the active flow channels but adjacent to recent sand banks. This wash is exposed during the dry season but inundated during flooding. It forms restricted deposits in the larger drainage systems such as the Palmer River. Deposits also form towards the junctions of smaller creeks with the major rivers.
3. High-level wash associated with old stream channels, situated some distance from the river, and forming terraces (sometimes 30 to 50m above present river level). These high-level deposits are remnants of alluvium and wash deposited prior to downcutting of the river bed to the present, lower level. They are generally shallow but carry a higher gold content than recent river wash.

Lam & others (1991) listed the sources of the gold as:

- auriferous quartz veins and lodes;
- stockworks of auriferous quartz veinlets;
- auriferous sulphide lodes;
- auriferous sedimentary units;
- *in situ* precipitation of gold nuggets; and
- accumulation of gold from reworking of earlier placer deposits.

In 1980, N. Adam investigated alluvium on the Palmer River at Mammoth Bend. It was inferred that there was 2.5 to 3.0Mm^3 of potentially economic material. Costean samples gave average grades of 0.02 to 0.908g/m^3 Au.

Investigations by Advocate Holdings Pty Ltd and Cambrian Resources N.L. indicated that Catalpa, Cradle and Jessops Creeks all contain significant gold grades. Pan concentrates assayed up to 4.12g/m^3 Au; bulk samples averaged 2.56g/m^3.

In 1988, Queensland Metals Corporation N.L. reported a mineable resource of 596 000m^3 at 0.4g/m^3 Au (with an additional 470 000m^3 at 0.2g/m^3) for leases it held along the West Normanby River.

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J.V. Gaudion reported an indicated resource of 600 000m^3 at 0.26g/m^3 Au for the West Normanby River - Granite Normanby River junction.

Laura Basin:

Gold-bearing deep-leads at the base of the Dalrymple Sandstone in the Conglomerate Range area of the Palmer Goldfield were an important source of alluvial gold in the Palmer River and its tributaries.

In the late 1980s, Gold Copper Exploration Ltd investigated the **alluvial gold** potential of the Laura River and its tributaries near Laura. Reconnaissance sampling indicated that the highest grades occur in a 10km stretch upstream from the crossing south-east of Laura. The indicated resource was 1.3Mm^3 at a grade of 4.2ppm Au; platinum and palladium contents are significant.

In 1987, a total of 1380m^3 of bulk samples from Kennedy Creek was treated for a gold recovery of 0.012 to 0.093g/m^3; minor platinum and cassiterite occur with the gold. The alluvium was considered to be uneconomic for bulk mining.

Bulk samples of alluvium from the Mosman River returned 0.25 to 0.4g/m^3 gold. The concentrates were high in platinum (385.5 to 840.5ppm) and palladium (2.2 to 6.1ppm). The indicated resource was calculated as 232 000m^3 at a grade of 0.19g/m^3 Au and a cutoff of 0.1g/m^3.

ANTIMONY

There has been little antimony production from the study area and most exploration of known deposits has been for their potential as gold deposits.

Coen Inlier:

Approximately 30 separate antimony occurrences have been located between Dickies Creek and Jerry Dodds Creek near Kimba Homestead in the southern Coen Inlier (Figure 14). Stibnite occurs in joint-controlled **quartz veins and stockworks** in the Coen Metamorphics and granite of the Kintore Supersuite. The stibnite is associated with gold, silver, chalcopyrite and malachite in a quartz-fluorite-pyrite gangue; stibnite is extensively altered to valentinite and stibiconite. The lodes range from a few metres to >500m long and a few centimetres to 2.5m wide. Ore shoots averaging 5% antimony are interspersed with low-grade (approximately 1.5% antimony) mineralisation. Kimba Mining Pty Ltd considered the mineralisation to be epithermal veins related to the granite, but the Kintore Supersuite comprises deep-level intrusives. The potential of the deposits is limited.

Stibnite occurs in association with pyrite, arsenopyrite and galena in gold-bearing quartz lodes in the Alice River and Ebagoola goldfields. Mineralisation is related to granites of the Kintore Supersuite.

At the Whites Creek Prospect, near Coen, minor stibnite occurs with arsenopyrite in gold-bearing quartz veins in the Coen Metamorphics. The rocks are hydrothermally altered and intruded by small bodies of aplite and granite of the Kintore Granite.

Hodgkinson Province:

Peters (1987) and Golding & others (1990) recognised two distinct quartz vein associations in the Hodgkinson Formation, namely, **Au-quartz veins and Au-Sb-quartz veins**. The Au-Sb-quartz veins are located in separate domains from the Au-quartz veins, or on domainal boundaries which truncate the Au-quartz veins. Golding & others (1990) suggested that the Au-Sb association postdates the Au veins. Veins of both associations are isolated into distinct structural and lithological domains by post-mineralisation faulting.

Stibnite-gold-quartz veins occur in major melange zones. The stibnite is commonly altered to cervantite. Although many of the deposits have been investigated as sources of antimony ore, most of them have been mined for their gold content only.

Deposits of this type occur at the Uncle Sandy and Cocoa Creek mines, north of Cooktown.

Minor stibnite occurs in some of the gold-quartz reefs at Munburra in the Starcke No. 2 Goldfield and has been reported to occur 5km north-east of Palmerville.

Stibnite occurs in gold-quartz veins in the Normanby Formation at the Six Mile, near Cooktown. The veins have crystalline, open space fill textures and are in altered intermediate volcanics.

TIN

Tin mineralisation is known to occur in a number of distinct areas:

- Cape York;
- Tin Creek and First Stony Point north of the Pascoe River;
- Granite Creek near the Archer River;
- the Jeannie River to Cape Melville area north of Cooktown;
- the Cannibal Creek - Granite Creek area south of the Palmer River;
- the headwaters of the West Normanby and Palmer Rivers; and
- the Cooktown Tinfield.

Minor mineralisation also occurs in the southern Coen Inlier.

Except for minor production from lodes at Cape York, Cannibal Creek, and in the Cooktown Tinfield, almost all cassiterite production has come from alluvial deposits. Lode deposit types include stockwork and brittle fracture types (veins and sheeted veins), greisen deposits and argillic alteration deposits, and are related to late Palaeozoic S- and I-type granites. Deposits associated with late Palaeozoic acid volcanics and intrusive porphyries at Cape York are high-level volcanic and may represent the highest level tin province in Australia. The deposits associated with I-type granites in the Coen Inlier are of the subvolcanic type. The tin lodes of the Cooktown Tinfield (S-type granites) are of the plutonic type (Gregory & others, 1980).

Figure 15 shows the general distribution of deposit types.

Cape York - Oriomo Inlier:

Several small **cassiterite-bearing lodes** occur associated with altered welded tuff of the Torres Strait Volcanics and intrusive porphyries in the hills behind Punsand Bay, near Cape York. The cassiterite occurs in narrow, iron-stained, quartzose veins and veinlets occupying joint fissures (Taylor, 1969). All the occurrences are minor and the largest vein in the field, Holland's Reef (Ginger Dicks), is up to 1m wide and was worked to only 10m depth. It was the main producer (10.4t of cassiterite concentrates from 142t of ore).

A quartz reef at the Northern Mine contains an inferred resource of 200t at 7.2% recoverable Sn. The highest grades intersected in drillholes were 2.4m at 0.28% Sn and 1.5m at 0.43% Sn. Cassiterite-bearing veinlets in quartz-feldspar porphyry at the Fourteen Acre Mine form an inferred resource of 1000t at 0.7% recoverable Sn.

Coastal outcrops of porphyritic rhyolite contain numerous, small, cassiterite-bearing veinlets and have attracted some attention as potential low-grade deposits. The largest deposit occurs at the Bluffs Quarry and comprises a 1.3m wide alteration zone with numerous narrow cassiterite veinlets. Bulk grades are extremely low (<0.10% Sn). Veinlets are too dispersed to allow large-scale mining operations (Taylor, 1969). Mineralisation is probably related to the Late Carboniferous Badu Granite and/or associated porphyritic microgranite.

Minor cassiterite occurs in wolframite-quartz veins on Moa Island.

Cassiterite has been mined from **alluvium and beach sands** in the Punsand Bay and Laradeenya Creek areas near Cape York, and has been shed from nearby quartz vein systems.

In 1968, Consolidated Mining Industries delineated a possible resource of $14.5 \times 10^6 m^3$ at $474 g/m^3$ cassiterite and $9.2 \times 10^6 m^3$ at $192 g/m^3$ cassiterite within an area of $20.7 km^2$ of shallow alluvium. Unfortunately, the sampling and assay methods used make these results suspect. Data concerning the grain size and nature of the alluvium are lacking.

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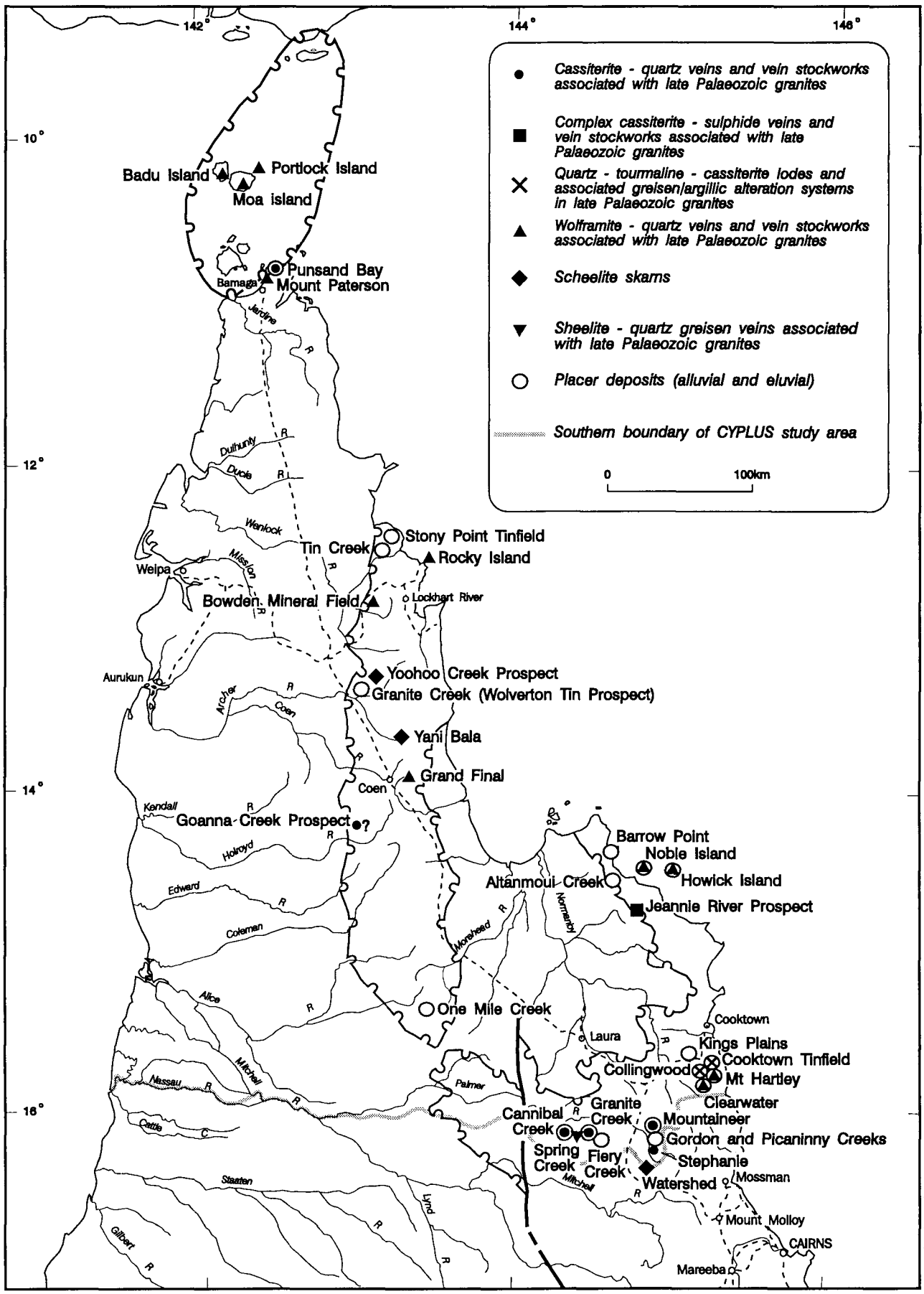

Figure 15. Distribution of tin and tungsten deposits.

Follow-up work by Cominco in 1970 and Jimbilly Pty Ltd in 1980 to 1982 indicated that grades are generally subeconomic, except along present day drainages. Jimbilly Pty Ltd calculated an estimated resource of 448 000m^3 grading 310g/m^3 cassiterite for Booty and Maula Creeks. In 1981, Halekka Pty Ltd concluded that tin concentrates do not reach the grades and volumes necessary for economic mining.

Investigations of beach sand placer deposits along Punsand Bay by Consolidated Mining Industries Ltd indicated inferred resources of 0.66Mm^3 at 193g/m^3 cassiterite for the Lady Luck lease area. Sampling indicated that no economic concentrations occur along Punsand Beach.

Coen Inlier:

The small **alluvial cassiterite deposits** at Tin Creek and the Stony Point tinfield were found to be uneconomic by BHP in 1962. It was estimated that <1t of cassiterite remained in workable areas in the Stony Point field. Cassiterite was probably derived from Permian granite and associated tourmaline-bearing pegmatite veins or from cassiterite-quartz veinlets in Carboniferous to Permian acid volcanic rocks.

Detrital cassiterite concentrations in Granite and Wet Creeks, near the Archer River north of Coen, correspond to outcrops of the Permian Wolverton Adamellite and to its derived alluvial outwash material. The Wolverton Adamellite is typically quartz-veined; sericitic greisen and pegmatite veining are less common. Moderately to highly anomalous cassiterite concentrations (50 to several thousand ppm) occur in streams and creek systems draining this intrusion. Lower concentrations, with local, anomalously high concentrations, occur in older Cainozoic deposits. Although no primary mineralisation has been located *in situ*, samples from the gravel dumps of recent alluvial workings indicate that cassiterite occurs along the margins of quartz veins with sericitic/greisen alteration selvedges.

In the 1980s, Wolverton Tin Pty Ltd estimated that there was 5.2Mm^3 of alluvium in Granite and Wet Creeks suitable for dry mining by excavator and trucks and 2.25Mm^3 of lower grade material in Wrights and Ringtail Creeks suitable for bucket-wheel dredging. Partially exposed palaeoplacer deposits were estimated to contain >50Mm^3, but grades were not known. Following further sampling, the overall potential resource of the area was estimated as up to 4.1Mm^3 of alluvium at 1.13kg/m^3 cassiterite. Wolverton Tin Pty Ltd and Strategic Resources Exploration N.L. (both subsidiaries of North Queensland Resources N.L.) took out ML's 3029 to 3033 and 3115. The company went into receivership in 1990 and the leases were rejected; no mining was carried out. Mining leases are still held by a number of individuals.

In 1978, CRA Exploration Pty Ltd discovered coarse-grained **cassiterite in narrow pegmatitic margins of quartz veins** in the Holroyd Metamorphics at the Goanna Creek Prospect in the southern Coen Inlier. Coarse cassiterite also occurs in the creek. No economic mineralisation was located. The source of the mineralisation is not known; no Permian granites have been mapped in the area.

In 1968, Consolidated Mining Industries located small **alluvial deposits** assaying 0.6kg/m^3 cassiterite in the One Mile Creek area east of the Alice River Goldfield. CSR Ltd also detected very low grades of fine-grained cassiterite in the same area in 1980. The source of the cassiterite is not known; no Permian granites have been mapped in the area.

Hodgkinson Province:

Minor cassiterite occurs in **wolframite-quartz veins** on Noble and Howick Islands. Cassiterite-bearing **alluvium** occurs in creeks draining granite at Barrow Point and on Howick Island.

Complex cassiterite-base metal sulphide veins and vein stockworks were discovered by Carpentaria Exploration Company in the Jeannie River area in 1979. Four centres of mineralisation (the Jeannie River, Saddle Hill, Radio Hill and Whitewater Creek Prospects) have been found but only the Jeannie River Prospect has been tested at depth by diamond drilling.

Mineralisation comprises cassiterite-base metal sulphide-quartz veins in the Devonian Hodgkinson Formation and is probably related to a porphyritic phase on the margins of the Permian Puckley Granite. The prospects are characterised by

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outcropping gossanous lodes, anomalous stream sediment geochemistry and magnetic anomalies.

Ore minerals in the veins include cassiterite, pyrite, pyrrhotite, sphalerite, galena, chalcopyrite, arsenopyrite and scheelite, with rare tetrahedrite, stannite, bornite and sulphosalts. Gangue minerals include quartz, chlorite, calcite, muscovite, siderite, tourmaline and axinite. Wall rock alteration is common close to mineralisation and comprises silicification, sericitisation and propylitic alteration (calcite, pyrite/pyrrhotite, epidote, chlorite). Minor tourmalinisation has also been noted.

A possible resource of 6.7Mt of mineralisation at a grade of approximately 0.8% tin has been indicated by exploration to date (Lord & Fabray, 1990). The best drill intersections were 0.8 to 5.5m grading 0.70 to 3.87% tin over a strike length of 1300m in five core drillholes.

Cassiterite occurs in discrete, narrow, **quartz-greisen lodes** crosscutting the Hodgkinson Formation at Cannibal Creek. The main zone of mineralisation has a strike length of 400m and width of 60m. This zone contains pegmatitic quartz veins with minor cassiterite, scheelite, chalcopyrite, pyrite and beryl. The cassiterite is erratically distributed but generally occurs as coarse to very coarse-grained crystals on vein margins, particularly within muscovite-rich zones. The host rocks are silicified and greisenised adjacent to the veins. Minor cassiterite-quartz-greisen veins also occur at Granite Creek.

Alluvial cassiterite has been mined from Cannibal and Granite Creeks and their tributaries. The primary source is narrow, quartz-greisen veins associated with granite intrusions. Alluvial cassiterite has been mined from Nine Mile, Tin and Fiery Creeks, which drain the Cannibal Creek Granite.

Fine-grained cassiterite occurs irregularly within **greisenised rocks** around the margins of the Windsor Batholith, in the headwaters of the West Normanby and Palmer Rivers. Tin lodes are known to occur at the Stephanie and Mountaineer mines.

Tin mineralisation at the Stephanie mine is associated with two subparallel **quartz veins** within a coarse-grained porphyritic granite dyke. Minor arsenopyrite, scorodite, cassiterite and granite fragments, and traces of pyrite, chalcopyrite and malachite occur in zones along the vein margins. Cassiterite also occurs within the granite adjacent to the veins.

Small, narrow, **cassiterite-bearing quartz-greisen veins** occur in the Hodgkinson Formation at the Mountaineer mine, within 1km of the Windsor Batholith. The Mountaineer claim has also been mined for **alluvial cassiterite**.

A number of primary tin mineralisation styles are evident in the Cooktown Tinfield. These include sheeted quartz-tourmaline lodes and veins, greisen veins, greisen alteration zones and argillic alteration zones. The most important deposits historically were extensive greisen and argillic alteration zones on the margins of granite intrusions. These deposits are generally low-grade, but are deeply weathered and proved amenable to hydraulic sluicing. Recent exploration has centred on the potential of sheeted vein systems in the granite and in the overlying Hodgkinson Formation.

A **cassiterite-bearing greisen** at the Sandhills Prospect, near Mount Hartley, contains 14 963 loose cubic metres at 0.74kg/m^3 cassiterite and 28 416 loose cubic metres at 0.66kg/m^3. The deposit is a 300m long by 150m wide by 4.5m deep zone of eluvium and weathered greisen.

In 1986, the Shell Company of Australia Ltd discovered a substantial **sediment-hosted vein system** at Mount Hartley. Rock chip samples of ferruginous tourmaline-arsenopyrite-cassiterite-muscovite-quartz veins in tourmalinised metasedimentary rocks assayed up to 12.8% Sn.

A 100 to 250m wide zone of **quartz-tourmaline-cassiterite mineralisation** occurs in granite close to the contact with the Hodgkinson Formation at Mount Amos. Lodes within this zone comprise 1 to 2m wide veins and lenses of tourmaline-quartz rock with adjacent silicification and greisenisation. Mineralisation includes cassiterite,

arsenopyrite and pyrite, with minor wolframite, molybdenite, native copper, galena and bismuth. The ore bodies are small, pipe-like shoots which are developed where greisenised veins and shears crosscut the lodes. The main concentrations of mineralisation are at the old Phoenician and Dreadnought mines. Similar mineralisation occurs at the Lion's Den workings on the Big Tableland.

A small **greisenised granite** deposit at Mount Poverty contains an inferred resource of 20 000m^3 of erratic tin mineralisation. The best result from core drilling was 21m at an average grade of 0.42% Sn; most assay results were <0.1% Sn. The greisen seams comprise quartz + muscovite + chlorite. Some of the chloritic greisen contains appreciable chalcopyrite as blebs and stringers.

The **Collingwood Tin Prospect** was discovered by the Shell Company of Australia Ltd in 1979. Geological investigations indicated a resource of 4.035Mt at 0.73% Sn (29 616t of contained tin). It is covered by ML 2796 which was purchased by Shell in 1983. In 1984, Shell entered into a joint venture with North Broken Hill Ltd to proceed with underground exploration of the prospect. An adit was excavated along the main mineralised zone. Underground drilling indicated probable reserves of 3 106 980t at 0.90% Sn (27 833t contained Sn), with a more readily extractable resource of 2 027 609t at 1.00% Sn (20 330t contained Sn) (Miezitis & McNaught, 1987).

The prospect is a subsurface, granite-hosted, **mineralised greisen vein system** which is 50m below the ground surface and is associated with the margin of the Collingwood Granite. Three types of endogranitic mineralisation have been recognised, namely, steep siliceous sheeted veins, albitic veins, and flat-lying greisen (Jones & others, 1990). Most of the cassiterite is associated with en echelon zones of siliceous, sheeted quartz-tourmaline and greisen veins, Associated minerals include chlorite, fluorite, apatite and sulphides (chalcopyrite, bornite, chalcocite, pyrite, arsenopyrite, stannite, sphalerite and bismuthinite). Mineralisation extends over a strike length of 950m and has a vertical extent of 50 to 130m depth. Albitic veins within the siliceous vein system are generally small but they contain the highest grade mineralisation. Flat-lying greisen zones are confined to small cupolas and irregularities in the granite-sediment contact.

Oxygen and hydrogen isotope studies of granite and greisen from the prospect have indicated that similar fluids were responsible for both the pervasive alteration of the granite and for fracture-controlled tin mineralisation (Golding & others, 1990). Re-equilibration of magmatic fluids with the cooling granite prior to the deposition of vein minerals has been inferred.

Since the completion of underground exploration in 1986, the investigation camp has been in a care and maintenance phase. Prefeasibility studies were completed in 1987 and an environmental impact assessment study was submitted in 1988. Several leases (ML's 3065 to 3070) were granted in 1989. Mining and metallurgical options have been fully investigated. Shell is currently looking for a buyer for the prospect.

Greisenised, chloritised and silicified granite also occurs at Mount Misery. **Greisen** occurs as near-vertical, sheet-like bodies in shear zones with included subvertical veins. Cassiterite, chalcopyrite, arsenopyrite, sphalerite and pyrite occur in the greisen zones and chalcopyrite and pyrite occur in altered granite; tourmaline is an ubiquitous accessory mineral. The mineralisation style is probably similar to that at Collingwood, but the granite and associated mineralisation are at about 400m depth.

The Cooktown Tinfield has been the major producer of **alluvial cassiterite** in the CYPLUS area. Cassiterite is found in recent stream channel alluvium, in eluvial deposits shed from stanniferous lode systems, in alluvial terraces adjacent to the main streams, in perched terraces well above present stream levels, in ferruginous gravels on high tablelands such as Mount Poverty, and in deep leads below Tertiary basalt flows.

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The main centres of production were Rossville, Mount Poverty, Upper Romeo, Shiptons Flat, Grasstree, Big Tableland, Little Tableland, Mount Hartley, Mount Finlayson, Tabletop and Mount Amos.

The Annan River, from its headwaters down to the Helenvale area, is known to contain alluvial cassiterite at subeconomic grades.

Alluvial cassiterite is also known to occur in the Mount Misery, Mount Boolbun North and Mount Boolbun South areas. The rugged topography and limited access of these areas has meant that there has been little mining activity or prospecting.

Large resources of alluvial cassiterite occur in an abandoned stream channel extending west from Waterfall Creek to Trevethan Creek. In 1967, Eastern Prospectors Pty Ltd calculated an inferred resource of 0.95Mm^3 of alluvium at an average grade of 482g/m^3 cassiterite. In 1978, Serem Australia Pty Ltd assessed the deposits and calculated overall indicated resources as 2.1Mm^3 at an average grade of 383g/m^3, comprising 0.9Mm^3 of wash at an average grade of 759g/m^3 cassiterite and 1.2Mm^3 of overburden.

Alluvial flats along Mungumby Creek, at the base of the Big Tableland, contain an indicated resource of 595 125m^3 at 0.20kg/m^3 cassiterite or 434 760m^3 at 0.43kg/m^3.

Alluvial flats along Mount Hartley Creek, below Mount Hartley, contain indicated resources of 381 440m^3 at 0.18kg/m^3 in the lower terraces and 453 125 m^3 at an unknown grade in the upper terraces.

Older, high-level alluvium occurs in the headwaters of Granite Creek, between Mount Hartley and Mount Amos. Shallow, gravelly clay upslope from the present stream grades up to 10kg/m^3 cassiterite (average 1.5kg/m^3). Cassiterite occurs in pisolitic, lateritised clay on low ridges and alluvial terraces.

The Kings Plains Prospect was first recognised on air photographs by K.G. Lucas and was subsequently confirmed by ground examination by K.G. Lucas and L. Cutler during geological mapping of the Cooktown 1:250 000 Sheet area by the Bureau of Mineral Resources and the Geological Survey of Queensland. The prospect is a former channel of the Annan River and was first described by Best (1962). Investigations by the Bureau of Mineral Resources and Queensland Department of Mines indicated that the ancestral Annan River valley is deeply incised and is at least 50.3m deep in places. The alluvium is stanniferous, the best grades being concentrated at depths of >30.5m. Mungumby Creek (and therefore the Big Tableland) may have been a major contributor of the cassiterite.

In 1965, Eastern Prospectors Pty Ltd drilled 304 scout holes in the Kings Plains area. Samples were assayed and basement contour maps were prepared. The inferred resource was calculated to be 128Mm^3 at 119g/m^3 cassiterite, suitable for dredging over a depth of 42.7m.

M.H. Wood assessed the Kings Plains deposit as a dredging proposition in 1975. The inferred resource was calculated to be 87Mm^3 at an average grade of 130g/m^3 cassiterite (cutoff 77g/m^3). The eastern section of the deposit is the richest (42Mm^3 at an average grade of 160g/m^3 cassiterite). It was concluded that the deposit may be physically dredgeable but the grade is too low to be economic.

From 1977 to 1983, Triako Mines N.L., in a joint venture with Serem (Australia) Pty Ltd and Buka Minerals N.L., investigated the potential of the Kings Plains deposit for a dredging or gravel pumping operation. Percussion drilling indicated the presence of two mineralised horizons in the wash, separated by a zone with very low grades. The best grade intersected was 10m of wash at 267g/m^3 cassiterite. The alluvium deepens to the west, with an accompanying lowering in grade.

Norminco Pty Ltd applied for ML 40070 over the prospect in June 1993.

Carpentaria Exploration Company Pty Ltd examined **clayey slopewash and colluvial deposits** at Grasstree Pocket and inferred a resource of 1Mt at an average grade of 138g/t cassiterite.

Cassiterite-bearing wash occurs as **deep-leads** below basalt, much of which is deeply weathered, in the Shiptons Flat - Bairds Creek area.

Dominion Mining N.L. calculated that there is an inferred resource of 96 449m^3 of **eluvium** at a grade of 0.55kg/m^3 cassiterite (0.2kg/m^3 cutoff) at the Just In Time claim on Mount Hartley.

TUNGSTEN

Tungsten mineralisation tends to occur in the same general areas as tin and is also related to late Palaeozoic granites (Figure 15). However, individual tungsten provinces are separated from or overlap the tin provinces. Scheelite skarn mineralisation in the Coen Inlier may be related to mid-Palaeozoic granites.

Cape York - Oriomo Inlier:

Wolframite occurs in **joint-controlled quartz lodes** on Moa Island in the Torres Strait. The main deposits are at Eet Hill, Blue Mountains (Mount Augustus) and near Kubin Village. The lodes occur in the Carboniferous Badu Granite and in hornfelsed Torres Strait Volcanics close to the granite contact. Wolframite has also been found at several other places on Moa Island and on adjacent islands (Badu Island, Portlock Island, North Possession Island). Wolframite has also been reported to occur on the mainland at Mount Paterson, 20km south-west of Cape York.

The lode at Eet Hill is a fissure-filling, chloritised quartz vein system with pyrite, arsenopyrite, chalcopyrite, marcasite and wolframite; chloritic and sericitic alteration occur along the vein margins. Shoad wolframite was also mined.

Coen Inlier:

Wolframite-quartz veins occur in a 2.5km long by 1.5km wide zone of mica schist of the Sefton Metamorphics in the Bowden Mineral Field. The lodes are up to 2m wide and are generally concordant with the strike and dip of the schist. Wolframite, with minor intergrown scheelite and tungstite, is commonly concentrated in bunches in the quartz and, in places, is accompanied by tourmaline, molybdenite, arsenopyrite, pyrite, galena and bismuthinite. The wall rocks are greisenised and tourmalinised. Mineralisation is related to the Permian Weymouth Granite; similar veins occur in granite on Rocky Island near Portland Roads.

A small deposit of wolframite and molybdenite occurs at the Grand Final, 12km east of Coen. Wolframite occurs as bunches in a quartz vein in the Silurian to Devonian Lankelly Granite. Mineralisation may be related to an unexposed intrusion of the Permian Twin Humps Adamellite.

Wolframite occurs in minor amounts with **alluvial cassiterite** in streams draining the Wolverton Adamellite in the Granite Creek area.

Scheelite occurs in weakly mineralised **skarns** in the Proterozoic Holroyd Metamorphics at Yoohoo Creek, north-east of the Wolverton Tin Prospect. Massive scheelite occurs in marble and disseminated scheelite/molyscheelite occurs in diopside ± tremolite ± epidote ± calcite ± vesuvianite ± garnet rocks, which probably represent altered and pegmatite-contaminated calcareous sedimentary rocks. The metamorphic grade of the host rocks is upper greenschist facies with superimposed contact hornblende hornfels facies. Quartzofeldspathic gneiss and quartz-muscovite pegmatite associated with the skarns appear to represent injections of magma of the Silurian to Devonian Kintore Granite, but the source of the mineralisation could equally have been the adjacent Wolverton Adamellite. Mineralisation is widespread but is nowhere present in sufficient concentrations to be economic.

Minor **scheelite** has been reported to occur in **calc-silicate rocks** in the Coen Metamorphics at the Yani Bala leases near Leo Creek. Base metal sulphide-bearing quartz veins occur in the same area. Mineralisation is related to either the McIlwraith Granite or the Twin Humps Adamellite.

Hodgkinson Province:

Wolframite is known to occur at two locations in the Cooktown Tinfield. Zones of **quartz-tourmaline-wolframite-sulphides veining** at Mount Hartley assay up to 0.12% W, 800ppm Cu and 250ppm Bi. The granite host is greisenised, silicified and tourmalinised adjacent to the veins.

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Rock chip samples at the Clearwater Prospect, near Romeo Creek, assayed up to 0.76% Sn and 1.18% W. Wolframite, scheelite and cassiterite occur in **sheeted quartz-tourmaline and quartz-feldspar veins** in argillised and unaltered microgranite and granite. Silicification and greisen alteration occur in granite adjacent to the veins.

Wolframite has been mined from **quartz vein stockworks** in hornfelsed Hodgkinson Formation on Noble Island. Locally, the veins contain up to 5% wolframite and arsenopyrite. Scheelite may also occur. Mineralisation is probably related to the Permian Altanmoui Granite.

Quartz-cassiterite-wolframite veins have been reported to occur in the Puckley Granite on Howick Island.

Minor **wolframite-quartz veins** occur in the headwaters of Gordan and Picaninny Creeks, on the western side of the Mount Windsor Tableland.

Scheelite occurs in **quartz-greisen veins** in tourmalinised metasediments of the Hodgkinson Formation at Spring Creek, near Cannibal and Granite Creeks. Coarse-grained crystals and aggregates of scheelite occur on vein margins and within muscovite-rich portions of the veins. Scheelite also occurs in anastomosing veinlets in the alteration halo of the lodes and as disseminations within the tourmalinised host rocks. The veins comprise pegmatitic quartz, muscovite and scheelite, with minor cassiterite, chalcopyrite, pyrite, beryl, and selvedges of tourmalinised host rock. A granitic pluton (Cannibal Creek Granite) has been intersected at 75m depth in drillholes.

Minor **scheelite** occurs in the **quartz-cassiterite-base metal sulphide veins** of the Jeannie River Prospect.

Scheelite also occurs as disseminated grains in calc-silicate rocks of the Hodgkinson Formation and in quartz-greisen veins in the calc-silicate rocks and intruding granites. The Watershed deposit is a steeply-dipping body of **calc-silicate rocks** in the hinge zone area of a megafold. Scheelite occurs as fine- to coarse-grained disseminations in the host rock and as coarse crystals in quartz-calcite veins. Within the calc-silicate rocks, the scheelite is accompanied by minor pyrite, pyrrhotite, arsenopyrite, fluorite, sphalerite, chalcopyrite and molybdenite. Scheelite is concentrated along vein margins, but also occurs within muscovite-rich portions of the veins. Pyrrhotite and arsenopyrite are commonly associated with the vein scheelite. Resources have been reported as 14Mt at 0.3% WO_3 (Miezitis & McNaught, 1987). The prospect is held under MDL 127 by BHP Australia Coal Ltd.

There is no recorded production of **alluvial or eluvial wolframite** from the study area, but shoad wolframite was probably mined on Noble Island. Gingell (1956) estimated that talus slopes surrounding the peaks on Noble Island carried 3.5kg/m^3 wolframite and could support a small-scale mining operation. Wolframite and quartz vein debris occur embedded in coral on the island. Shoad wolframite has also been reported to occur in the Altanmoui Range.

A small amount of **scheelite** (0.5 to 1%) was recovered with **alluvial cassiterite** in the Mountaineer area, at the head of the West Normanby River. The primary source has not been determined.

MOLYBDENUM

The only recorded production of molybdenite in the study area was 127kg of concentrates from the Grand Final lease, east of Coen (Figure 15), where molybdenite occurs on the margins of a **quartz-wolframite vein**. Traces of molybdenite also occur associated with quartz-wolframite veins in the Bowden Mineral Field, on Rocky Island near Portland Roads, and on Moa Island in Torres Strait. A quartz-molybdenite vein has been reported to occur on Barrow Island. Molybdenite occurs as rare traces in some of the tin lode systems in the Cooktown Tinfield. None of the occurrences represents a significant deposit.

BASE METALS

Figure 16 shows the distribution of base metal deposits and occurrences in the study area.

Cape York - Oriomo Inlier:

Minor **copper mineralisation** is common in the southern part of the Cape York - Oriomo Inlier. Mineralisation occurs mainly as chalcopyrite, partly oxidised to malachite and azurite, in **quartz-veined and hydrothermally altered fracture zones** in late Palaeozoic welded tuff and porphyritic microgranite.

Occurrences have been reported from Hammond, Horn, Badu, Moa, Booby, Goods, Thursday and Possession Islands, Pai Bai Tud Islet, and Peak Point and some of the tin lodes on the mainland. Galena and sphalerite are common accessory minerals in gold-quartz veins in the area, particularly on Horn Island and Possession Island.

Coen Inlier:

In the Iron Range district, minor **malachite and azurite** and traces of pyrite, galena and chalcopyrite occur in minor **shear zones in greenstone bands** of the Sefton Metamorphics south of the Claudie River. Mineralisation is close to the contact of calc-silicate rocks and the Kintore Adamellite. At Cooks Prospect No. 1, minor malachite and azurite and traces of pyrite and chalcopyrite are related to shearing in greenstone. One sample assayed 1.65% copper. At Cooks Prospect No. 2, a galena-bearing gossan assayed 23.6% Pb and 0.1% Cu.

Minor **copper, lead and zinc sulphide mineralisation** is associated with **quartz veins and gold-quartz veins** associated with mid-Palaeozoic granites in the northern Coen Inlier. Galena is the most common of these sulphides.

Near Potallah Creek, the Holroyd Metamorphics host **stratiform/stratabound massive and disseminated base metal sulphide mineralisation** (iron, copper, lead, zinc and minor silver and gold) (Bain & others, 1990). Mineralisation occurs in an intensely sericitised zone in the "Lukin Schist", an informal field subdivision of the Holroyd Metamorphics. The "Lukin Schist" comprises a layered sequence of alternating graphitic and sericitic siltstone and subordinate greywacke and altered mafic volcanic rocks. The sequence is isoclinally folded, has a strong penetrative cleavage, and is metamorphosed to upper greenschist - lower amphibolite grade.

The Gossan Prospect, 4.8km south-east of the Perseverance Mine at Potallah Creek, is a **stratiform polymetallic massive sulphide body** hosted by a black shale sequence and associated with basic igneous rocks. Mineralisation is discontinuous and patchy and is confined to a shear zone near the contact with the Kintore Adamellite.

Reconnaissance drilling has indicated a 0.7 to 1.8m thick deposit, at least 200m by 250m in area and containing up to 8.5% total sulphides. Assays of drill samples gave grades of 0.37 to 0.46% Cu, 1.68 to 11.51% Pb, 2.13 to 6.36% Zn, 19.7 to 94ppm Ag and 0.2 to 0.6ppm Au. Primary sulphides include chalcopyrite, galena and sphalerite. The surface expression of the mineralisation is a highly altered, brecciated, leached and partly gossanous rock. From 1978 to 1980, Anaconda Australia Incorporated carried out percussion drilling and calculated an indicated resource of 50 000t of ore with 10% combined copper, lead and zinc sulphides. The deposit is not exploitable on a large scale.

The Copper Prospect, east-south-east of the Alice River Goldfield, is a **copper-nickel mineralised ?dyke** of metamorphosed ultramafic rock. Mineralisation is stratabound and is associated with fractured rocks in the south-eastern portion of the outcrop. Copper occurs as malachite (replacing talc or tremolite) and as minor cuprite. Nickel probably occurs as nickel-bearing silicate. Costean samples assayed up to 1.42% Cu and 1.19% Ni.

Galena is a common accessory mineral in the **gold-quartz vein deposits** of the Alice River, Potallah Creek and Ebagoola goldfields.

Yambo Inlier:

No base metal mineralisation has been found in the Yambo Inlier.

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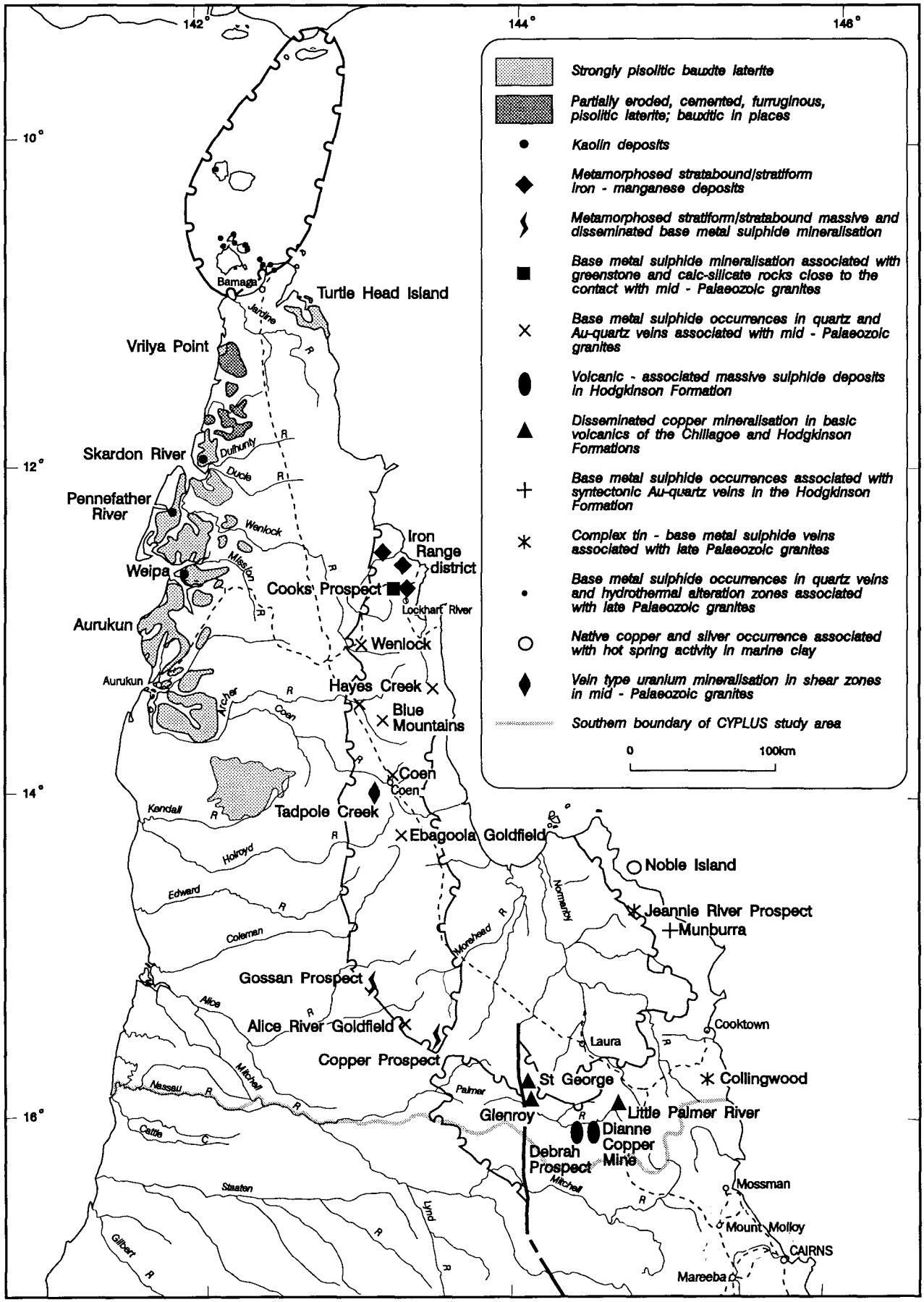

Figure 16. Distribution of bauxite, kaolin, iron-manganese, base metal and uranium deposits.

Hodgkinson Province :

Minor sphalerite, galena, chalcopyrite, bornite and tetrahedrite occur in the **cassiterite-quartz veins** of the Jeannie River Prospect. Minor galena is associated with some of the **gold-quartz reefs** at Munburra.

Native copper and silver, with a little gold, occur in uneconomic quantities below the high water mark on the eastern side of Noble Island. Mineralisation occurs as small threads and beads in black and yellow clays at 2.5m depth below a surface of coral and sand. The metals were apparently deposited by reduction from **hot spring water**.

Minor copper mineralisation occurs associated with **tin and tungsten vein systems** at Cannibal Creek, Spring Creek and in the Cooktown Tinfield.

Volcanic-associated massive sulphide deposits occur in the Hodgkinson Formation at the Debrah prospect and the Dianne Copper Mine.

These deposits comprise predominantly chert/quartzite beds associated with basic volcanic (spilitic) sills or flows. The tabular-shaped ore bodies are >100m long and are capped by ferruginous gossans. The sulphide zones contain pyrite bands replaced by chalcopyrite, sphalerite and galena (Fe>>Cu>Zn>>Pb and Ag>>Au). Past mining has been confined to secondary enrichment carbonate zones grading 20 to 25% Cu.

The Debrah Prospect and other copper prospects in the Mount Bennett area comprise discontinuous lenses of pyritic quartzite which have a gossanous expression and are anomalous in copper. There is a potential for massive sulphide deposits at depth.

The Dianne deposit is a stratiform copper- and zinc-rich, tabular, pyritic massive sulphide body which forms a steeply-pitching lens within an overturned sequence of interbedded shale and greywacke. The ore body is >150m long and is capped by a ferruginous gossan. Along strike, the massive sulphides grade into a thin, pyritic chert and, locally, stratabound pyrite, chalcopyrite and minor sphalerite occur in a sericitic shale. Supergene enrichment has occurred to approximately 100m depth. Past mining concentrated on the supergene enriched zone, which contained ores assaying up to 25% copper. Drilling intersected primary mineralisation with a grade of 3.8% Cu over 5m.

Gregory & Robinson (1984) concluded from sulphur isotope studies that the ore fluid was dominantly of magmatic origin. A decrease in temperature and fluid mixing with seawater probably initiated the precipitation of the ore minerals. No stockwork mineralisation is evident, apart from minor sulphide veining in chert beds in the footwall. Mineralisation may have formed distally from the source of the ore fluids.

Copper-mercury deposits in the Glenroy Creek - St George Copper mines area, north of Palmerville, occur in narrow, discontinuous lenses of basic volcanics and breccias interbedded with silicified sediments of the Chillagoe Formation. Mineralisation comprises chalcopyrite, chalcocite, malachite, native copper and cinnabar as disseminations and fracture fills and in quartz and calcite veins.

An area of **basic volcanics and chert** of the Hodgkinson Formation in the Little Palmer River area contains minor copper mineralisation (chalcopyrite and copper carbonates). The highest assay result was 380ppm Cu for a gossan sample.

URANIUM

Despite fairly extensive exploration for sedimentary and vein style uranium mineralisation, only one occurrence of definite uranium mineralisation has been found in the study area.

The Tadpole Creek Prospect (CRA Hill Prospect) (Figure 16) comprises **disseminated secondary uranium mineralisation** (autunite and metatorbernite) in mylonite and thin, concordant quartz veins in a shear zone in the Kintore Granite. The shear zone is radioactive for a length of 1300m and width of 0.7 to 2.4m, but the highest

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uranium content intersected in drillholes was only 350ppm. Minor gold is associated with the uranium.

Radiometric anomalies elsewhere in the study area have generally proved to be due to accumulations of **monazite in alluvial deposits**.

In 1972, Horizon Exploration Ltd delineated palaeostream channels incised in the Hodgkinson Formation and Permian granitic rocks at the base of the Laura Basin sequence, east of Laura, and considered the channels to be a suitable environment for **Colorado Plateau type uranium deposits**. Roll-front colour banding was found in quartzofeldspathic sandstone of the Gilbert River Formation. Rock chip samples indicated a limited to no potential for sedimentary uranium deposits.

IRON AND MANGANESE

Metamorphosed, stratabound/stratiform iron-manganese deposits occur in the Iron Range area (Figure 16). They comprise steeply-dipping lenses of magnetite and hematite-bearing schist and quartzite within the Sefton Metamorphics. The lenses locally contain traces of gold, possibly confined to small quartz veins in the schist.

The deposits were investigated by the Broken Hill Pty Company Ltd between 1957 and 1962 and contain about 1.0Mt of indicated resources ranging from 54 to 62% iron (including manganese) and 300 000t of inferred resources containing 45 to 55% combined iron and manganese. The small size of individual deposits renders them uneconomic.

BHP identified two types of iron deposits in the area. The southern type is in the Lamond Hill area and comprises hematite and quartz with some magnetite and very minor manganese minerals. The northern type is in the Black Hill area and consists of magnetite and quartz with lesser amounts of manganese oxides, rhodochrosite, calcite, pyrite and pyrrhotite. Petrological studies have indicated that most rocks of the ore zones have been derived from ferruginous siltstones by low to medium-grade metamorphism; some of the ore lenses may be metamorphosed basic rocks.

Highly oxidised manganese-rich residual cappings form an important part of the ore reserves of both deposit types. These cappings of massive ore may have formed by metasomatic replacement of silica, in iron-formation rocks, by iron and manganese oxides under the influence of meteoric water (Canavan, 1965). Scree has formed by mechanical breakdown of the massive ore and also forms an important proportion of the total resource.

BAUXITE

Aluminous laterite extends, with minor erosional gaps, for a distance of 350km along the west side of Cape York Peninsula, from Vrilya Point in the north to the Holroyd River in the south (Figure 16), and covers an area of approximately 11 000km^2, of which at least 520km^2 contains economic grade bauxite (Evans, 1975). The bulk of the bauxite is in 2500km^2 of mining leases held by Comalco Aluminium Ltd. Small residuals of aluminous laterite occur beneath a cover of dune sand on Turtle Island and east of the Escape River on the eastern side of Cape York.

In the Weipa Peninsula area, the laterite has developed on the "Weipa beds", a fluvial or deltaic unit overlying the Early Cretaceous, shallow marine Rolling Downs Group. The basal unit of the Weipa beds is a coarse quartz sandstone, overlain by interbedded kaolinitic clay and quartz sand. Bauxite has formed in the upper part of this sequence. North and south of the Weipa Peninsula, the aluminous laterites have formed on sediments of the Rolling Downs Group. Recent drilling by Comalco has indicated that the Weipa beds may be a facies of the Rolling Downs Group (Schaap, 1990).

The aluminous laterites are almost entirely restricted to the thicker Cretaceous to Tertiary sediments close to the present coastline. Inland, where Jurassic and Cretaceous sediments have been lateritised, the profiles are ferruginous, sandy, devoid of pisolites, and non-bauxitic.

The bauxite deposits formed by *in situ* weathering of the underlying sediments. The bauxite is considered to be the result of *in situ* weathering of the Weipa beds during the normal process of lateritisation. This is supported by the widespread field evidence of bauxite-coated fragments of the original sediments. In the Pera Head area, a quartz pebble zone found in the underlying sediments can be traced up-dip into the overlying bauxite. Additionally, the heavy mineral suite found in the bauxite layer is similar to that of the underlying weathered strata. The pisolitic bauxite is thought to have been concentrated within the zone of fluctuation of the old water table (Evans, 1975). Topographic position and porosity/permeability may have been important factors in determining the distribution of economic deposits.

The typical weathering profile is 20 to 35m deep and boundaries are gradational. The profile comprises:

- Laterite zone — 0.5m soil, 1 to 5m bauxite, 1 to 2m ironstone;
- Mottled zone — characterised by decreasing iron content with depth; stained by red and yellow iron oxides;
- Pallid zone — relatively low in free iron oxides; Weipa beds are white; kaolin deposits occur in Weipa area;
- Saprolite zone — transition between pallid zone and unweathered sediments.

The bauxite layer is a flat to gently dipping surface deposit averaging 2.4m thick, with <1m of overburden. The bauxite is strongly pisolitic and generally loose and friable. Pisolites are <1mm to 20 mm in diameter and occur in a sandy matrix. Available alumina is present in two varieties — gibbsite (trihydrate) and boehmite (monohydrate). Silica content (combined silica and quartz) is 1 to >10% and there are both low- and high-iron varieties.

In its 1992 Annual Report, Comalco reported total bauxite reserves of 248Mt (>50% Al_2O_3) for the Weipa and Andoom areas and a total resource of 3700Mt for its ML 7024 (formerly SBML 1).

Alcan South Pacific Ltd holds ML 7031 (formerly SBML 8) which extends from north of Weipa to the Dulhunty River. The lease is reported to contain 75Mt of bauxite (White, 1991).

Aluminium Pechiney Holdings Pty Ltd holds ML 7032 (formerly SBML 9) which extends from north-east of Aurukun to as far south as the Archer River. Opencut mining was planned, but the project has been in a care and maintenance phase since 1984. The mineable resource is approximately 300Mt (White, 1991).

In 1971, Pacminex Pty Ltd calculated pisolitic bauxite resources for the area south and south-east of Vrilya Point as 3.6Mt at a cutoff grade of 50% total Al_2O_3, 13.7Mt at a cutoff of 45% total Al_2O_3, and 38.4Mt at a cutoff of 40% total Al_2O_3 and <10% reactive silica. In 1982, resources were recalculated as 100Mt grading 44 to 45% total Al_2O_3 and 7% reactive silica. This resource is made up of numerous, scattered, thin (average 1.4m thick) deposits with significant boehmite in the upper portion of the profile. Physical beneficiation of the bauxite to produce a product with an acceptable reactive silica level is not currently economically viable.

Small residuals of aluminous laterite are exposed in cliffs beneath silica sand dunes on the north-east coastline of Turtle Head Island and along the coast from the Escape River south-east to about 1.5km north of Logan Jack Creek. These deposits are thought to be a product of lateritisation of the Helby beds (Smart & others, 1980). The bauxite is a 0.3 to 5.0m thick layer of hard, red pisolitic to nodular material and overlies a ferruginous nodular band, grading downwards into partly iron-stained sediments. The bauxite is too high in iron and silica to be exploited commercially. A white, low-iron variety occurs in cliff faces on Turtle Head Island

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and on the mainland from White Beach to Sharp Point and in the headwaters of creeks in the area. The silica content of this bauxite renders it unsuitable for alumina production but it may be suitable for use as refractory grade bauxite. The white bauxite occurs in low areas, below the permanent water table.

Enterprise Exploration Company inferred a resource of 280Mt of bauxitic material (with <2m overburden) on the mainland, with another 100Mt deduced from the topography. The inferred resource on Turtle Head Island was 30Mt with <2m overburden and 30Mt beneath sand dunes up to 91m deep. The approximate average grade was reported to be 35 to 40% total available alumina (7 to 10% of which is the monohydrate variety) and 12 to 15% total silica (7 to 10% of which occurs as combined silicate). Altarama Search Pty Ltd inferred a resource of ~19Mt with >40% alumina, <10% reactive silica, and >2m mineable thickness. Comalco Aluminium estimated that SBML 5, which covered the Turtle Head Island and mainland deposits, contained an inferred resource of 230Mt of red bauxite.

KAOLIN

The distribution of kaolin deposits is shown on Figure 16.

Weipa:

At Weipa, kaolin is mined for the production of premium quality coating clays. The kaolin occurs in the pallid zone of the laterite profile and is mined from areas from which the overlying bauxite has been removed. The deposits are discontinuous clay lenses approximately 2 to 3km long, 300m wide and 4.5m in average thickness. They overlie a shallow quartz sand aquifer. The top and bottom contacts with sandstone and clayey sandstone are sharp.

Studies of the kaolin and the relationship between the claystones and sandstones of the Weipa beds indicate that the kaolin was laid down as a clay. The purity of the kaolin probably is the result of alterations which occurred during the formation of the laterite profile.

The crude kaolin ore contains 70 to 90% kaolinite, 5 to 20% quartz sand, 0.1 to 0.3% hematite, 1.2 to 1.6% anatase and 1 to 3% muscovite. Accessory minerals include zircon, tourmaline, leucoxene, rutile, ilmenite, goethite, sphene, siderite, magnetite, apatite, monazite, andalusite, staurolite, spinel and halloysite (Schaap, 1990). The kaolin product comprises kaolinite plus a small amount of anatase.

The deposit contains proved and probable reserves of 17.8Mt and a total resource of approximately 50Mt.

Recently, extensive areas of kaolin have been found in the Pennefather River - Mapoon area, about 20km north of the Weipa deposit (White, 1991).

Skardon River:

Venture Exploration N.L. is investigating the mining potential of paper-coating grade kaolin deposits on its ML 6025 (formerly ML 5, Weipa) near the Skardon River. Reserves are estimated at 27Mt of raw kaolinite, containing 15 to 50% of <2μm kaolin (White, 1991). The aluminium and iron contents are reportedly lower than in the Weipa deposits. There are about 8Mt of shippable kaolin product (at an estimated average of 32% of <2μm kaolin). Capital costs are low and interests have been registered for purchasing the kaolin. Dredging is planned to produce 0.2Mt/year as a slurry. In 1991, the Federal Government's Industry Research and Development Board awarded Venture Exploration a grant of $171 000 to assist in construction of a pilot processing plant. This pilot plant in Cairns is already producing high quality, refined kaolin. The company is currently seeking financing to allow establishment of the first stage of the mine by mid to late 1995. The mine is expected to have a 200 000t/y production rate and an expected lifespan of 40 years (Cooper, 1993c).

SILICA SAND

Significant deposits of Quaternary dune sands occur along the east coast of Cape York Peninsula (Figure 17). Deposits at Cape Flattery and Shelburne Bay are suitable for glass manufacturing and foundry sand.

Archer Point: Extensive deposits of white dune sand occur at Archer Point, south of Cooktown. The sands occupy a 4km by 3km area and form a thin veneer on sedimentary rocks of the Hodgkinson Formation. Martin (1980b) concluded that the fineness of the sand and the large variation in some size fractions render it unsuitable for use in glass making. The average grade is 97.8% SiO_2, 0.7% Fe_2O_3, 0.2% Al_2O_3 and 0.21% loss on ignition, making the sand chemically inferior to that at Cape Flattery.

Cape Flattery - Cape Bedford dunefield: The Cape Flattery - Cape Bedford dunefield extends from Cooktown north to Lookout Point. It is 55km long by up to 22km wide and covers an area of 580km^2.

The dunefield occupies a low-lying coastal plain, 5 to 10m above sea-level, and formed because of a local abundance of sand derived from Palaeozoic granites and Mesozoic sandstones and exposure to strong onshore winds. Quartz sand drifted north until trapped by the bedrock headlands of Cape Bedford, Cape Flattery and Lookout Point. Transgression of a rising sea in Pleistocene interglacial periods eroded frontal dunes and created a sand source by recycling the existing dunes (Cooper & Sawers, 1990).

The field consists predominantly of white, sharp-featured, active, transgressive parabolic and elongate parabolic dunes, and rounded degraded dunes stabilised by vegetation. The almost unidirectional south-easterly winds have resulted in dunes which are >7km long and only 0.5km wide. The apical sand mound can be up to 90m above the surrounding sand plain. The active dunes consist predominantly of quartz sand; heavy mineral content ranges from a trace to about 0.75% (mainly ilmenite).

Mining is currently carried out at the Cape Flattery Silica Mine, 60km north of Cooktown, where Cape Flattery Silica Mines Pty Ltd has proved reserves of 200Mt under mining lease (Cooper, 1993d); the potential resource in the area would be much greater. The optimum source of white silica sand is the bare apical mounds of the elongate parabolic dunes. The grain size distribution is particularly suitable for glass manufacture and foundry moulding. Cooper & Sawers (1990) gave a chemical analysis for export quality sand of 99.82% SiO_2, 0.01% Fe_2O_3, 0.05% Al_2O_3, 0.02% TiO_2, <0.01% CaO, <0.01% MgO and 0.10% loss on ignition.

Ninian Bay area: Sand dunes on the western side of Ninian Bay represent a silica sand resource that would require beneficiation to produce a marketable product. The bulk of the sand averages >99.5% SiO_2, but iron and titanium impurities exceed standards for glass manufacturing. There is an estimated 24m depth of sand in the main dune area and 12m in the low dunes. The area investigated is now within the Cape Melville National Park. An extensive area of vegetated dunes occurs to the south and south-west of Ninian Bay; these dunes have not been investigated.

Colmer Point: After processing, silica sand forming the palaeobeach ridge system of the Colmer Point heavy minerals deposit may be suitable for use in glass making. Inferred resources are 192Mt of contained silica (Cooper, 1993d).

Cape Direction to Cape Weymouth: Sand dunes in the Cape Direction and Cape Weymouth areas have not been investigated as potential sources of silica sand.

Olive River dunefield: The Olive River dunefield extends from the Olive River north to Shelburne Bay and inland for 15km; it covers an area of 550km^2 of a roughly triangular-shaped, low coastal plain. The dunefield is of Quaternary age and overlies Jurassic and Cretaceous quartzose rocks of the Carpentaria Basin. Theories on the genesis of the dunes differ from those for the Cape Flattery - Cape Bedford dunefield, and the Olive River dunes are thought to be much younger. Cape Grenville may have

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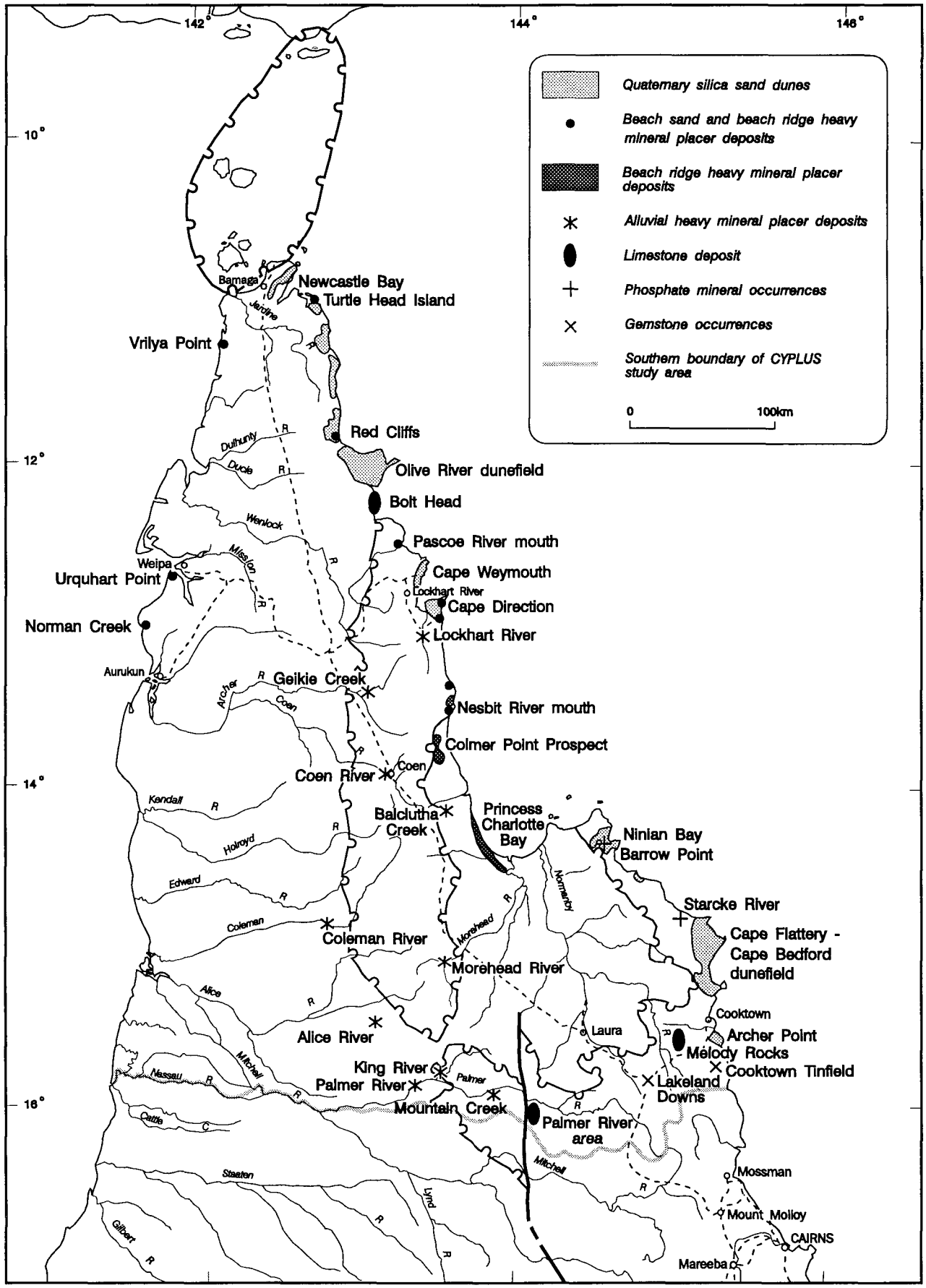

Figure 17. Distribution of silica sand, heavy mineral, limestone, phosphate and gemstone deposits.

acted as an anchor point for the progradation of a sand barrier, with the resultant accumulation of the field (Cooper & Sawers, 1990).

The field is characterised by active parabolic and elongate parabolic dunes aligned parallel to the prevailing south-east winds and by older stabilised and lateritised dunes. The dunes consist almost entirely of quartz sand; heavy mineral content is 0.024 to 0.206% (mainly ilmenite and zircon).

In the central and northern areas, active parabolic and elongate parabolic dunes, with numerous shallow deflation lakes and swamps, are all well developed on a relatively low interdune sandplain. The north-eastern sector contains well vegetated, hummocky, degraded, older, stabilised and lateritised dunes, with a small area of white, active, elongate parabolic dunes which have been investigated as a source of silica sand. These dunes are over 80m high, and have a central deflation corridor and interdune lakes. Conical Hill and Saddle Hill are about 1.5km long and up to 250m wide. Major dunes in the north and north-west include Round Point and White Point.

In 1967 and 1968, Metals Exploration N.L. delineated a potential resource of 6Mt of high-grade sand with >99% SiO_2 to 12m depth at Shelburne Bay. In 1973 to 1977, A.C.I. delineated >200Mt of good quality glass making sand within 16km of Round Point.

More recent activity centred around the Shelburne Bay silica sand project in the northern part of the field. A firm development proposal was formulated by the Shelburne Silica Joint Venture, comprising Shelburne Silica Pty Ltd and ASP Resources (Queensland) Pty Ltd (jointly owned by Toyo Menka Kaisha Ltd and Nippon Sheet Glass Company Ltd). Exploration on ML 5945 proved reserves of 8.76Mt of high quality sand at Conical and Saddle Hills, where a >40m thickness of white sand has been derived from aeolian reworking of well-developed podsolic A_2 horizons. There is 40Mt of probable reserves covered by mining lease tenure. Inferred resources are 143Mt (Cooper, 1993d).

The sand meets specifications for foundry moulding and glass manufacture. Cooper & Sawers (1990) gave a chemical analysis for Conical Hill sand of 99.80% SiO_2, 0.001% Fe_2O_3, 0.037% Al_2O_3, 0.013% TiO_2, 0.0001% Cr_2O_3, <0.01% CaO and <0.01% K_2O. Grainsize range is similar to that of sand currently mined at Cape Flattery.

An opencut mine was planned with an expected capacity of up to 2.0Mt/y, using Margaret Bay as a port site, but the project was deferred when Commonwealth Government action prevented the development on environmental grounds. The main deposits are protected by a Department of Minerals and Energy Restricted Area.

Shelburne Bay to Newcastle Bay: Extensive, shallow, windblown dunes of white sand extend inland for up to 8km from Red Cliffs north to Newcastle Bay. Dunes in the Red Cliffs area were drilled by Altarama Search Pty Ltd in 1970 and 1971 but the company did not consider the sand to be sufficiently pure for use as silica sand.

Dunes in the Orford Bay - Orford Ness area are unlikely to be economic. Processing would be required to remove heavy minerals from the sand (White, 1991). The dunes are now within the Jardine River National Park.

Newcastle Bay to Escape River: High quality sand suitable for glass manufacture overlies bauxitic laterite along the coast from Newcastle Bay to the Escape River and on Turtle Head Island. The dunes on Turtle Head Island are up to 91m deep. Comalco Aluminium Ltd delineated a probable resource of >30Mt of high purity sand. Chemical analyses of samples gave 99.70 to 99.78% SiO_2, 0.011 to 0.014% Fe_2O_3, 0.04 to 0.06% Al_2O_3, 0.026 to 0.064% TiO_2, <0.01% CaO, <0.01% MgO, <0.001% Cr_2O_3 and 0.10 to 0.15% loss on ignition.

Skardon River: Silica sand could be produced as a by-product during processing of the Skardon River kaolin.

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HEAVY MINERALS

Heavy mineral sands occur extensively throughout Cape York Peninsula (Figure 17) but few deposits are of economic interest. The main deposit types are beach and beach ridge placer deposits, dune placer deposits and alluvial placer deposits. The dominant mineral present is ilmenite, but rutile, zircon and leucoxene also occur; tantalite has been reported from some alluvial deposits. Many of the deposits contain significant proportions of rare earth minerals such as monazite and xenotime. The primary source of the heavy minerals is the Proterozoic metamorphic rocks and the Palaeozoic granitic rocks of the Coen and Yambo Inliers and Hodgkinson Province and reworked detrital grains from Mesozoic and Cainozoic sedimentary sequences. The most significant deposit is the palaeobeach ridge placer deposit at Colmer Point.

West coast of Cape York Peninsula:

Beach sands along the western coast of Cape York Peninsula have no potential as heavy mineral deposits, but some beach ridge systems have some potential.

A sizeable deposit of moderately high grade black sand occurs in **beach ridges** near Urquhart Point, opposite Weipa. Associated Minerals Consolidated Ltd (a wholly owned subsidiary of Renison Ltd) currently holds ML 6023 over the deposit. The deposit is unusual in that up to 80% of the concentrates consist of rutile and zircon, rather than ilmenite.

Another deposit with rutile and zircon as the main constituents occurs at the mouth of Norman Creek, but is subeconomic.

Heavy minerals also occur in **coastal sands** at Vrilya Point (White, 1991).

Streams draining west into the Gulf of Carpentaria commonly carry subeconomic concentrations of heavy minerals (mainly ilmenite, with some zircon, rutile, leucoxene, monazite and xenotime). Total heavy minerals generally constitute <1% of the alluvium and volumes of material available are generally too low for a viable mining operation. River systems known to carry heavy minerals include the Palmer, Red, Mitchell, King, Coleman, Alice and Coen.

East coast of Cape York Peninsula:

Beach sands on Turtle Head Island contain 5 to 10% heavy minerals (zircon, rutile, ilmenite and garnet) but deposits are too small to be economic. Drilling samples collected by A.O. (Australia) Pty Ltd returned >0.5% heavy mineral concentrates. **Sand dunes** at Chandoogoo Point also contained >0.5% heavy minerals.

Thin, discontinuous surface concentrations of heavy minerals occur on present **beaches** on the east coast of the Peninsula, especially between Princess Charlotte Bay and Orford Bay.

Low **beach ridges** in the Princess Charlotte Bay area have generally low heavy mineral contents. Although auger samples have contained up to 3.1% heavy minerals, the minerals are invariably magnetite and ilmenite.

A number of thin, discontinuous seams occur on narrow **beaches** between Cape Sidmouth and Cape Direction and near the mouths of the Nesbit and Pascoe Rivers. The concentrates contain >90% ilmenite, with minor zircon, rutile, magnetite and monazite. A sandbar extending north from the Nesbit River mouth contains concentrates that are dominantly ilmenite and are extremely poor in rutile and zircon.

Thin, discontinuous surface seams of heavy minerals occur on **beaches** north of Shelburne Bay, particularly in the Red Cliffs area. The sands contain up to 0.43% heavy minerals (mainly ilmenite, rutile and zircon). Drilling has indicated a total potential resource of only 500m^3 of sand.

A Pleistocene, quartzose **sand dune** system near Colmer Point is currently being investigated as a heavy mineral resource. The main dune system extends north and south of the Rocky River and is 20km long, up to 3km wide, and up to 100m above sea level. A second large dune system extends north of the Nesbit River. The dunes may be **beach ridge deposits**.

The dunes were investigated by Alberta Mines N.L. as a potential source of silica sand. However, Alberta Mines concluded that the heavy mineral content was too high for a silica sand operation without incorporating a processing stage.

Peko Wallsend Operations Ltd (in joint venture with Lake Libby Pty Ltd and Arkara Minerals Pty Ltd) is currently investigating the dune systems under EPMs 5767, 5772 and 5830. The dunes contain low grade concentrations of ilmenite, rutile, zircon and leucoxene.

Generally, the transgressive **dune systems of silica sand** on the east coast of the Peninsula contain only minor proportions of heavy minerals. Heavy mineral content ranges from a trace to 0.75% at Cape Flattery and 0.02 to 0.2% at Shelburne Bay (Cooper & Sawers, 1990). The main minerals present are ilmenite and zircon.

Streams draining into Princess Charlotte Bay, such as Balclutha Creek, and the Stewart, Morehead, Laura, Kennedy and Normanby Rivers carry ilmenite, rutile, zircon, monazite and xenotime. Alluvial sands of other streams draining east of the main divide, such as Lockhart River, are known to contain subeconomic concentrations of ilmenite, monazite, zircon and rutile.

LIMESTONE

Bolt Head: Limestone crops out at Bolt Head in the Temple Bay area (Figure 17). It is coarsely crystalline and schistose, has a stratigraphic thickness of at least 100m, and is part of the Sefton Metamorphics. It is cut by calcite and quartz veins, thereby adversely affecting the overall grade. Broken Hill Pty Company Ltd estimated that there is only about 25 000t of limestone readily available. Hand-picked material, free of quartz veins, assayed 53.0% CaO, 1.2% MgO and 2.4% SiO_2. It is unlikely that the total resource would be >1Mt.

Melody Rocks: Queensland Metals Corporation Ltd currently hold MDL 5 over the Melody Rocks limestone deposit near Kings Plains. The limestone occurs as lenses in the Hodgkinson Formation in a 2700m by 700m area, with vertical exposures of up to 120m. Eight bodies are of potential economic interest and five are of major significance. The limestone is light grey, fine-grained and homogeneous. The five major lenses comprise approximately 900 000t/vertical m of limestone at 55% CaO, <1.0% SiO_2, <0.4% MgO, <0.2% Fe_2O_3 and <0.4% Al_2O_3. Indicated resources are >100Mt of high to chemical grade limestone. The company has carried out feasibility studies on setting up a cement clinker plant at Archer Point. The high quality of the limestone would allow it to be marketed, not only for cement manufacture, but also for the chemical and mineral processing industries or agriculture.

Palmer River area: Large resources of limestone (~1500Mt) occur in a belt in the Chillagoe Formation extending between the Mitchell and Palmer Rivers (Krosch, 1990). This belt extends northwards beyond the Palmer River but is difficult to access.

The limestone normally is light to dark grey, massive, and recrystallised in the vicinity of granite intrusives. Chert, sediments and basalt are interbedded with the limestone.

PHOSPHATE

Phosphate minerals are associated with thinly bedded black chert and shale sequences of the Hodgkinson Formation in the Starcke River and Barrow Point areas, north of Cooktown (Figure 17). The rocks are intensely silicified and veined; ferruginous gossans are developed.

The cherts contain small, white lenses which contain apatite and may represent flattened phosphate pellets and balls which formed during deposition of the chert-black shale sequences. These lenses rarely constitute >25% of the total rock and it is unlikely that the rock as a whole would grade >5% P_2O_5. Wavellite, strengite, variscite and gorceixite occur on joints and weathered surfaces and as veins. The deposits are not economic.

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GEMSTONES

Zircon, garnet and sapphire occur in the weathering products of basaltic pyroclastic deposits at Mount McLean, Hoskin's Vent and Tom's Hollow, in the Lakeland Downs area (Figure 17). Zircon, garnet and rare sapphire occur in the drainage system within Bull Hollow (Domagala & others, 1993).

Diamonds have been recovered from the East and West Normanby Rivers and Little Palmer River during alluvial gold mining operations, as well as from the Laura River drainage system in the Lakeland Downs area. Diamond indicator minerals have been found at Tom's Hollow and Bull Hollow. Extensive company exploration has failed to find the source of the diamonds.

Minor sapphires have been recovered from time to time during alluvial tin mining operations in the Cooktown Tinfield and from Campbell and Spear Creeks, which are tributaries of the Palmer River.

COAL

In Cape York Peninsula, coal is known to occur in Carboniferous, Permian and Mesozoic sediments (Figure 18). In recent years, several companies have been active in prospecting for coal around the margins of the Laura Basin and the eastern margin of the Carpentaria Basin. The general philosophy has been to examine the possibility of coal in basal Jurassic fluviatile sediments, or in possible subsurface Permian sediments beneath the Mesozoic sequence.

Pascoe River area:

Morton (1924) reported that the presence of coal in the Pascoe River valley had been known to prospectors for at least 30 years. He investigated outcrops along the Pascoe River and Hamilton Creek and found that they consist mainly of carbonaceous shale with coal bands up to several centimetres thick. He described one outcrop, near the Hamilton Creek junction, as 3m of "highly metamorphosed carbonaceous strata, including 50% of stony bands". The original carbonaceous material is now graphitic. A sample from a 50 to 100mm thick coal seam gave the following analysis: 1.3% moisture, 37.9% volatiles, 51.3% fixed carbon, 9.5% ash.

Several coal seams occur in the **Carboniferous** Pascoe River beds, both in outcrop and in bore holes, but the seams are generally thin (<150mm thick) and are uniformly of very poor quality. They are steeply dipping and are disrupted by shearing parallel to bedding planes and by large-scale normal and wrench faulting. An estimate of reserves (of the order of 1.8Mt) suggested that the coal is uneconomic.

Morton (1924) reported that coal also occurs in a thin shale bed near the base of the **Mesozoic** sandstone overlying the Pascoe River beds near the confluence of Canoe Creek and the Pascoe River. A sample gave the following analysis: 0.6% moisture, 34.1% volatiles, 42.6% fixed carbon, 22.7% ash. Drilling of the Mesozoic sequence indicated that only rare, very thin (<300mm) lignite coal seams are present and that the Mesozoic rocks have no coal-producing potential.

Olive River Basin:

Permian coal seams occur over a restricted area in the Olive River Basin (Wells, 1989a). The seams are at 98 to 364m depth and are of coking quality. The known areal extent is small and the sequence is probably affected by faults. Exploratory drilling to date has not delineated any economic deposits. Coal has also been intersected in the **Mesozoic** Garraway Sandstone in this area.

Little River Coal Measures:

Coal was first discovered along the Little Kennedy River in 1872 by Norman Taylor, the geologist accompanying Hann's expedition. The proximity of the coal to the Palmer Goldfield and the announcement of a projected rail link between Laura and Palmerville led to intensive prospecting in 1881.

Jack (1882) reported on the results of shaft sinking and described several outcrops along the river and its tributaries. The coal is weathered in outcrop but reportedly

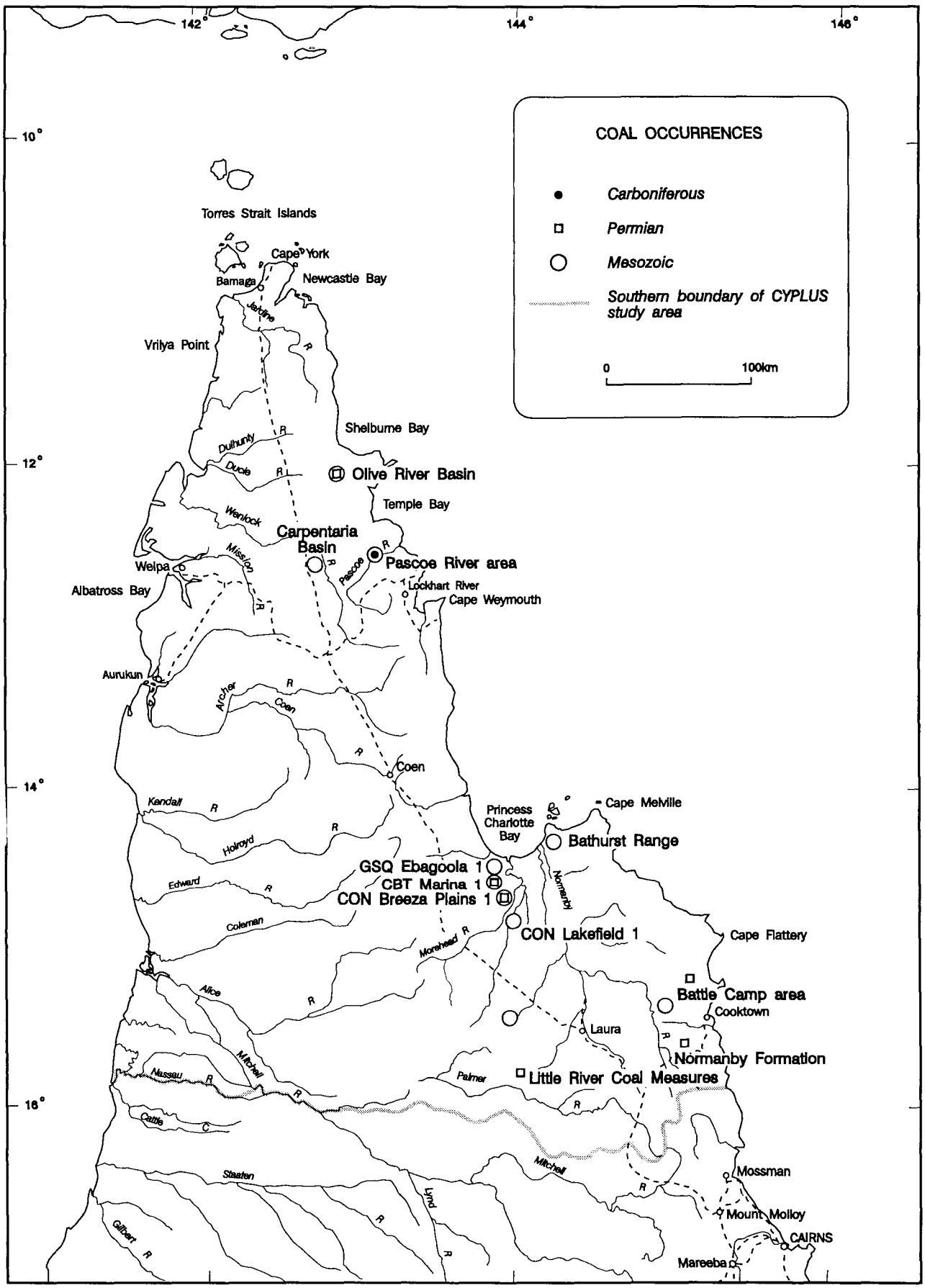

Figure 18. Coal occurrences, Cape York Peninsula.

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improved at depth, although still containing a high proportion of clay. The seams occur in the **Permian** Little River Coal Measures and are up to 6m thick, but are steeply dipping and strongly deformed, faulted and slickensided. Two samples collected by Jack (1882) contained 0.919% and 2.763% moisture, 9.388% and 26.197% volatile hydrocarbons, 58.606% and 62.998% fixed carbon, and 31.087% and 8.042% ash. The coal is of poor quality (Carr, 1975b; Wells, 1989b).

Rands (1893) also described prospecting operations in the area. The analyses of three coal samples were: 1.60 to 1.68% moisture, 9.41 to 12.94% volatile hydrocarbons, 76.10 to 82.38% fixed carbon, 0.08 to 0.44% sulphur and 5.94 to 10.78% ash. Rands concluded that the coal is of very inferior quality and that the steep dip of the seams would make them uneconomical to mine.

Normanby Formation:

The **Permian** Normanby Formation contains at least 30m of shaly coal in outcrops about 1.6km north-east of the Brothers. The coal is of poor quality and has a high ash yield (Carr, 1975b; Wells, 1989b).

Jack (1879a) reported the discovery of coal in the Little Oakey Creek - Deep Creek area. A shaft was sunk to 6m depth on a 460mm thick seam of dark carbonaceous clay with coal streaks and a 250mm seam of impure argillaceous coal. Jack found numerous coal seams, some of very good quality, between Oakey Creek and the Normanby Range; the thickest seam was only 200mm. Jack noted that the deposits are older than Mesozoic sediments capping hills in the area.

Jack (1879b) reported that the coal-bearing sediments extend over a 9.6km long by 2.4km wide area. Some good quality coal was found, but only in seams <75mm thick.

Permian sediments beneath the Laura Basin:

Coal traces and carbonaceous material have been recorded in Permian strata beneath the Laura Basin sediments in petroleum exploration wells CBT Marina 1 and CON Breeza Plains 1 (Carr, 1975b; Wells, 1989b). Coal exploration has also led to the discovery of thin coal bands in Permian sediments beneath the basin.

Laura Basin:

Carbonaceous shale and very thin coal seams (generally <300mm thick) are common in the lower part of the **Mesozoic** Dalrymple Sandstone, particularly the basal 30m of the formation.

Jack (1879b) noted a 200mm thick shale section with thin coal bands near the base of the formation on the northern side of the Endeavour River. Thin coaly beds and laminae occur at about 30m above sea level on the western side of a hill west of Cape Flattery (Lucas & de Keyser, 1965b). The ash content of coal from the Dalrymple Sandstone has been recorded as 8 to 26% (Dunstan, 1913).

Coal occurrences have been known in the Battle Camp Siding area since the 1880's. They attracted interest because of their proximity to the Cooktown - Laura railway. All of the seams are within the Dalrymple Sandstone. Jack (1887) reported that shafts had been excavated on coal seams to 0.46m thick in the Welcome Creek area. Two samples assayed 8.25% and 7.16% moisture, 30.42% and 20.96% volatile hydrocarbons, 42.31% and 35.35% fixed carbon, and 19.02% and 36.53% ash.

Jack (1895) reported that Christie's shaft (105m deep) at the "38 Mile" intersected a 250mm thick coal seam which assayed 0.95% moisture, 19.77% volatile hydrocarbons and sulphur, 66.88% fixed carbon, and 12.40% ash. Other thin coal seams (to 75mm thick) were also intersected in the shaft. An adit excavated at Stack's Creek exposed 250mm of good quality, clean coal which was used on the Laura locomotive with satisfactory results.

Jackson (1902) reported assay results for four samples from two coal seams in Christie's adit. The samples gave 0.80 to 1.645% moisture, 17.89 to 20.185% volatile hydrocarbons, 33.95 to 42.94% fixed carbon, and 36.34 to 46.51% ash. Jackson concluded that the coal contained too much ash and was poor in quality. Ball (1909) has also reviewed the coal deposits in this area.

Traces of coal have been found in Mesozoic sediments in a number of petroleum exploration holes in the area. Jurassic coal crops out in the area north-east of

Laura, but by far the most important discovery to date has been an underground, coking coal resource at Bathurst Range.

From 1978 to 1986, Utah Development Company delineated an underground coking coal resource in Jurassic sediments at Bathurst Range. A number of seams occur at up to 400m depth over a 140km^2 area. Exploration has concentrated on one major seam which is up to 2m thick and averages 1.6m. Resources have been variously quoted as 15Mt (Miezitis & Bain, 1991), 255Mt (White, 1991), and 157Mt (Queensland Department of Minerals and Energy, 1993). The deposit is currently covered by EPC 463, which was held by BHP-Australia Coal Ltd but has recently been sold to Bathurst Coal and Power Ltd. The coal is a medium to low volatile, bituminous coking coal with a moderately high sulphur content (Hawkins & Williams, 1990) and can be washed to produce a low ash, high swelling product with good yield (Doyle & others, 1986). Bathurst Coal and Power Ltd have commenced a feasibility study to produce a mine plan for production and export of high grade coking coal by the end of 1995 (North Queensland Register, 23rd June 1994).

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MINERAL RESOURCE ASSESSMENT

Gold (Au)

Model AuA: Iron-formation-hosted gold

Commodities, by products and trace metals: Gold

Geological setting: Greenstone belts; commonly near regional division or "break" between predominantly metavolcanic and predominantly metasedimentary rocks. Greenschist facies metamorphism. Rock types include regionally metamorphosed mafic and felsic metavolcanic rocks, komatiites and volcaniclastic sediments interlayered with banded iron-formation. Intruded by felsic plutonic rocks and locally by quartz porphyry and syenite porphyry. Depositional environment may be submarine hot spring activity related to volcanism, or later hydrothermal activity related to intrusive rocks.

Age: Precambrian

Deposit description: Stratabound to stratiform gold deposits in iron-rich chemical sediments in metavolcanic terrane. Deposits comprise narrow, thinly laminated beds, veins or lenses overlying stringers (stockworks). Bedded ores occur in Fe-rich siliceous or carbonate-rich chemical sediments with veins and stockworks in feeder zones in these sediments, often interlayered with flow rocks. Beds may be cut by concordant or sharply discordant quartz-carbonate veins with gold. The host rocks contain quartz + siderite and/or ankerite + tourmaline + chlorite + magnetite in volcanic terranes. Mineralogy comprises native gold + pyrite + pyrrhotite ± arsenopyrite ± magnetite ± sphalerite ± chalcopyrite. May contain minor tetrahedrite + scheelite + wolframite + molybdenite ± fluorite ± stibnite.

Geochemical signature: Au + Fe + As + B + Sb (+ platinum group metals in mafic volcanic terranes). Bi, Hg and minor Cu-Pb-Zn-Ag-Mo. Gossans form from oxide and carbonate iron-formation.

Geophysical signature: Strong magnetic response of host iron-formation.

Known deposits: Iron Range area

Assessment criteria:

1. Distribution of iron-formation.
2. Distribution of known stratabound and vein gold mineralisation associated with iron-formation.

Assessment:

Area AuA1 (Map 2)

Gold mineralisation is associated with iron-formation of the Proterozoic Sefton Metamorphics in the Iron Range area. Deposit types include stratabound mineralisation and discordant sulphide breccias and quartz-sulphide veins and breccia. There is a high resource potential for small gold deposits with a certainty level of C.

Higher grade gold is associated with quartz-sulphide veins and siliceous, silicate-pyrite-rich rocks in a banded iron formation comprising mixed silicate, silica, sulphide, oxide and carbonate facies. The banded iron formation carries traces of gold (0.2 to 2.0ppm).

Area AuA2 (Map 2)

The iron formation rocks of the Sefton Metamorphics are exposed in the Larrads Hill area, north of the Pascoe River. There is no known gold mineralisation in this

area and there is a moderate resource potential for small gold deposits with a certainty level of B.

Economic significance: The grade/tonnage of known deposits at Iron Range are given on Figure 19. Most deposits are very small (<1000t of ore) but there is potential for deposits of ~10 000t at grades of ~20g/t Au. Deposits of this type are significant gold producers in Western Australia, Canada and the United States.

Equivalent/ related deposit types: Volcanogenic gold, Archaean greenstone gold, Homestake gold / mesothermal Au-quartz veins.

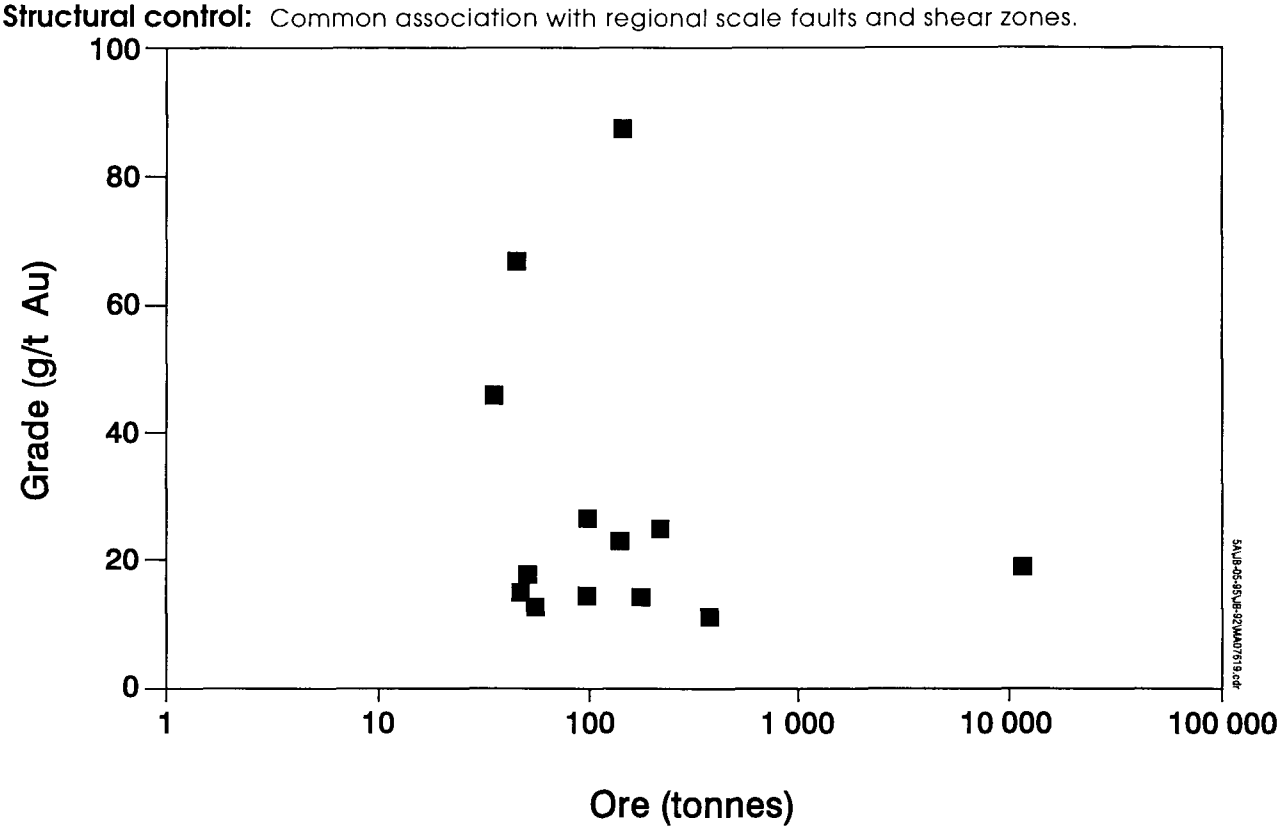
References: Bruvel & Morwood (1992)
Cox & Singer (1986)
Eckstrand (1984)

Model AuB: Mesothermal Au-quartz veins (Coen type)

Commodities, by products and trace metals: Gold, antimony

Geological setting: Coen and possibly Yambo Inliers. Veins in and adjacent to regional shear zones which extend for tens of kilometres in Silurian to Devonian granites and adjacent Proterozoic metamorphic rocks.

Structural control: Common association with regional scale faults and shear zones.



Iron Range area - historical production

Figure 19. Grade-tonnage diagram, iron-formation-hosted gold deposits.

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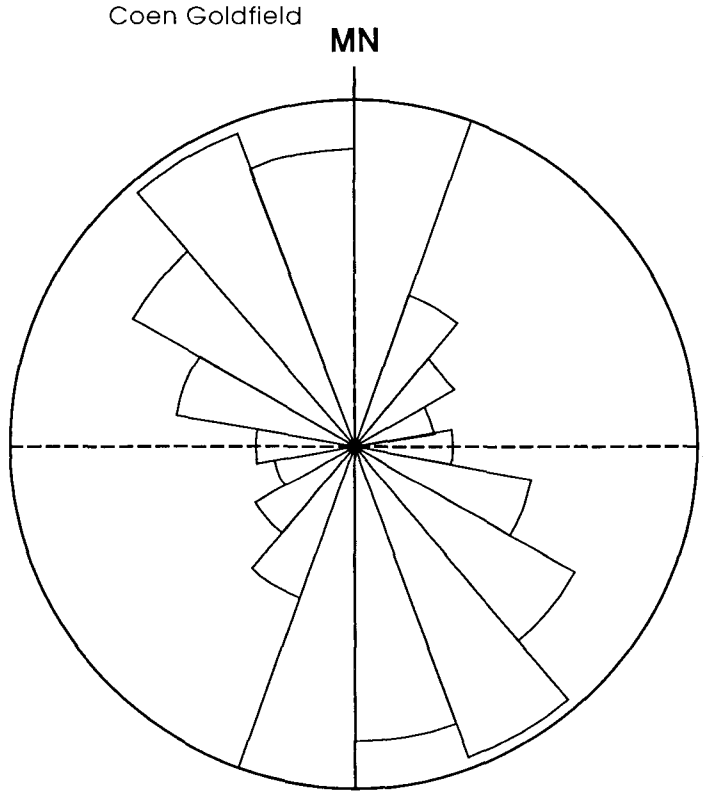
Age: Host rocks Proterozoic to Devonian. Mineralisation may be related to intrusion of Silurian to Devonian granites and associated metamorphism and/or later Carboniferous to Permian granites and acid dykes.

Deposit description: The deposits occur as simple or compound quartz reefs in fissures and as lenticular, en echelon and anastomosing quartz bodies along shears. Individual reefs are up to 2m wide and several hundred metres long, strike south-south-east to south (Figure 20), and dip steeply. Massive euhedral and comb quartz is cut by veinlets and infilled with later generations of vugh-forming quartz. Wall rock alteration comprises sericite ± carbonate ± pyrite ± chlorite selvedges up to 2 or 3 times the vein width and is most prominent in the granites. Brecciation and silicification are characteristic of the major producing mine — the Great Northern, at Coen. Some reefs have graphitic selvedges adjacent to ore shoots.

Mineralisation comprises a simple pyrite ± arsenopyrite ± base metal sulphide assemblage. Free gold generally occurs adjacent to sulphides; the gold has a gold:silver ratio of approximately 3:1. Mineralisation is generally restricted to short, rich shoots containing crosscutting generations of quartz and rarely occurs in primary quartz or wall rocks. Economic ore shoots tend to occur at inflection points along the shear zones. The best grades are in narrow leaders on the footwall and/or hanging wall. Veins mined in the past were very high grade (up to 300g/t and generally 30 to 60g/t). Stockwork and spur vein systems adjacent to the reefs are not well developed and generally grade up to 8g/t Au. Altered granite generally assays <2.5g/t Au (average 0.15ppm).

The veins probably formed from hydrothermal fluids during brittle reactivation of faults and mylonite zones. Graphitic wall rock zones may have controlled deposition of gold in some of the ore shoots.

Type area: Coen Goldfield



Strikes plotted by area
Mesothermal Au-quartz veins (Coen type)
N=288

5A\JB-05-95\JB-92\MA07620.cdr

Figure 20. Rose diagram, strikes of mesothermal Au-quartz veins (Coen type).

Geochemical signature: Arsenic best pathfinder in general; Ag, Pb, Zn, Cu. Abundant quartz chips in soil; gold may be recovered by panning.

Known deposits: Coen Goldfield, Ebagoola Goldfield.

Assessment criteria:

1. Regional shear zones, particularly zones separating Proterozoic metamorphic rocks and mid-Palaeozoic granites.
2. Distribution of known deposits and goldfields.

Assessment:

Area AuB1 (Map 2)

This area covers Au-quartz vein mineralisation in the old Wenlock Goldfield and possible extensions under cover. There is a high resource potential for small Au-quartz vein deposits with a certainty level of C.

The main known deposits are at Lower Camp, Top Camp, Golden Unit, Chock-a-Block Creek and Iguana Mountain. Gold occurs with pyrite arsenopyrite galena in quartz veins in sheared and chloritised/sericitised granite of the Kintore Granite. The veins are generally <1m wide and comprise comb quartz with white and blue banding. Free gold occurs in short rich shoots; the best grades are in narrow leaders on the footwall and/or hanging wall. Most of the veins mined in the past were only short leaders, but veins extending for >450m along strike and to >100m depth were mined at Lower Camp.

Grades mined in the past were generally high, for example, the average mined grade of the Main Leader at Lower Camp was 46g/t. This vein is a fissure reef with well-defined, slickensided walls. Gold Copper Exploration Ltd carried out core drilling at Lower Camp and Top Camp. The grades of the quartz veins intersected were disappointing compared with the historical results. The best intersection was 2m at 3.39g/t Au at Lower Camp.

At Lower Camp, a 10m wide formation of sericitised granite between the Main Leader and the Peacock Leader graded 6.2g/t. However, core assay results were generally low for granite not containing quartz veins.

At Top Camp, Gold Copper Exploration delineated a zone of sheared and graphitic granite enclosing a 3 to 5m wide zone of silicified breccia. Rock chip samples indicated that mineralisation grading up to 2.28ppm was discontinuous, downgrading the potential for a bulk tonnage deposit.

Area AuB2 (Maps 2 and 3)

This area is largely inaccessible and is under explored. It contains a number of distinct areas with known gold mineralisation (Hayes Creek, Mullimbidgee, Leo Creek, Rocky River and the Klondyke). The alignment of the known mineralisation and the Lockhart River suggest a possible regional shear or fracture system. However, there is no geophysical evidence for a regional shear zone of the Coen and Ebagoola shear zone types (Wellman, personal comment, 1994). There is a low resource potential for small Au-quartz veins with a certainty level of B. Much of the area is covered by tropical rainforest.

Area AuB3 (Map 2)

In the old Hayes Creek Goldfield, gold occurs with pyrite ± arsenopyrite ± galena ± sphalerite ± chalcopyrite in quartz veins in sheared/foliated, chloritised/sericitised and silicified granite of the Buthen Buthen Granite. The veins are generally <1m wide and comprise euhedral buck and saccharoidal quartz with white and blue banding. Sericitised ribbons of host granite and sulphide-rich vughy sections are common. Infill breccia textures occur in places. Free gold occurs in short rich shoots; the best grades are in narrow leaders on the footwall and/or hanging wall. Most of the veins mined in the past were only short leaders. The predominant strike direction is 140° to 170° and veins dip 40° to 50° and 85° south-west. A field inspection of the main workings in the Hayes Creek Field indicated that at least some of the shoots mined occurred along the intersections of 45° and 85° dipping veins. There is a moderate resource potential for small Au-quartz veins with a certainty level of C.

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Area AuB4 (Map 2)

At Mullimbidgee, there are at least two, subparallel vein systems. Gold occurs in quartz veins in shears along or adjacent to the contact of the McIlwraith Granite and the Coen Metamorphics. The veins strike south-east to south, dip 60° to 65° east, and comprise quartz + Au + pyrite + arsenopyrite + galena. The average grade of handpicked ore mined in the past was 314g/t. There is a moderate resource potential for small Au-quartz veins with a certainty level of C.

Area AuB5 (Map 2)

A number of gold-bearing quartz reefs occur in rainforest in the headwaters of Leo Creek. The main reef mined in the past was the Claudie Lakeland, which averaged 147g/t Au. It strikes southerly and dips 45° to 75° east in a shear zone along the contact of the McIlwraith Granite and a roof pendant of Coen Metamorphics. Quartz samples from the reef assayed 1.5 to 38ppm Au and drilling intersected a 5.8 to 9.7m wide zone with 2.2 to 3.7g/t Au.

Gold-bearing quartz reefs reportedly occur in the headwaters of the Rocky River. There is a moderate resource potential for small Au-quartz veins with a certainty level of C.

Area AuB6 (Map 2)

The average grade mined in the Klondyke - Breakfast Creek area was 52.8g/t Au. Mineralisation occurs in narrow (<2m wide), lenticular quartz pods parallel to major, milky white quartz reefs in north-trending shear zones along or near the contact of the Lankelly Granite and the Coen Metamorphics. There is a moderate resource potential for small Au-quartz veins with a certainty level of C.

Area AuB7 (Maps 2 and 3)

This area covers known mineralisation along and adjacent to the Coen Shear Zone, a major regional structure separating the Coen Metamorphics and the Lankelly Granite. Mineralisation occurs near Coen and at the Springs and includes the largest mine in the old Coen Goldfield — the Great Northern, which produced 2.17t of Au. There is a high resource potential for small Au-quartz veins with a certainty level of C.

Mineralisation occurs in quartz veins in metamorphic and granitic rocks and is most commonly associated with the Lankelly Granite, Kintore Granite and the Flyspeck Granodiorite. In the Coen area, some gold remobilisation may have occurred due to emplacement of ?late Palaeozoic rhyolite dykes within the Coen Shear Zone.

The deposits occur as simple or compound quartz reefs in fissures and as lenticular, en echelon and anastomosing quartz bodies in crushed quartz-greisen and mylonite zones in the shear zones. Individual reefs are up to 2m wide, several hundred metres long and steeply dipping; they pinch and swell along strike and down dip. Massive euhedral and comb quartz is cut by veinlets and infilled with later generations of vugh-forming quartz. Wall rock alteration comprises silicification and sericite ± carbonate ± pyrite ± chlorite selvedges up to 2 or 3 times the vein width and is most prominent in the granites. Brecciation and silicification are characteristic of the major producing mine — the Great Northern. Some reefs have graphitic selvedges adjacent to ore shoots.

Mineralisation comprises a simple pyrite ± arsenopyrite ± base metal sulphides assemblage. Free gold generally occurs adjacent to sulphides; the gold has a gold:silver ratio of approximately 3:1. Mineralisation is generally restricted to cross-cutting generations of quartz and rarely occurs in primary quartz or wall rocks. Economic ore shoots tend to occur at inflection points along the shear zones. Stockwork and spur vein systems adjacent to the reefs are not well developed and generally grade up to 8ppm Au. No opencut resources have been proven yet, despite extensive exploration in the Coen area. Remaining underground resources are probably limited. Potential exists for the discovery of high-grade ore shoots where the Coen Shear Zone extends under alluvium north-north-west of Coen.

Area AuB8 (Map 2)

This area covers the probable extension of the Coen Shear Zone north-north-west under alluvial cover to join with the Archer River Shear Zone. There is a moderate resource potential for small Au-quartz veins with a certainty level of B.

Area AuB9 (Map 2)

This area covers the known surface and near-surface extent of the I-type Blue Mountains Adamellite, the host of gold mineralisation at Blue Mountains. Ore mined here averaged 37g/t Au. Gold occurs in narrow quartz lodes in shear zones in the Blue Mountains Adamellite and Kintore Granite. The veins are 0.10 to 0.25m wide and pinch and swell noticeably. Investigations by Augold N.L. in the 1980's indicated that gold grades are erratic, ranging from 0.005 to 2.95ppm in drillholes and from 0.015 to 34.9ppm in surface samples. Wall rock alteration (mainly silicification and sericitisation) does not extend more than a few tens of centimetres from the lodes. Stream sediment surveys by AGSO have identified the Blue Mountains area as highly anomalous in gold. The geochemical characteristics of the Blue Mountains Adamellite suggest some gold potential (Knutson & others, 1994). There is a high resource potential for small Au-quartz veins with a certainty level of C.

Area AuB10 (Map 2)

This area covers known gold mineralisation at the Battery Lease and has a moderate resource potential for small Au-quartz veins with a certainty level of C. Old workings are at the end of a large quartz vein system intruding Holroyd Metamorphics and Morris Adamellite. Exploration has indicated anomalous Cu, Pb, Ag and As in the area, but quartz-veined, brecciated metamorphic rocks have disappointingly low gold grades. The known quartz vein mineralisation is the most promising prospect in the area.

Area AuB11 (Maps 2 and 3)

This area covers known gold mineralisation along the Ebagoola Shear Zone. Regional stream sediment geochemical surveys by AGSO have delineated gold anomalies over the Hamilton (Ebagoola) Goldfield. There is a high resource potential for small Au-quartz veins with a certainty level of D.

Mines from within this area have produced about 1.6t of gold from quartz veins; the average grade of the ore treated was 46.8g/t Au. There is potential for the discovery of additional, small, high-grade vein deposits. Despite extensive exploration in recent years, no bulk low-grade stockwork deposits have been found.

Area AuB12 (Map 3)

The geological environment of this area, covering the Lukin River, Lindalong and Lucy Swamp Shear Zones, is suitable for the development of Au-quartz veins. However, no significant mineralisation has been found to date. AGSO regional geochemical surveys have indicated that stream sediment gold anomalies occur along the Lindalong Shear Zone. There is a low resource potential for small Au-quartz veins with a certainty level of B.

Area AuB13 (Map 3)

The Perseverance reef in the old Potallah Creek Goldfield is 1.8m wide, strikes northerly, and occurs in schist of the Holroyd Metamorphics, about 1km west of a contact with the Kintore Adamellite. The ore mined averaged 32.6g/t Au. There is a high resource potential for small Au-quartz veins with a certainty level of C. Ore shoots are small but rich; there does not appear to be any potential for bulk low-grade deposits.

Area AuB14 (Map 3)

In the old Alice River Goldfield, gold-bearing quartz veins occur in shears in locally altered Kintore Adamellite. The reefs are up to 1.9m wide and strike north-west. The ore mined averaged 78.0g/t Au. There is a high resource potential for small Au-quartz veins with a certainty level of C. Ore shoots are small but rich. Although there is some stockwork veining in the old workings there is little potential for a bulk low-grade deposit.

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Area AuB15 and AuB16 (Map 3)

Exploration in these areas has indicated the presence of small, discontinuous Au-quartz veins. There is a low resource potential for small Au-quartz veins with a certainty level of B.

Area AuB17 (Maps 3 and 4)

Stream sediments in this area are anomalous in gold. This gold has been traced to small, discontinuous metamorphic quartz veins. One vein, the Balterra Reef near Palmerville, is anomalous in gold for a 400m strike length. Rock chip samples from the gossanous, quartz-veined outcrop assayed up to 292g/t Au and costean samples assayed up to 7.14g/t Au. There is a low resource potential for small Au-quartz veins with a certainty level of C.

Economic significance: Remaining underground resources at known mines are probably limited. Because no sheeted vein or stockwork vein systems are known to be associated with this deposit type, there is very limited potential for an economic bulk low-grade deposit. No opencut resources have been proven yet, despite extensive exploration in the Coen and Ebagoola areas. The Au-quartz veins themselves are narrow (1 to 2m) and ore shoots are very small; Figure 21 shows grade-tonnage information for known deposits. They would be of economic interest to individual miners and small syndicates only.

Equivalent/ related deposit types: Low sulphide Au-quartz veins, Mother Lode veins, plutonic veins / porphyry intrusion-related gold deposits, Au skarn deposits, alluvial placer gold deposits.

References:

Cox & Singer (1986)
Culpeper & Burrows (1992)
Culpeper & others (1992b)
Denaro & Morwood (1992b,c)
Denaro & others (1993)
Morrison (1988)

Model AuC: Chert-hosted gold deposits

Commodities, by products and trace metals: Gold.

Geological setting: Chert-sulphide beds in predominantly mafic volcanic terrane of the Hodgkinson Province.

Structural control: Folds and fracture systems related to folding.

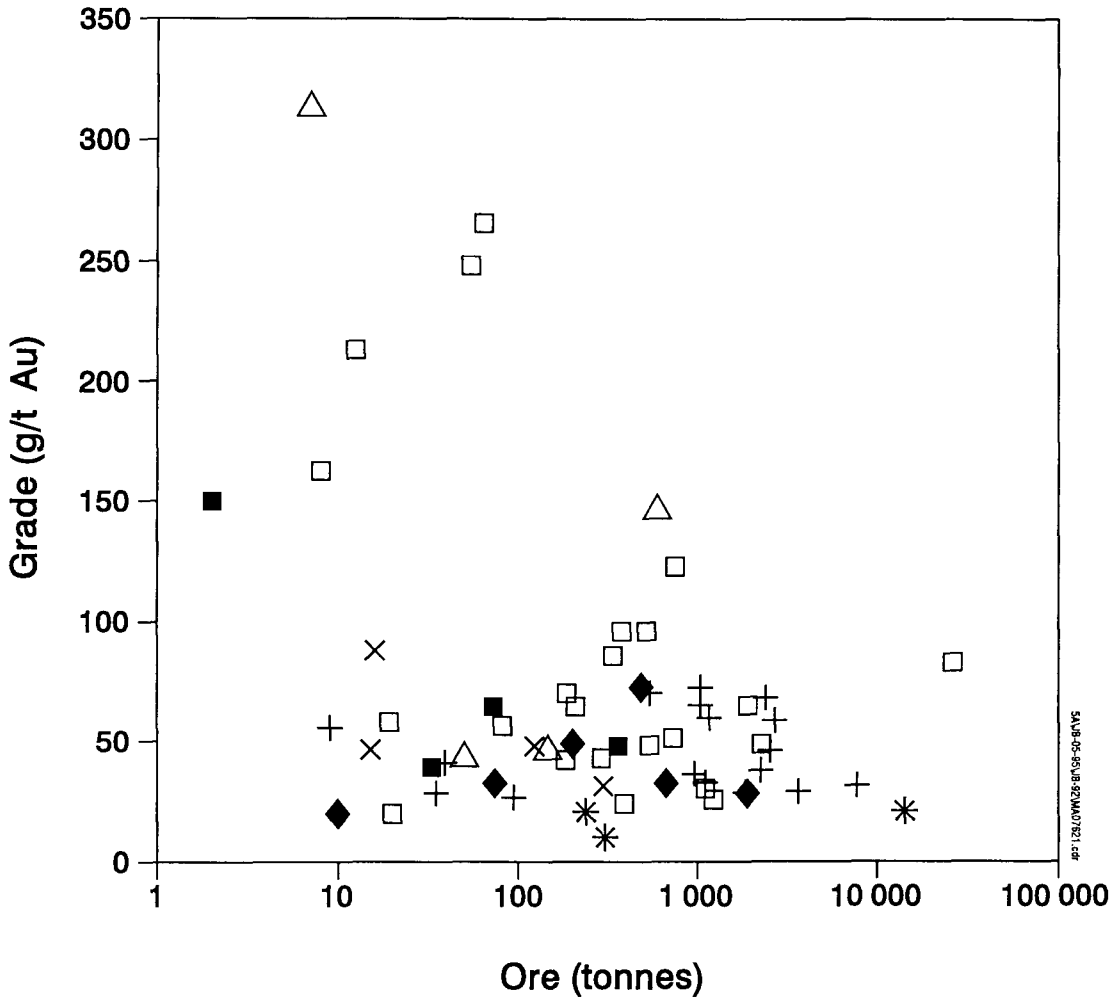
Age: Palaeozoic.

Deposit description: Stratabound to stratiform; in part, disseminated uniformly in the host units and, in part, irregularly distributed in structurally controlled quartz-sulphide veins. Commonly thickened and structurally remobilised in fold hinges. Minerals include native gold, pyrite, arsenopyrite, pyrrhotite, magnetite, hematite, quartz and carbonates. Up to 5% pyrite and arsenopyrite is disseminated in the chert and associated mafic volcanics. Overall gold grades are generally low (<6g/t Au). The highest gold contents (up to 30g/t) are associated with quartz veins in fold noses and faults. The chert beds tend to form resistant ridges.

Type area: Mount Madden.

Geochemical signature: Au, As, Cu, Pb, Zn, Se, Ag.

Known deposits: Mount Madden, Mount Buchanan, Mount Jessop.



Historical production

- □ Coen Goldfield
- + Ebagoola Goldfield
- ✳ Wenlock Goldfield
- ■ Hayes Creek Goldfield
- × Blue Mountains
- ◆ Alice River and Potallah Creek
- △ Other areas

Figure 21. Grade-tonnage diagram, mesothermal Au-quartz veins (Coen type).

Assessment criteria:

1. Distribution of chert units in the Hodgkinson Formation, particularly those associated with mafic volcanics.
2. Distribution of known mineralisation.

Assessment: **Area AuC1 (Map 4)**

This area covers known chert-hosted gold mineralisation at Mount Madden, Mount Buchanan and Mount Jessop. The deposits are on the margins of a domal structure. There is a high resource potential for small chert-hosted gold deposits with a certainty level of D.

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Area AuC2 (Map 4)

This area covers interbedded chert and basic volcanics extending through the Mount Bennett area. There is a low resource potential for small chert-hosted gold deposits with a certainty level of B.

Area AuC3 (Map 4)

Interbedded chert and basic volcanics of the Hodgkinson Formation, adjacent to the contact with the Chillagoe Formation, have a low resource potential for small chert-hosted gold deposits with a certainty level of B.

Area AuC4 (Map 4)

This extensive area comprises numerous north-north-west trending chert ridges interbedded with arenite and argillite of the Hodgkinson Formation. Numerous gold prospects have been identified in the area.

Oilmin N.L. drilled an 8km long chert outcrop in the Campbell Creek area; mineralised zones up to 10m wide and assaying up to 0.6ppm Au were intersected; one sample assayed 5.05ppm Au.

Cambrian Resources N.L. located extensive stratabound gossans in the Mammoth Bend area of the Palmer River. Detailed rock chip sampling of gossanous banded cherts indicated that highly anomalous gold is associated with anomalous arsenic (up to 2.74ppm Au and 549ppm As). Results of 1.24ppm and 0.96g/t Au were obtained for chip samples adjacent to the intersection of sulphidic volcanics and a Tertiary basalt dyke. Drilling results indicated that the gold content of the primary zone of the mineralised cherts is uniformly subeconomic.

Queensland Metals Corporation N.L. discovered a series of auriferous, gossanous, quartz-veined chert lenses in the middle of the West Normanby Goldfield. The largest is a breccia stockwork at Mount Eykin. Gossanous samples assayed up to 1500ppm As and 2.56ppm Au. Drilling results did not reveal any economic mineralisation.

Anomalous gold occurs in an area with pyritic-hematitic cherts at the Taipan Prospect. Rock chip samples assayed up to 0.64ppm Au and 838ppm As.

Anomalous gold occurs in a siliceous magnetite-garnet-amphibole-sulphide unit at the Sporing Creek Prospect. Sulphides are minor (<5%) and comprise mainly pyrrhotite, minor chalcopyrite, and traces of galena and arsenopyrite. The unit is transected by quartz-calcite veinlets.

At the Dingo Shear Prospect, anomalous gold is associated with pyritic and oxidised, silicified, brecciated, quartz-veined greywacke, sandstone, shale and schist. Drilling intersections ranged from 2m at 1.06g/t Au to 36m at 0.34g/t Au. There is a low resource potential for small chert-hosted gold deposits with a certainty level of B.

Area AuC5 (Map 4)

In the Cocoa Creek area, widespread areas of hematitic brecciated chert assay up to 4.74g/t Au. The cherts are also anomalous in As, Sb, Se and Ag. There is a low resource potential for small chert-hosted gold deposits with a certainty level of B.

Area AuC6 (Map 4)

Gossanous, quartz-veined chert is common in this area. In outcrop, the rocks comprise brecciated zones of quartz-veined chert fragments in a ferruginous pelitic matrix. Hematite staining is extensive. There is a low resource potential for small chert-hosted gold deposits with a certainty level of B.

Area AuC7 (Map 4)

Numerous chert ridges, some of possible exhalative origin, crop out in the Hodgkinson Formation in this area. Some of these ridges have been investigated as potential gold deposits. The ridges comprise chert and silicified metasedimentary rocks. Quartz stockwork veining and iron and manganese-rich gossans are common. The cherts and stockwork zones are slightly anomalous in gold and some of the cherts are phosphatic.

Visible gold was reported to occur in chert core from a hole drilled by Carpentaria Exploration Company at the Chert Ridge prospect. Rock chip samples returned a maximum assay result of 1.52ppm Au. Petrological examination revealed that the cherts are locally altered basic volcanic and sedimentary rocks, with some primary/syngenetic chert, generally occurring as large boudins in deformed metasedimentary rocks. Alteration comprises epidote and chlorite, and magnetite is visible in hand specimen. Quartz veins and inclusions and limonite-stained fractures are common.

The Lagoon Prospect is an 80m high chert ridge with some gossanous outcrops. Carpentaria Exploration Company delineated three areas of low-level gold-anomalous soil. Samples of fractured and limonitic rock from a costean assayed up to 0.07ppm Au.

Geochemical sampling gave low-level gold assays for samples from Brown's Peak, which is a weakly magnetically anomalous ridge of ferruginous chert with some gossanous outcrops. There is evidence of old workings in a chert outcrop on Four Kilometre Hill.

There is a low resource potential for small chert-hosted gold deposits with a certainty level of B.

Area AuC8 (Map 4)

Cambrian Resources N.L. carried out extensive investigations of a number of chert outcrops between Barrow Point and Bathurst Bay. The area consists of shallow to moderately dipping, siliceous laminated sediments, pelitic sediments, and minor zones of stockworking and/or brecciation. Gold is generally more anomalous in the more altered rock types.

The best gold assay result was 3.67ppm for a floater of ferruginous breccia. Iron and/or manganese-rich gossanous zones are common in outcrop. There is widespread evidence of sulphide mineralisation as fine to coarse-grained disseminations and as stratabound massive sulphide units up to a few metres thick. Creeks draining chert outcrops in the area carry traces of fine-grained alluvial gold.

Some of the siliceous sedimentary units are impregnated with carbon, and a discordant, carbon-rich, pipe-like zone with sulphides and quartz stockworks was intersected in one drillhole.

Cambrian Resources applied an epithermal model to the prospects but Western Mining considered the prospects to be typical Hodgkinson Formation rocks with surface silicification.

There is a low resource potential for small chert-hosted gold deposits with a certainty level of D.

Economic significance: Deposits of this type offer potential for large tonnage/low grade mineralisation.

Equivalent/ related deposit types: / alluvial placer gold deposits.

References:

Denaro & others (1992)
Eckstrand (1984)
Lam & Genn (1993)
Lam & others (1991)

ISBN 0 7242 5286 1

Model AuD: Syntectonic Au-quartz and Au-Sb-quartz veins (Palmer type)

Commodities, by products and trace metals: Gold, antimony.

Geological setting: Mainly in regionally metamorphosed volcanic and sedimentary rocks (greywacke-shale sequences). Late granitic batholiths usually present. Veins are post-metamorphic. May show a spatial relationship with acid to intermediate dykes.

Structural control: Common association with regional scale faults and shear zones, plus more local structural and lithological control. Fault and joint systems produced by regional compression. Deposition of gold related to dilatant structures. Veins persistent along regional high-angle faults and joint sets. Veins isolated into distinct structural and lithological domains by post-mineralisation faulting.

Age: Hosted by Silurian to Devonian rocks of the Hodgkinson Province. Mineralisation age probably Carboniferous to Permian.

Deposit description: The veins occur as single, locally irregular quartz veins which fill and are restricted to late brittle to brittle-ductile shear zones crosscutting previous deformations. Veins pinch and swell from pods within the crushed material of the zones. They show evidence of incremental quartz deposition and multiple shear movement. Splays and spur veins are common but multiple joins, sheeting and cross veins are not. The main quartz textures (buck, ribbon, breccia and assimilation) are characteristic of the mesothermal environment. Ore shoots are a complex mixture of quartz and gouge. The total sulphide content is generally low (<5%) and comprises pyrite, arsenopyrite, pyrrhotite and stibnite; base metal sulphides are present as accessory minerals only. The gold is free, typically of high fineness (+900) and occurs as small irregular masses and discrete grains in quartz and intermixed with pyrite and arsenopyrite. Grades mined averaged 30 to 60g/t Au.

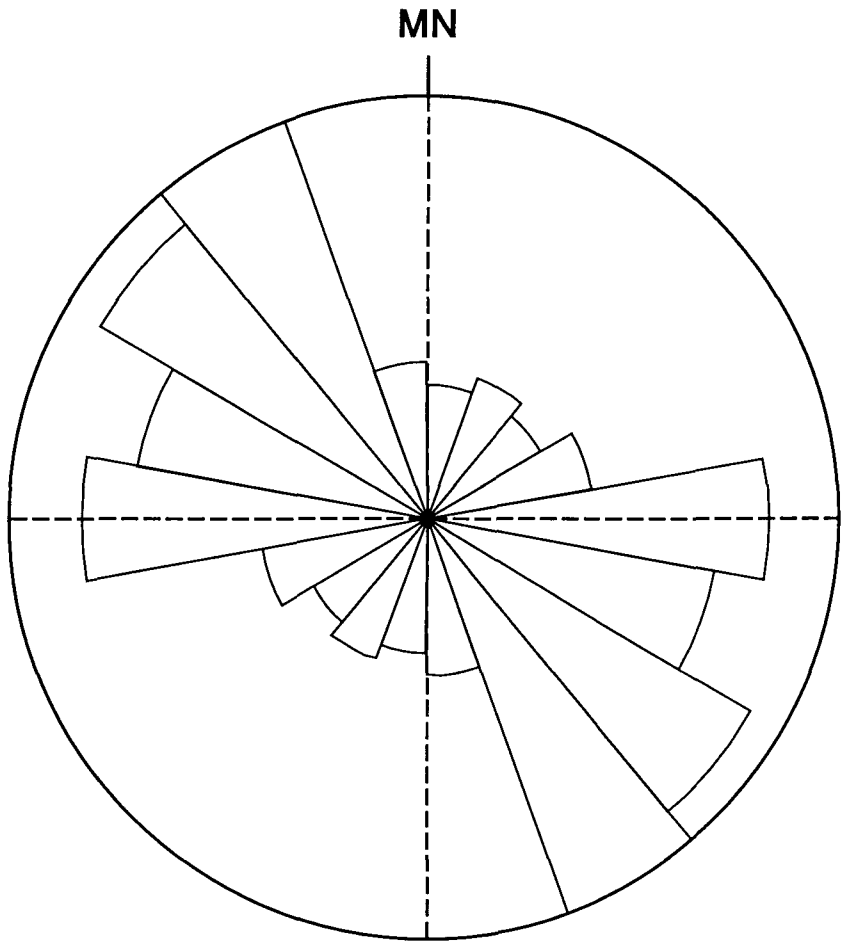
The veins pinch, swell and branch and occur as groups of en echelon veins localised in secondary brittle shears associated with larger, often regionally significant, shear and melange zones. The majority of veins trend easterly to south-south-easterly (Figure 22). Gold is unevenly distributed and is generally concentrated in shoots associated with dilation zones, which are caused by changes in strike, splays, lithologic contacts and fissure intersections. Barren quartz commonly occurs along strike from economic ore shoots. Wall rocks, particularly adjacent to gold-bearing shoots, may have narrow sericitic alteration selvedges, but most veins show little alteration. Brecciated margins are common.

In the Hodgkinson Goldfield (Mossman 1:250 000 Sheet area), the calculated oxygen isotopic composition of the gold-bearing fluids is 10 $\pm$ 2 per mil, which overlaps the fields for metamorphic and primary magmatic fluids (Golding & others, 1990). The calculated hydrogen isotopic composition for the hydrothermal fluid is -100 $\pm$ 20 per mil at 300 $\pm$ 50°C. Fluid inclusion studies, together with shear zone characteristics, indicate that the veins in the Hodgkinson Formation formed at 270 to 350°C (assuming a fluid pressure of ~1Kbar).

In summary, Golding & others (1990) postulated that the veins were deposited during regional tectonism and channelled to dilational sites in shear zones. The stable isotopic characteristics of these mesothermal auriferous fluids mainly reflect extensive fluid-rock interaction, either at source or within fluid conduits.

Morrison (1988) reported that alteration muscovite from veins in the Hodgkinson Goldfield gave a K-Ar age of Late Carboniferous. Peters (1987) suggested that the veins formed during Permian tectonism, following injection of dolerite dykes and sills and localised east-west shearing during the Early Carboniferous. The Permian tectonism was a melange-forming event, with localised high heat flows and intrusion of regional plutons (with associated Sn and W mineralisation).

Type area: Palmer Goldfield.



Strikes plotted by area
Syntectonic Au-quartz veins (Palmer type)
N=582

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Figure 22. Rose diagram, strikes of syntectonic Au-quartz veins (Palmer type).

Geochemical signature: Arsenic best pathfinder in general; Ag, Pb, Zn, Cu. Abundant quartz chips in soil; gold may be recovered by panning.

Known deposits: Palmer Goldfield, Hodgkinson Goldfield, West Normanby Goldfield, Starcke Goldfields.

Assessment criteria:

1. Distribution of known mineralisation.
2. Regional faults and shear zones.
3. Distribution of alluvial placer gold deposits in the Hodgkinson Province.

Assessment: **Area AuD1 (Map 4)**

This area extending from the Palmer River near Maytown north to the Conglomerate Range contains the greatest concentration of known Au-quartz veins in the Palmer Goldfield.

The main features of the veins are:

- They occur in groups within a 2km wide, north-north-west trending zone.
- Within each group, the veins are subparallel.
- They strike predominantly 100° and dip 70° to 90°S.

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- Pinching and swelling occur along strike and tabular boudinage features occur down dip.
- They are brecciated on the margins and slickensided down dip.
- Branching or bifurcation occurs in some of the major veins and closely spaced subparallel veinlets, spur veins and bends are common.
- They commonly are cut off by doleritic dykes.
- Gold is disseminated in the veins, but is concentrated particularly in host rock laminae, small ore shoots and pinches in lodes.
- Gold fineness is upward of 920 to 940.
- Associated sulphide minerals include pyrite, arsenopyrite, marcasite, galena, sphalerite, pyrrhotite and stibnite.

Meta-sedimentary rocks in the Maytown area comprise a sequence of greywacke, phyllite, sandstone and siltstone intruded by basic dykes and gold-bearing quartz veins and barren quartz veinlets. The only mineralisation within the sedimentary rocks themselves is pyrite cubes to 10mm diameter in some greywacke beds.

Medium-grained doleritic dykes, up to 1m wide and often traceable for 1km along strike, are common in the area. They are subparallel to the regional north-north-west trend and commonly cut off the mineralised quartz veins. Up to 5% pyrite and arsenopyrite occur in the dykes, which invariably contain xenoliths of quartz vein material.

At least two distinct types of quartz veins occur — large, gold-bearing veins and narrow, barren veins. The barren veinlets parallel S_1 and S_3 fold axial planes striking 125 and 060°, respectively, and are commonly crosscut by mineralised veins. The veinlets are of limited strike length, commonly tapering off into the host rocks. Rock chip samples from some of the barren quartz veinlets indicate grades of 1 to 9ppb gold; phyllitic sediments assay 10s of ppb gold; sediments with stockwork veins assay 100s of ppb gold; and larger veins contain gold in part per million levels.

The mineralised veins are tens of metres in strike length and in depth. They occur as groups of en echelon veins with a predominant strike of 100° and steep dip to the south. The veins range from <10mm to 0.3m in width and are shear-controlled; some appear to have been deposited along faults. The spatial/temporal relationship of the veins to deformation events has not been determined, but the direction of shearing conforms with the regional north-north-west trend. Some of the characteristics of the veins include brecciated margins, pinching and swelling along strike, tabular boudinage down dip and branching. Closely spaced, subparallel veinlets and spur vein development are common features in most of the veins. The veins were extremely rich, averaging 30 to 60g/t gold, and were persistent to below the water table.

The mineralised veins comprise white drusy quartz with localised comb, vugh and ribbon textures, and carry gold, minor sulphide minerals and inclusions of host rock laminae.

Gold is unevenly distributed and is generally concentrated in pinches and in shoots associated with dilation zones in the veins. Gold occurs as discrete grains and as intermixes with pyrite and arsenopyrite. Gold is extremely rare in the mullock and the remaining vein exposures. Occasional, discrete, anhedral grains, <1mm across, are present in some quartz mullock. The gold is deep in colour and appears to be of high fineness.

Most of the sulphides in the quartz mullock are fresh grains ranging in size from <1mm to 10mm across. Occasional, oxidised, larger aggregates are sparsely disseminated in the veins. The mineralogy varies from mine to mine but generally pyrite, marcasite and arsenopyrite are more common than pyrrhotite, sphalerite, galena, stibnite and ?chalcopyrite.

Host rock laminae, ranging from <1mm to centimetres wide, form crude bands in the veins. They are not evenly distributed throughout the veins but are preferen-

tially distributed along vein margins. Laminae edges are commonly limonite-stained by oxidised sulphides.

Some of the veins' physical attributes, such as tabular boudinage down-dip features, would suggest that they have undergone intense ductile deformation as a result of faulting or folding and metamorphism. Most of the veins occur in blocks on line with the regional north-north-west trend. Between the blocks are narrow belts with few to no veins. A possible explanation is that these veins were evenly spaced prior to block faulting occurring during folding events. The barren belts may represent zones of movement between blocks. The kinks and bends in veins probably represent initial fracture refraction across competent sandstone beds and incompetent siltstone beds.

There is a high resource potential for small Au-quartz veins with a certainty level of D.

Area AuD2 (Map 4)

This broad band of country trending north-north-west to the Maytown area is known to contain numerous, small, discontinuous Au-quartz veins. Despite extensive prospecting, no significant quartz reefs have been found. It was the site of extensive historical and recent alluvial gold mining. There is a low resource potential for small Au-quartz veins with a certainty level of C.

Area AuD3 (Map 4)

This area covers known mineralisation in the West Normanby Goldfield. The lodes lie within a north-north-west trending shear zone which follows the West Normanby River. They comprise discrete, narrow, gold-bearing quartz veins. They are quartz fissure infillings which tend to be erratic in width along strike and down dip. They follow joints and shears in a zig zag pattern. Minor spur veins follow the host rock schistosity and joints for short distances.

The mineralised veins average 0.3m wide and range from <0.1m to >1m. They comprise white drusy quartz with localised comb, vugh and ribbon textures. Gold is unevenly distributed and is often concentrated in pinches and shoots associated with dilational zones in the veins. The gold is deep in colour, upwards of 940 fineness, and occurs as discrete grains and intermixed with pyrite and arsenopyrite.

This area is one of the few in the CYPLUS area where lode gold mining is currently being carried out. There is a high resource potential for small Au-quartz veins with a certainty level of D.

Area AuD4 (Map 4)

One Au-quartz vein occurrence (the Sussex Mine) is known in this area. There is a low resource potential for small Au-quartz veins with a certainty level of B.

Area AuD5 (Map 4)

Au-Sb-quartz veins in the Hodgkinson Formation in the Cocoa Creek area trend north-north-west. Gold occurs associated with both quartz and stibnite. The mineralisation is relatively high level (certainly higher than that at Maytown and the West Normanby) but does not exhibit any significant epithermal characteristics. There is a moderate resource potential for small Au-Sb-quartz veins with a certainty level of B.

Area AuD6 (Map 4)

This area covers known gold mineralisation in the Starcke No. 2 Goldfield. Gold-quartz veins occur within steeply dipping, north-trending metasedimentary rocks of the Hodgkinson Formation. The host rocks are mainly coarse to medium-grained sandstone or greywacke and carbonaceous slatey mudstone, with interspersed lenses of chert and broken formation.

The Hodgkinson Formation has been intruded by porphyry dykes which strike north to north-east, subparallel to dominant bedding and schistosity trends, and generally dip steeply west. Mineralisation occurs as quartz veins and stockworks spatially associated with quartz-felspar porphyry ("felsite") dykes and with some east to north-east-trending structural control.

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Almost all historical production came from discrete, steeply dipping, lenticular quartz fillings with gold, pyrite, arsenopyrite and minor chalcopyrite. Minor stibnite is present in some veins. Total sulphide content is <5%. The veins range from several centimetres to 3m in width (generally 200 to 250mm) and strike north-east and south-east across general bedding trends. The veins comprise euhedral buck quartz with ribbons and angular inclusions of pyritic host rock, giving the veins a brecciated texture. Comb and fibre textures have been noted in the narrower veins. Historical grades were very rich at the surface (up to 300g/t) but decreased rapidly with depth. The gold was commonly fairly coarse and yellow. Silver content ranged up to 8g/t. Distribution was patchy; ore shoots were generally pipe-like in form and steeply west pitching. Reefs commonly branched or frayed out.

Quartz veinlet stockworking is generally confined to the more competent rock types such as sandstone/greywacke, silicified slate, chert and felsite and contains low-grade, disseminated gold. The stockworking is best developed in the felsite dykes, but can extend for several metres from fissure veins and dykes. Individual veinlets are 1 to 20mm wide and comprise medium to coarse-grained quartz with minor sulphides (dominantly pyrite). Minor sericitic alteration is associated with the stockworking. Pervasive but inhomogeneous silicification of felsite dykes and the host metasediments is likely to be due to this mineralising event.

Gold also occurs in a 50m wide mylonitic shear zone which comprises quartz and chert lenticles in an anastomosing, dark grey, carbonaceous, slatey matrix. Pyrite is common along greasy, slickensided slatey cleavage surfaces, as discrete grains in quartz lenticles and veins, and as coatings on microfractures which crosscut all of the former.

There is a moderate resource potential for small Au-quartz veins with a certainty level of D. Extensive exploration in the Munburra area has not delineated any economic deposits. The best potential is in other areas of the field, particularly in the headwaters of Diggings Creek.

Economic significance: Exploration for bulk-tonnage, low-grade stockwork deposits centred on these vein systems has been unsuccessful. Mineralisation occurs in rich shoots of limited extent (Figure 23) and wall rocks and crosscutting veinlets are too low-grade to constitute a mineable resource. Deposits of this type are still of interest to the small-scale miner, as evidenced by the renewal of lode gold mining in the old West Normanby Goldfield.

Equivalent/ related deposit types: Low sulphide Au-quartz veins, turbidite-hosted vein and shear zone gold, mesothermal gold-quartz veins, slate belt veins / syntectonic Sb-Au-quartz veins, alluvial placer gold deposits.

References:

Cox & Singer (1986)
Denaro & others (1992)
Eckstrand (1984)
Golding & others (1990)
Lam & Genn (1993)
Lam & others (1991)
Morrison (1988)
Peters (1987,1991)

Model AuE: Carbonate-hosted gold

Commodities, by products and trace metals: Gold.

Geological setting: Highly carbonaceous interbedded shale-carbonate sequences that include both bedded and replacement black cherts. Best host rocks formed as carbonate turbidites in somewhat anoxic environments. Deposits formed where these are intruded by felsic igneous rocks under nonmarine conditions.

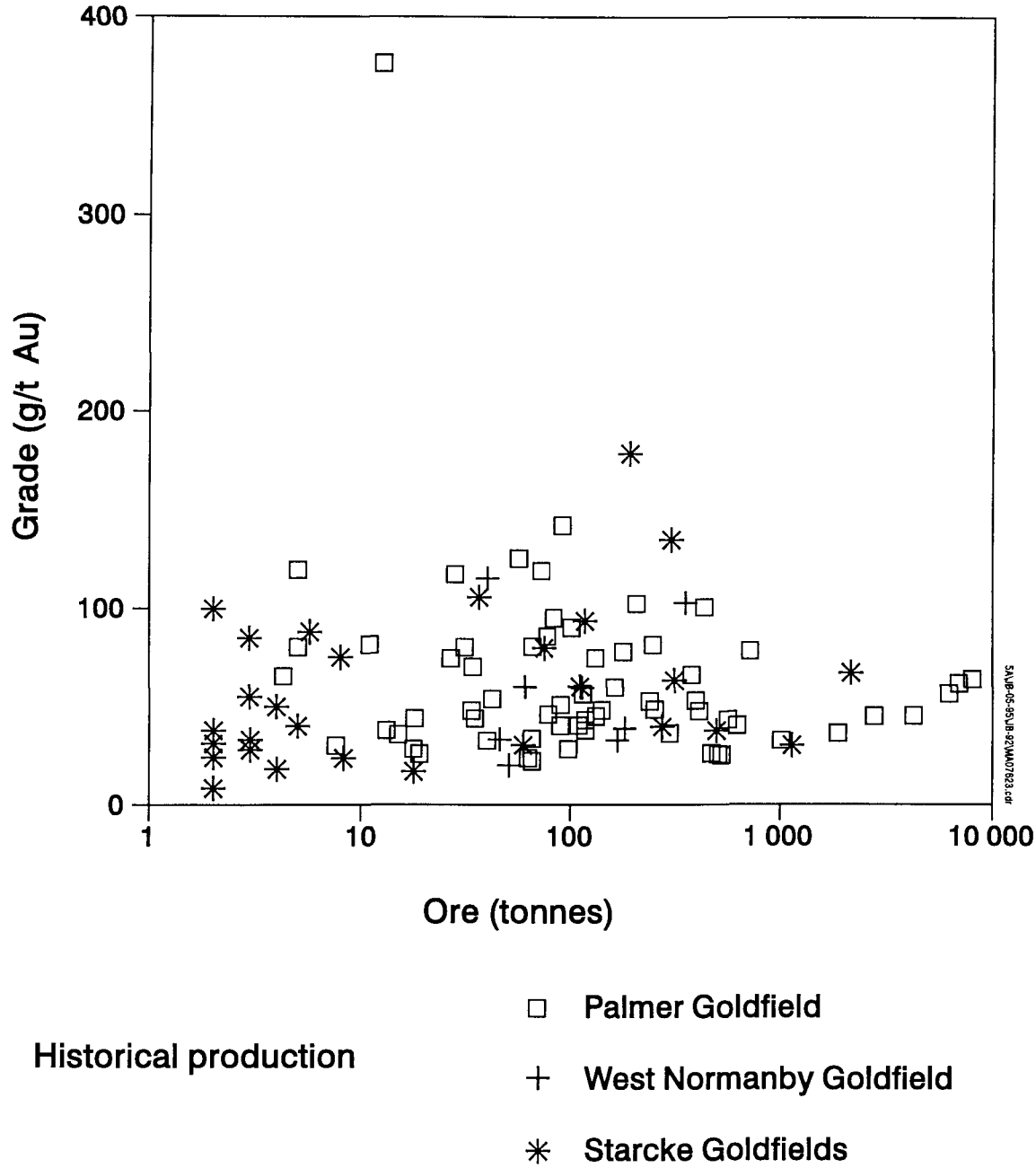

Figure 23. Grade-tonnage diagram, syntectonic Au-quartz veins (Palmer type).

Structural control: Selective replacement of carbonaceous carbonate rocks adjacent to and along high-angle faults or regional thrust faults or bedding.

Age: Mainly Tertiary, but can be any age.

Deposit description: Generally tabular, stratabound bodies that are irregular in detail; very fine-grained gold and sulphides disseminated in carbonaceous calcareous rocks and associated jasperoids. Ore minerals include native gold + pyrite + realgar + orpiment ± arsenopyrite ± cinnabar ± fluorite ± barite ± stibnite; gangue minerals include quartz, calcite and carbonaceous matter. Sulphides generally form <1% of ore. Unoxidised ore comprises jasperoid + quartz + illite + kaolinite + calcite; locally abundant carbon appears to be introduced. Hypogene oxidised ore comprises kaolinite + montmorillonite + illite + jarosite + alunite. Silica replacement of carbonate is a prominent texture. Alteration consists of decarbonatisation, silicification, argillisation, pyritisation, redistribution and local concentration of carbon, and near-surface acid leaching and oxidation.

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Geochemical signature: Au + As + Hg + W + Mo; As + Hg + Sb + Tl + F as superimposed stage.

Assessment criteria:

1. Highly carbonaceous carbonate or shale-carbonate sequences may be the main ore control.
2. Presence of small felsic plutons that may have caused geothermal activity.
3. Other possibly favourable indicators are black chert, realgar and orpiment, stibnite, and barite or tungsten mineralisation in the general area.
4. As and Hg (in some case Tl and Sb) geochemical anomalies are considered to be highly favourable.

Assessment:

Areas AuE1 and AuE2 (Map 4)

These areas in the Chillagoe Formation comprise limestone, muddy limestone, basalt, chert, sandstone, siltstone and mudstone. It is not known if there are any potentially mineralising subsurface felsic plutons in the area. There is a low resource potential for small carbonate-replacement gold deposits with a certainty level of B. Copper and mercury mineralisation occur in Area AuE2.

Area AuE3 (Map 4)

At the Taipan Prospect, very closely spaced bulk cyanide leach stream sediment sampling defined a 1500X600m gold source area comprising pyritic cherts, carbonate-altered spilites and fine-grained carbonaceous sediments of the Hodgkinson Formation. The geological environment may be suitable for the formation of carbonate-hosted gold deposits. There is a low resource potential for small deposits with a certainty level of B.

Economic significance: Deposits of this type have potential as large tonnage/low grade resources (1 to 265Mt at 0.5 to 8.0g/t Au).

Equivalent/ related deposit types: Carlin-type, carbonaceous shale - carbonate-hosted gold, sediment-hosted gold deposits.

References: Cox & Singer (1986)
Eckstrand (1984)

Model AuF: Porphyry intrusion-hosted Au-base metal sulphides-quartz veins and stockworks

Commodities, by products and trace metals: Gold, silver, base metals.

Geological setting: Apical portions of porphyry intrusions, stocks and dykes and in adjacent country rocks. Known deposits in Cape York Peninsula are associated with I-type granitoids.

Structural control: Deposits show a tendency to be aligned along and within regional fracture systems.

Age: Host rocks may be Proterozoic to Palaeozoic. Associated intrusives are late Palaeozoic in age.

Deposit description: Veins, sheeted veins, stockworks, and disseminated deposits. Minerals include quartz, pyrite, arsenopyrite, molybdenite, Bi minerals, chalcopyrite, sphalerite, galena, fluorite, Au-Ag tellurides, cassiterite, wolframite, electrum and calcite. Alteration styles include sericitic (locally greisen), silicification, argillic and potassic. These deposits contain higher percentages of base metal sulphides than other Au-quartz vein deposits in the CYPLUS area.

Geochemical signature: Au, Ag, Cu, Pb, Zn, As, W, Sn.

Known deposits: Horn and Possession Islands, Scrubby and Packers Creeks.

Assessment criteria:

1. Late Palaeozoic, subvolcanic I-type porphyritic intrusives.
2. Distribution of known primary and alluvial gold mineralisation.
3. Alignment of intrusives and known mineralisation in regional fracture systems.

Assessment:

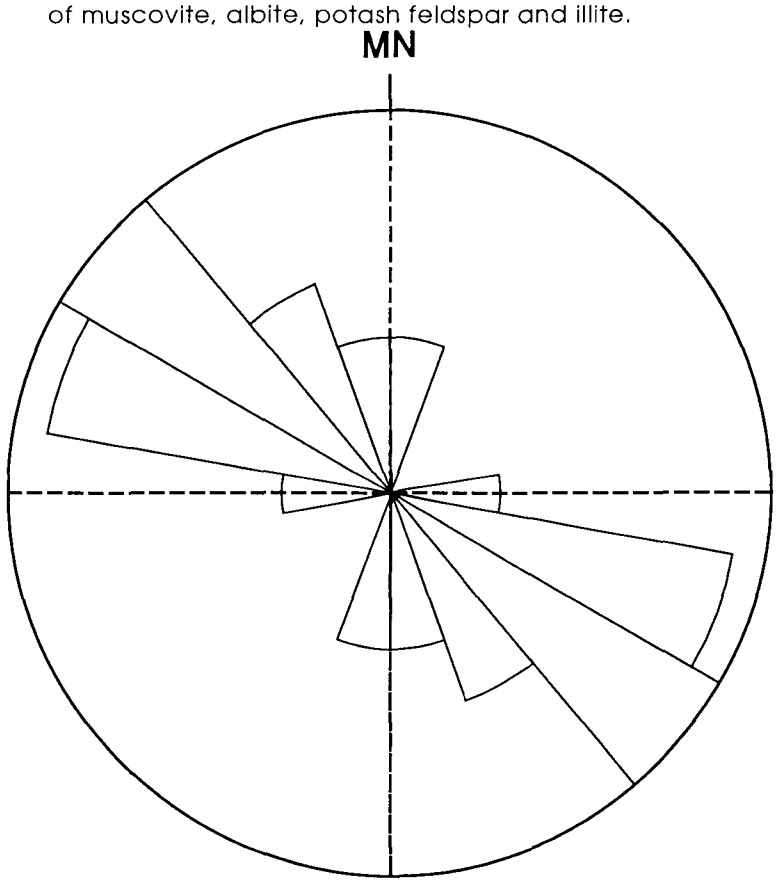
Area AuF1 (Map 1)

The Prince of Wales Group of islands in Torres Strait has a high resource potential for small porphyry-hosted gold veins with a certainty level of C.

Gold-base metal sulphide-quartz veins and stockworks occur in welded tuff and porphyritic granite on Horn, Possession, Hammond, Goods, Prince of Wales and Thursday Islands in the southern Torres Strait area. The major focus of exploration has been the Horn Island Goldfield, where Torres Strait Gold Pty Ltd delineated indicated and inferred resources of 2.35Mt at an average grade of 2.37ppm Au in the 1980's (Levy & Storey, 1990).

The Horn Island Gold Mine is within a south-east trending structural corridor which encompasses gold mineralisation on neighbouring islands. Ore-bearing structures are flat-lying structures and two orthogonal sets of steep structures dipping to the south-west and north-west. The dominant trend of veins on Horn Island is south-easterly (Figure 24).

Extensive propylitic alteration related to hydrothermal fluid movement is developed along the structural corridor. Alteration is vein controlled. Rocks adjacent to veins are completely sericitised and chloritised, and may show local development of muscovite, albite, potash feldspar and illite.



Strikes plotted by area
Porphyry-hosted Au-base metal sulphide-quartz veins (Torres Strait)
N=62

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Figure 24. Rose diagram, strikes of porphyry-hosted Au-based metal sulphide-quartz veins (Torres Strait).

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Sulphide minerals are common but do not represent a large proportion of the rock as a whole. Typically, <7% by weight of ore veins is sulphide. Pyrite, galena and sphalerite, with lesser chalcopyrite and arsenopyrite, occur within veins and along vein margins. Gangue minerals include quartz, chalcedony, calcite, chlorite and fluorite. Sulphide stringers are common within lode zones. Traces of molybdenite and wolframite have been noted. Only minor to trace amounts of galena and sphalerite occur in granite outside the lode zones. However, pyritisation of the altered granites is common. Unaltered granite is generally pyrite-free, except on joint faces. Levy & Storey (1990) noted that the deeper parts of the deposit are chalcopyrite-bearing whereas arsenopyrite had been observed in the upper levels.

Individual veins range from 0.01 to 2m wide (average 0.2m). The veins are tensional features, with well-developed comb quartz, laminated quartz and breccia textures. Much of the silica is cryptocrystalline and fluorite occurs in some veins. Gold is free in the oxidised zone (to approximately 3m depth), but is closely associated with base metal sulphides (particularly galena) in the primary ore and is restricted to quartz-sulphide veins and zones; some micro-nuggets of free gold have been observed. Very little gold occurs in altered granite free of quartz veining.

Lodes are composites of several veins and are typically 1m wide, but are up to 15m wide in places, especially near brecciated intersections with other lodes. Major lodes can be traced discontinuously along strike for up to 1km but most extend for <60m. The lodes have been intersected in drillholes to a vertical depth of 100m, but only the upper 50m was systematically drilled.

Elsewhere on Horn Island, and on Possession Island, gold occurs in quartz-base metal sulphide veins in silicified, brecciated and sericitised volcanic rocks of the Torres Strait Volcanics.

Torres Strait Gold Pty Ltd investigated zones of silicified volcanic rocks and associated granitic intrusives at Cable Bay Ridge, Horned Hill, Lucky Strike Extended and the Southern Silicified Ridge on Horn Island. These zones contain quartz veining with sericitic envelopes. Surface rock chip samples from Cable Bay Ridge assayed up to 0.8ppm Au. Rock chip samples from a 100m by 50m quartz-fluorite-chalcedony breccia at the Southern Silicified Ridge assayed up to 2.54ppm Au.

Two lines of quartz reef were worked on Possession Island. The eastern reef strikes 140° and is near-vertical. It comprises a 2m wide zone of quartz-sulphide veins (to 50mm wide) in dacitic ignimbrite; a sample from the mullock assayed 57.7g/t Au and 33.8g/t Ag. The western reef has the same strike and dips steeply south-west. It comprises a 20m wide zone of quartz veining in stockworked, intensely altered (kaolinised, chloritised and sericitised) and fractured ignimbrite. Copper staining has been found in outcrops of silicified ignimbrite north-east and south-west of the old workings. Some galena and pyrite occur on joints north-east of the workings.

Gold-bearing quartz-sulphide veins on Hammond, Goods, Thursday and Prince of Wales Islands are in extensively stockworked and altered (kaolinised and silicified) dacitic ignimbrite. Traces of gold have been reported to occur at Peak Point on the mainland.

Area AuF2 (Map 1)

The Badu Granite and associated volcanics on Moa and Badu Islands provide a suitable geological environment for the development of porphyry-hosted gold veins. However, there is no known gold mineralisation in the area and the rocks lack the fracture systems and alteration evident in Area AuF1. There is a low resource potential for small porphyry-hosted gold vein systems with a certainty level of B.

Area AuF3 (Map 2)

The Early Permian Weymouth Granite hosts Au-bearing quartz veins in the Scrubby and Packers Creek areas. There is a moderate resource potential for small gold deposits with a certainty level of C.

At Scrubby Creek, mineralisation is structurally-controlled by a 0.5 to 15m wide, east-trending regional shear zone in kaolinised and greisenised granite. Narrow,

well-defined, quartz-limonite breccia veins carry the gold mineralisation. The sheared granite itself is poorly mineralised.

At Packers Creek, gold-bearing quartz veins are up to 1m wide, strike east to east-south-east, and dip 45° northerly.

Areas AuF4 and AuF5 (Map 2)

These areas cover the known extent of the late Palaeozoic Weymouth Granite and associated volcanics, as well as the Wigan and Wolverton Adamellites. Gold has been found in pan concentrate samples from streams in the area of the Wigan and Wolverton Adamellites and the remains of an old gold stamper reportedly occur near Granite Creek. There is a low resource potential for small porphyry-hosted gold-quartz veins with a certainty level of B.

Area AuF6 (Map 2)

Known mineralisation in this small area of the late Palaeozoic Wigan Adamellite includes McLennan's Lode and the White Heather. Deep lead mineralisation in the Bairdsville area indicates the potential for additional lode mineralisation in the area. There is a moderate resource potential for small porphyry-hosted Au-quartz veins with a certainty level of C.

Gold mineralisation at McLennan's Lode and White Heather comprises quartz veins in shear zones in the Wigan Adamellite. Associated sulphides include pyrite, arsenopyrite, galena and chalcopyrite. The main mineralised zones are silicified breccia zones (fragments and blocks of lode quartz in silicified and sericitised granite) in dykes of fine-grained granite. The gold is generally very fine-grained; lode samples collected during field checking assayed 4.5 to 9.9g/t gold.

Areas AuF7 and AuF8 (Map 2)

The Late Permian, I-type Twin Humps Adamellite intrudes mid-Palaeozoic granitoids near Coen and is broadly contemporaneous with the Weymouth Granite. AGSO stream sediment geochemical data indicate that streams draining immediately north of Area AuF7 are anomalous in gold. There is a low resource potential for small porphyry-hosted Au-quartz veins with a certainty level of B.

Area AuF9 (Map 3)

Two small stocks of porphyritic biotite microgranite (late Palaeozoic Lindsay Flat Microgranite) occur in the Flying Fox Hill area. Interpretation of AGSO aeromagnetic data indicates that the two stocks merge into a single body at shallow depth (a few hundred metres) below the surface. The intrusion is elliptical in plan and is about 4km long by 2km wide. The microgranite (particularly in the southern stock) is altered and variably pyritised, and is cut by veinlets of calcite and quartz. No gold mineralisation is known in the area and exploration results, to date, have been negative.

An extensive, north-east trending zone has potential for additional subsurface porphyry intrusions. There is a low resource potential for small porphyry-hosted Au-quartz vein systems with a certainty level of B.

Economic significance:

Most veins of this type comprise low-tonnage high-grade ore shoots (Figure 25). Historically, mining was confined to the oxidised ore (above the water table) because the high sulphide content made the primary ore difficult to process with the simple treatment methods used at that time. The potential for large tonnage low-grade stockwork deposits makes this ore deposit type an attractive target. However, overall ore grades at Horn Island proved to be lower than indicated by exploration, mainly due to the high proportion of barren rock between the gold-bearing veins.

Equivalent/ related deposit types:

Polymetallic veins / alluvial placer gold deposits.

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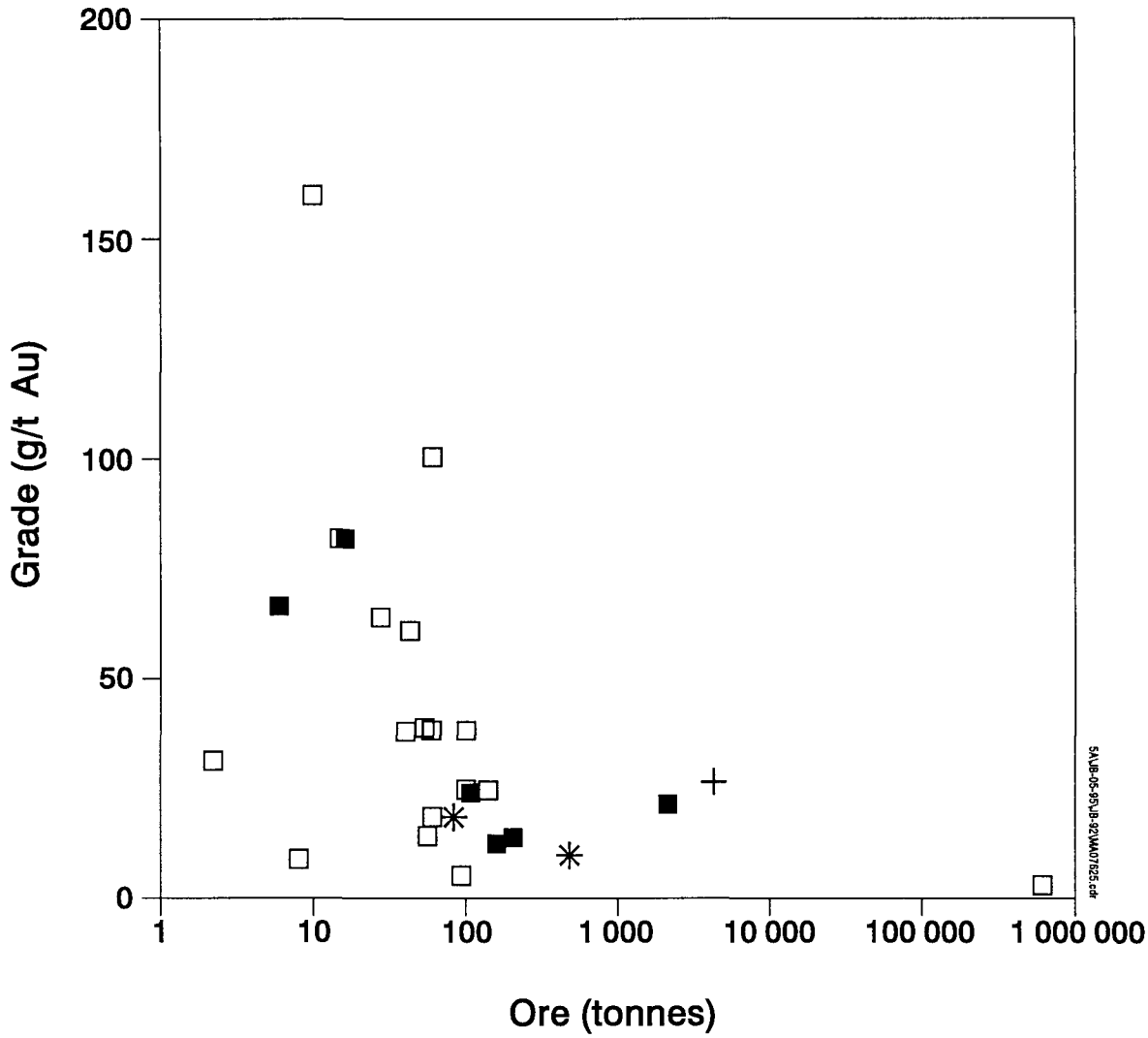

Historical production and resources

□ Horn Island

+ Possession Island

✳ McLennans

■ Iron Range area

Figure 25. Grade-tonnage diagram, porphyry-hosted Au-base metal sulphides-quartz veins and stockworks.

References:

Bruvel & Morwood (1992)
Culpeper & others (1992b)
Denaro (1993)
Denaro & Morwood (1992b,c)
Denaro & others (1993)
Levy & Storey (1990)

Model AuG: Au skarn deposits

Commodities, by products and trace metals: Gold, copper.

Geological setting: Carbonate sequences adjacent to diorite to adamellite (locally rhyolitic) I-type intrusives. All the significant occurrences in north Queensland are associated with Carboniferous to Permian subvolcanic complexes with dykes, plugs, stocks and breccias of rhyolitic to trachytic composition.

Structural control: Occurrences tend to occur in discrete corridors characterised by concentrations of subvolcanic intrusions and, in some cases, crustal scale faults.

Age: Host rocks could be Proterozoic to Palaeozoic. Mineralisation is likely to be Palaeozoic.

Deposit description: Skarn replacement of carbonates (and associated calcareous sediments and altered volcanics). Massive, pipe, sheet and vein replacements controlled by lithology and structure. Minerals include garnet (grossular-andradite), clinopyroxene (hedenbergite-diopside), vesuvianite, wollastonite, magnetite, hornblende. Retrograde mineralisation comprises amphiboles, chlorite, biotite, epidote-clinozoisite, quartz, fluorite, carbonates, K-feldspar, scapolite, hematite and clays. Sulphides are commonly retrograde and include chalcopyrite, pyrite, pyrrhotite, arsenopyrite, bornite, sphalerite, galena, tetrahedrite, Bi minerals and Te minerals. Gold is typically deposited at the retrograde stage. At Red Dome, gold mineralisation is associated with a green garnet phase and comprises free gold, gold-bearing tellurides, chalcocite and sphalerite. Alteration comprises skarn replacement of carbonate-bearing rock (exoskarn) and local endoskarn development (particularly as networks of veins) in intrusives. Retrograde skarn development commonly coincides with retrogression of intrusive.

At Red Dome, a karst collapse breccia capping the skarn forms a significant part of the gold resource.

Geochemical signature: Au, As, Bi, Te.

Geophysical signature: Gravity and magnetic anomalies suggesting underlying subvolcanic plutons and faults.

Known deposits: Red Dome (near Chillagoe, immediately south of the CYPLUS area).

Assessment criteria:

1. Presence of suitable host rocks (limestone, calcareous sediments).
2. Late Palaeozoic subvolcanic I-type intrusives.
3. Structural corridors delineated by concentrations of subvolcanic intrusives and faults.

Assessment:

Area AuG1 (Map 2)

Drilling has indicated the presence of subsurface intrusions in the Bolt Head area. Limestone, dolomite and calcareous schist of the Proterozoic Sefton Metamorphics have potential to host gold-bearing skarn deposits. There is a low resource potential for small Au skarn deposits with a certainty level of B.

Area AuG2 (Maps 2 and 3)

Gold mineralisation is associated with calc-silicate lenses in the Coen Metamorphics in this area. Deposits are small and/or low grade and are characterised by deep weathering and red soils. There is a low resource potential for small Au skarn deposits with a certainty level of B.

Areas AuG3 and AuG4 (Map 4)

These areas in the Chillagoe Formation comprise limestone, muddy limestone, basalt, chert, sandstone, siltstone and mudstone. It is not known if there are any

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potentially mineralising subsurface felsic plutons in the area. There is a low resource potential for small gold skarn deposits with a certainty level of B.

Areas AuG5 and AuG6 (Map 4)

Limestone crops out in the Hodgkinson Formation in these areas. There is a low resource potential for small Au skarns with a certainty level of B.

Economic significance: The most significant example of this style of mineralisation is the Red Dome mine, near Chillagoe, just to the south of the CYPLUS area.

References: Denaro & Morwood (1992a)
Morrison (1988)

Model AuH: Porphyry dyke-related Au-quartz veins and stockworks

Commodities, by products and trace metals: Gold.

Geological setting: Porphyry dykes in reactivated shear zones or in complex fault and fracture sets formed in a regional stress field during intrusion. Significant occurrences are associated with dykes of rhyolitic to trachytic composition, related to late Palaeozoic subvolcanic complexes.

Structural control: Regional felsic dyke systems intruded in regional shear zones. Occurrences tend to occur in discrete corridors characterised by concentrations of subvolcanic intrusions and, in some cases, crustal scale faults.

Age: late Palaeozoic.

Deposit description: Breccia, vein and stockwork deposits related to felsic porphyry dykes. Dykes are pyritic, silicified and brecciated, and carry low-grade gold mineralisation. Gold-bearing quartz-calcite-fluorite-pyrite veins occur in shears marginal to the dykes and in parallel and feather shears. These veins also contain minor arsenopyrite, galena and sphalerite. Sulphides typically constitute 15 to 20% of the ore shoots. Fissure, rather than shear, lodes predominate in most deposits and individual veins have sharp walls and minor wallrock inclusions. The veins are dominated by fine, clear, elongate, euhedral quartz growing in combs, lining vughs, or as cockade overgrowths. Vein infill is zoned and multigeneration, with distinct Fe-As, Cu-Pb-Zn and Bi-As-Sb-Te-Ag stages. Phyllic alteration is dominant either as narrow selvedges on discrete veins or as pervasive zones enclosing stockworks. Secondary biotite and K-felspar, silica, smectite and carbonate are present in some deposits.

Dykes are closely associated with mesothermal Au-quartz veins in the Coen Goldfield and may have caused some remobilisation of gold from those veins.

Geochemical signature: Au, As, Cu, Pb, Zn.

Geophysical signature: Gravity and magnetic anomalies suggesting underlying subvolcanic plutons and faults.

Assessment criteria:

1. Regional shear zones with regional felsic dyke systems.
2. Distribution of known Au-quartz vein mineralisation.

Assessment:

Area AuH1 (Maps 2 and 3)

Within this south-south-east trending area surrounding Coen, rhyolite dykes occur as single dykes (for example, the Lankelly Dyke) and as dyke swarms intruded in mylonite zones and fracture zones associated with the Coen Shear Zone. The dykes themselves contain disseminated pyrite and arsenopyrite and low gold grades. They are closely associated with high-grade gold-bearing quartz veins. At some deposits (for example, Sirdar and Horseshoe Creek) mineralisation is associated

with rhyolite breccia dykes. There is a low resource potential for small rhyolite-hosted gold deposits with a certainty level of B.

Area AuH2 (Map 3)

This north-trending zone contains numerous subparallel rhyolite dykes associated with Au-quartz vein mineralisation along the Ebagoola Shear Zone. The dykes contain minor disseminated pyrite and arsenopyrite and low gold grades. There is a low resource potential for small rhyolite-hosted gold deposits with a certainty level of B.

Area AuH3 (Map 3)

There are numerous rhyolite dykes in this north-east trending zone around Flying Fox Hill. There is a low resource potential for small rhyolite-hosted gold deposits with a certainty level of B.

Economic significance: These deposits are generally low grade and there is little potential for economic mineralisation. Higher gold grades occur in associated mesothermal Au-quartz veins.

Equivalent/ related deposit types: / mesothermal Au-quartz veins (Coen type).

References: Culpeper & others (1992b)
Denaro & others (1993)
Morrison (1988)

Model AuI: Porphyry-related Au-breccia deposits

Commodities, by products and trace metals: Gold.

Geological setting: Late Palaeozoic subvolcanic complexes with dykes, plugs, stocks and breccias of rhyolitic to trachytic composition. Mineralised breccias are typically localised near the intersection of intrusive "corridors" with major structural or lithological contacts.

Structural control: Occurrences tend to occur in discrete corridors characterised by concentrations of subvolcanic intrusions and, in some cases, crustal scale faults.

Age: late Palaeozoic.

Deposit description: Breccia bodies are up to 2km in diameter, have a pipe-like form and are characterised by multiple breccia and intrusive phases. *Subvolcanic breccias* have the form of an inverted cone centred above a porphyry plug or stock, a predominance of angular, clast-supported breccia with a tabular style typical of the pipe margin, an equant partly rounded style in the core, and, in some cases, a collapsed roof that partly preserves original host rock stratigraphy. *Diatreme breccias* are more complex, typically nested breccia bodies with extrusive apron as well as pipe facies. The predominant breccia type is matrix-supported, with subrounded fragments, and locally exhibits crude layering, size grading and other sedimentary structures.

In both breccia types, mineralisation is most commonly in structurally controlled post-breccia veins that may be restricted to one portion of the pipe, or as cavity fill or breccia matrix replacement that may be more extensive within the pipe. Metal zoning and stages and gold distribution are comparable with those described for Model AuH (porphyry-related Au-quartz veins and stockworks).

Geochemical signature: Au, As, Cu, Pb, Zn.

Geophysical signature: Gravity and magnetic anomalies suggesting underlying subvolcanic plutons and faults.

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Assessment criteria:

1. Intrusive corridors with subvolcanic rhyolitic to trachytic intrusions.
2. Presence of mineralised breccias.

Assessment:

Area Au11 (Map 2)

At Mount Croll, porphyritic rhyolite intrudes Lankelly Granite and there are numerous rhyolite outcrops in the surrounding area. Numerous mineralised quartz veins occur along shears in rocks at the base of Mount Croll. These veins contain quartz, calcite, arsenopyrite and fluorite. Although no old workings have been found here, old reports indicate that 1.3kg of gold was produced in 1899. There is a low resource potential for small porphyry-related Au-breccia deposits with a certainty level of B.

Area Au12 (Map 3)

A 300m diameter rhyolite plug intrudes the Flyspeck Granodiorite at Spion Kop. Gold occurs in quartz-sulphide (pyrite, arsenopyrite) veins and along fractures in the granite. The mineralisation closely follows the contact of the rhyolite and the granite, where a hybrid, polymict felsite breccia with abundant arsenopyrite is developed. The breccia assays up to 0.98ppm Au and quartz veins assay up to 2.4ppm Au. Mullock from old workings assays up to 30ppm Au. The intrusion is within a zone of north-trending fractures and rhyolite dykes which may contain additional subsurface rhyolite intrusions. There is a low resource potential for small rhyolite-hosted breccia deposits with a certainty level of C.

Economic significance:

Significant deposits of this type include Mount Leyshon and Kidston which are both outside the CYPLUS area.

References:

Culpeper & others (1992b)
Denaro & others (1993)
Morrison (1988)

Model AuJ: Epithermal gold deposits

Commodities, by products and trace metals:

Gold, silver, mercury, antimony.

Geological setting:

Deposits formed near the surface, mineralisation taking place generally within 1000m of the surface. Deposits form in extensional tectonic settings, in areas with well developed tension fracture systems and normal faults. Mineralisation commonly occurs in volcanic terranes with well differentiated, subaerial pyroclastic rocks and numerous, small subvolcanic intrusions.

Structural control:

Fracture systems are commonly, but not necessarily, associated with large-scale volcanic collapse structures. Through-going fracture systems, major normal faults, fractures related to doming, ring fracture zones, joints.

Age:

Can be any age. North Queensland examples are commonly in Carboniferous to Permian volcanic and sedimentary terranes.

Deposit description:

Epithermal gold deposits include a number of sub-types, such as high sulphidation acid sulphate (quartz-alunite) deposits and low sulphidation adularia-sericite and alkalic (quartz-adularia) deposits.

Veins are the most common ore host, although breccia zones, stockworks and fine-grained bedding replacement zones also occur. Ore zones (ore shoots) bottom in either barren rock or pass downward into subeconomic zones containing base metal sulphides. Ore and associated minerals are deposited dominantly as open space filling with banded, crustiform, vughy, drusy, colloform and comb textures. Repeated cycles of mineral deposition are evident. Gold and silver are the main economic minerals and occur along with anomalous concentrations of Hg, As, Sb and, rarely, Tl, Se and Te. The main ore minerals are native gold and silver, electrum, argentite and silver-bearing arsenic-antimony sulphosalts. Additional minerals which may be present include galena, sphalerite, chalcopyrite,

enargite, cinnabar, stibnite and tetrahedrite. Gangue minerals are mainly quartz and calcite, with lesser fluorite, barite and pyrite; chlorite, hematite, dolomite, rhodonite and rhodochrosite are less common. Silica occurs as quartz, opal, chalcedony and cristobalite. Alteration zones include silicification, argillic, propylitic and alunitic. Precious metals are generally associated with silicification.

Epithermal deposits elsewhere in north Queensland are of the low sulphidation quartz-adularia type, with banded chalcedonic and comb quartz exhibiting bladed pseudomorph textures, internal brecciation, and local concentrations of carbonate and sulphate minerals. Silicic, argillic, sericitic and propylitic alteration are well developed, and advanced argillic alteration has been noted locally.

Geochemical signature: Au + Ag + As + Sb + Hg higher in system; increasing Cu, Pb and Zn at depth.

Assessment criteria:

1. Distribution of late Palaeozoic subvolcanic intrusions and associated volcanic/sedimentary sequences.
2. Appropriate structural control such as fracture systems, ring structures and faults.
3. Known mineralisation and geochemical anomalies.

Assessment:

Area AuJ1 (Map 1)

There is a moderate resource potential for small epithermal gold deposits in the Torres Strait area with a certainty level of B. Acid pyroclastics and lavas in the area contain extensive alteration zones with low gold grades. Chalcedonic quartz veins are known to occur in the volcanic rocks and in ?co-magmatic porphyritic intrusives. The volcanics and intrusives of the Prince of Wales Group of islands may represent a caldera structure.

Area AuJ2 (Map 1)

The geological environment of the Badu-Moa Islands area is permissive for epithermal gold deposits. There is a low resource potential for small epithermal gold deposits with a certainty level of B.

Area AuJ3 (Map 2)

The presence of late Palaeozoic felsic to intermediate volcanics and high-level felsic intrusives that have been unroofed partially, where exposed, can be regarded as a favourable environment for epithermal Au systems to develop.

Exploration has delineated a number of potential epithermal mineralising systems in the Temple Bay area. Distinct bedrock Hg, As and Sb anomalies have been detected beneath Mesozoic cover; quartz-pyrite-arsenopyrite veins in narrow, linear breccia zones in ignimbrite and silicified tuff of the Kangaroo River Volcanics assayed up to 0.55ppm Au. Several Hg, As and Au anomalies have been delineated in the Kangaroo River Volcanics.

Reconnaissance whole rock oxygen-isotope data for the volcanic rocks has indicated an extensive area of whole rock ^{18}O depletion and highlighted the epithermal potential of this region (Ewers & Cruikshank, 1993); no data are available for the intrusive rocks. The isotope depletion pattern of the volcanics is similar to one observed in the northern Drummond Basin — an area of north Queensland known for its epithermal gold potential. A multi-element index normally associated with epithermal mineralisation (Au, Ag, As, Sb, Tl) derived from an AGSO stream sediment geochemical survey indicates a highly anomalous and promising area south of Temple Bay and, to a lesser extent, in the Mount Carter - Jacks Knob area. There is a moderate resource potential for small to medium epithermal gold deposits with a certainty level of C.

Area AuJ4 (Map 2)

This area has a similar geological environment to that in Area AuJ3. There is a moderate resource potential for small to medium epithermal gold deposits with a certainty level of B.

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Area AuJ5 (Map 1)

There is a moderate resource potential for the Cape Grenville Volcanics to host small to medium epithermal gold deposits with a certainty level of B.

Area AuJ6 (Map 4)

This area covers Permian sediments, volcaniclastic sediments and volcanics of the Normanby Formation; the Normanby Formation is now known to extend farther to the south than shown on the Mossman 1:250 000 geological map. Anomalous Hg and Au occur along the eastern faulted boundary of the Normanby Formation with the Hodgkinson Formation and there is some evidence for a subsurface intrusion in the area. Queensland Metals Corporation N.L. reported that the anomalous Hg-Au prospects in the area may represent the upper part of an epithermal system with potential to host a significant gold deposit at depth (Forbes, 1986). There is a low resource potential for small epithermal gold deposits with a certainty level of B.

Area AuJ7 (Map 4)

Gold-bearing quartz veins occur in a north-north-east trending belt of acid to intermediate volcanics and intercalated silty to sandy sediments of the Normanby Formation in the Six Mile area, west of Cooktown; the rocks are shown as Hodgkinson Formation on the old Cooktown 1:250 000 geological map. Significant mineralisation occurs in a 2200m long by 60m wide zone of quartz-limonite stockwork veining and brecciation in sheared and highly altered intermediate volcanics and sediments. Intense silicification and sericitisation are associated with the veining and the vein textures indicate an epithermal origin. Historically, the Six Mile Workings produced 2.7kg of gold at an average grade of 24.2g/t. Mullock samples assay up to 41g/t Au but drilling returned assay results of up to 0.59g/t. Antimony mineralisation also occurs in the area but is generally low in gold grade. There is a moderate resource potential for small epithermal gold deposits with a certainty level of C.

Economic significance: Epithermal gold deposits offer potential for large tonnage resources with low to moderate gold grades. Significant Queensland deposits occur in the Drummond Basin west of Mackay.

Equivalent/ related deposit types: / alluvial placer gold deposits.

References:

Cox & Singer (1986)
Denaro & Morwood (1992a)
Ewers & Cruikshank (1993)
Morrison (1988)
Roberts & Sheahan (1990)

Model AuK: Alluvial placer gold

Commodities, by products and trace metals: Gold, platinum group elements.

Geological setting: Deeply weathered terrane (commonly part of a stable craton containing suitable auriferous host rocks) having moderately incised stream valleys containing various types of alluvial deposits. Occur in high energy alluvial environment where gradients flatten and river velocities lessen, for example, at the inside of meanders, below rapids and falls, beneath boulders, and in vegetation mats.

Age: Cainozoic, Mesozoic. Preservation of older (Mesozoic) deposits as deep leads requires special conditions.

Deposit description: Gold and platinum group alloys in grains and nuggets in gravel, sand, silt and clay, and their consolidated equivalents in modern and fossil alluvial deposits. The highest gold grades occur at the base of gravel deposits in various gold "traps" such as natural riffles trending transverse to the flow of the stream (fractured

bedrock, dykes, bedding planes). Gold concentrations also occur in gravel deposits above clay layers that constrain the downward migration of gold particles. Deposits range from narrow pay streaks on or near bedrock in narrow valleys to zones or layers of sparsely disseminated, very fine-grained gold in flood plain deposits. Grain size decreases with distance from source. Some gold in placer deposits may be contributed by chemical migration and accretion processes.

Geochemical signature: Anomalously high Ag, As, Hg, Sb, Cu, Fe, S, and heavy minerals such as magnetite, chromite, ilmenite, hematite, pyrite, zircon, garnet and rutile. Gold nuggets have decreasing silver content with distance from source.

Geophysical signature: Regional geophysical surveys are of little use, although radiometrics can be used to delineate heavy mineral concentrations. Local seismic surveys may be useful for determining the thickness of placer gravels.

Known deposits: Palmer Goldfield, Coen Goldfield, Ebagoola Goldfield.

Assessment criteria:

1. Gold-bearing source rocks.
2. Suitable alluvial deposits.
3. Distribution of known alluvial gold resources.
4. Coarser gold is commonly found in the upper reaches of streams and on steeper gradients; the richest and coarsest gold concentrations typically occur in comparatively coarse sediment.

Assessment:

Area AuK1 (Map 1)

Alluvial and eluvial gold have been mined in the Horn Island Goldfield. There is a moderate resource potential for small alluvial gold deposits on those islands with Au-quartz veins; the certainty level is C.

Area AuK2 (Map 2)

In this area, alluvial gold occurs in Recent alluvium and in Mesozoic palaeoplacers (deep leads). There is a moderate resource potential for small alluvial gold placers with a certainty level of C.

Gold-bearing deep leads occur in gutters at the base of the Mesozoic Gilbert River Formation at Bairdsville, Top Camp, Lower Camp, and Iguana Mountain. Leads have also been found in gullies draining the Mesozoic rocks between the Wenlock River and Iguana Mountain.

The leads occur in the basal conglomerate of the Gilbert River Formation, generally over a basement of decomposed granite. The basal conglomerate of the Gilbert River Formation comprises well rounded cobbles of quartz and basement rocks in a medium to coarse-grained clayey quartzose matrix. The gold-bearing wash is well cemented and occurs in narrow gutters.

Most of the gold at Lower Camp occurred in specimen stone (associated with ironstone and quartz). The gold was mainly fine-grained but coarse-grained gold and nuggets to 150g were common. The average grade mined was 15.5g/t but the gold content was irregular and was mainly governed by irregularities in the bottom and the gradient of the channel. The wash at Lower Camp and at Top Camp is closely associated with gold-bearing quartz veins and the placer deposits may be essentially eluvial rather than alluvial. At Bairdsville, there are no known associated gold-bearing quartz veins.

Gold Copper Exploration Ltd (Wynn, 1982) carried out extensive costeaning in the Wenlock area, but concluded that significant gold is not shedding from the nonconformity at the toe of the Mesozoic escarpment.

Small alluvial placers have also been mined in the Wenlock area. These are generally along gullies dissecting gold-bearing deep leads and represent a reconcentration of gold from those leads. At Chock-a-Block Creek, eluvial gold occurs in decomposed granite and apparently has been shed from nearby quartz leaders. Gold reportedly occurred in decomposed granite beneath the deep lead at Top Camp.

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Investigations of the Larsen's Creek area by Coal Country No. 14 Pty Ltd indicated that the basal gravelly wash of the Tertiary Falloch beds contains gold. One sample assayed 0.33g/m^3 gold. The company estimated the alluvial resources to be of the order of 250 000m^3 but did not investigate overall grades.

In general alluvial deposits in the area are either too small or too low-grade to be economic as company-scale operations.

Area AuK3 (Maps 2 and 3)

This extensive area covers potentially gold-bearing country along the McIlwraith Range and alluvial and coastal flats to the east. Alluvial gold has been reported to occur in most of the rivers and creeks in this area, but generally not in economic quantities or grades. There is a low resource potential for small alluvial placer gold deposits with a certainty level of B.

Augold N.L. estimated that 5000m^3 of wash in a 1m thick section in Buthen Buthen Creek, immediately downstream of the Golden Gate workings, grades up to 0.33g/m^3 Au.

Tri-State Mining Ltd calculated inferred alluvial resources of 56.25kg of gold in Whites Creek and 89.5kg of gold in Skae Creek. The company mined the Skae Creek deposits.

In 1985, Alberta Mines N.L. investigated the alluvial gold potential of the Rocky River. Stream bed gravels returned 18.83 to 21.53g/m^3 along a 2.2km length of the river. However, bulk samples assayed only 0.23g/m^3 in the stream bed and much lower in terraces and flats. The high initial results were probably caused by biased sampling due to large boulders. Alberta Mining concluded that the deposits were too low grade for economic mining.

Leo Creek, where it drains the Claudie Lakeland reef, and creeks draining the Mullimbidgee reefs are considered to be highly prospective for small alluvial gold deposits. Minor illegal mining has been carried out at Leo Creek in the past and stream bed alluvium and residual soils on the banks produce good colours of gold when panned.

Area AuK4 (Maps 2 and 3)

Alluvium in the Coen area has a low resource potential for small placer gold deposits with a certainty level of C. The Coen Goldfield was never an important alluvial producer; only 310kg out of a total of about 4000kg of gold was alluvial. Streams such as the Coen River and Oscar Creek are known to carry gold but recent mining operations by Saracen Minerals N.L. indicated that grades are too low to be economic. The absence of a stream sediment geochemical gold anomaly in the Coen area suggests limited potential for alluvial gold accumulations.

Area AuK5 (Map 3)

Creeks and gullies in the Ebagoola area have a moderate resource potential for small alluvial placer gold deposits with a certainty level of C. This area has been the scene of recent small-scale alluvial mining. The most promising prospects are eluvial deposits shedding from areas of old lode gold workings. Grades are generally patchy and most deposits are too small or too low grade to be economic.

Area AuK6 (Map 3)

This stretch of the Palmer River has been mined and prospected in the past, with little success. Upstream of Strathleven Homestead, 105.8kg of gold was produced at an average grade of 108mg/m^3. Exploration of the active river channel and high-level palaeochannels has indicated that gold occurs in the alluvium but is flaky and very fine-grained. Grades are erratic and volumes are generally insufficient for large scale operations. The palaeochannel deposits are the most prospective. Testing at Lukinville indicated average grades of 167mg/m^3. There is a low resource potential for small alluvial placer gold deposits with a certainty level of C.

Area AuK7 (Maps 3 and 4)

This extensive area covers the Palmer River and its tributaries upstream from Lukinville. It was mined extensively in the early days of the Palmer Goldfield and in the last decade. Small-scale mining is currently being carried out in the Palmer, North Palmer, South Palmer and Little Palmer Rivers areas. There is a moderate resource potential for small alluvial placer gold deposits with a certainty level of C.

Exploration has indicated a number of areas with gold resources, for example, 139 000m^3 at 0.41g/m^3 in Spear Creek, 254 000m^3 at 0.20g/m^3 in Blackfellow Creek, 1 400 000m^3 at 0.26g/m^3 along the Palmer River, 850 000m^3 at 0.8g/m^3 in the upper reaches of Doughboy Creek, and 70 000m^3 at 0.26g/m^3 in the Little Palmer River.

Gold occurs in Recent wash in flow channels and under active sand banks, in old wash adjacent to recent sand banks, and in high-level wash associated with palaeochannels. Gold is uniformly dispersed throughout the alluvium, but is concentrated on the inside of bends. Most of these bends have been reworked many times. Isolated patches of alluvium in the river bed contain grades comparable to those of the river bends.

The tributary creeks are generally narrow and winding. Gold occurs in stream bed alluvium and in patches of buried gravel on gentle slopes above the streams. Highest grades are in the creek beds.

Gold also occurs in deep lead deposits beneath Cainozoic basalt, particularly in the Jimmy Ah Chee's Tableland area.

Area AuK8 (Map 4)

This area covers the Palmer and North Palmer Rivers in the Maytown area, as well as Chinky Creek in the Conglomerate Range. Mining is currently being carried out at a number of locations within this area, particularly along small gullies draining the old lode workings. There is a high resource potential for small alluvial placer gold deposits with a certainty level of D.

Area AuK9 (Map 4)

This area covers the Conglomerate Range, where gold-bearing deep leads at the base of the Mesozoic rocks of the Laura Basin were worked in the early days of the Palmer Goldfield. Some rich patches were mined but the leads are generally patchy in grade, discontinuous, and hard to follow. It is unlikely that any leads found today would be economic to mine. There is a low resource potential for small palaeoplacer gold deposits with a certainty level of D.

Area AuK10 (Map 4)

The Laura and Mosman Rivers and Pine Tree and Kennedy Creeks have been explored for alluvial gold. The upper reaches of the Mosman River were worked in the early days.

Reconnaissance sampling of the Laura River indicated that the highest grades occur in a 10km stretch upstream from the crossing south-east of Laura. The indicated resource was 1.3Mm^3 at a grade of 4.2ppm Au; platinum and palladium contents are significant.

In 1987, a total of 1380m^3 of bulk samples from Kennedy Creek was treated for a gold recovery of 0.012 to 0.093g/m^3; minor platinum and cassiterite occur with the gold. The alluvium was considered to be uneconomic for bulk mining.

Bulk samples of alluvium from the Mosman River returned 0.25 to 0.4g/m^3 gold. The concentrates were high in platinum (385.5 to 840.5ppm) and palladium (2.2 to 6.1ppm). The indicated resource was calculated as 232 000m^3 at a grade of 0.19g/m^3 Au and a cutoff of 0.1g/m^3.

There is a low resource potential for alluvial placer gold deposits with a certainty level of C.

Area AuK11 (Map 4)

Alluvium along the upper reaches of the North Palmer River has a low resource potential for small alluvial placer gold deposits with a certainty level of B.

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Area AuK12 (Map 4)

The West Normanby and Granite Normanby Rivers have a low resource potential for small alluvial gold deposits with a certainty level of C.

Area AuK13 (Map 4)

Approximately 117.5kg of gold has been won from shallow alluvial and eluvial deposits at Munburra and in the headwaters of Diggings Creek. Recent attempts to rework the alluvials have met with little success. There is a low resource potential for small alluvial placer gold deposits with a certainty level of D.

Economic significance:

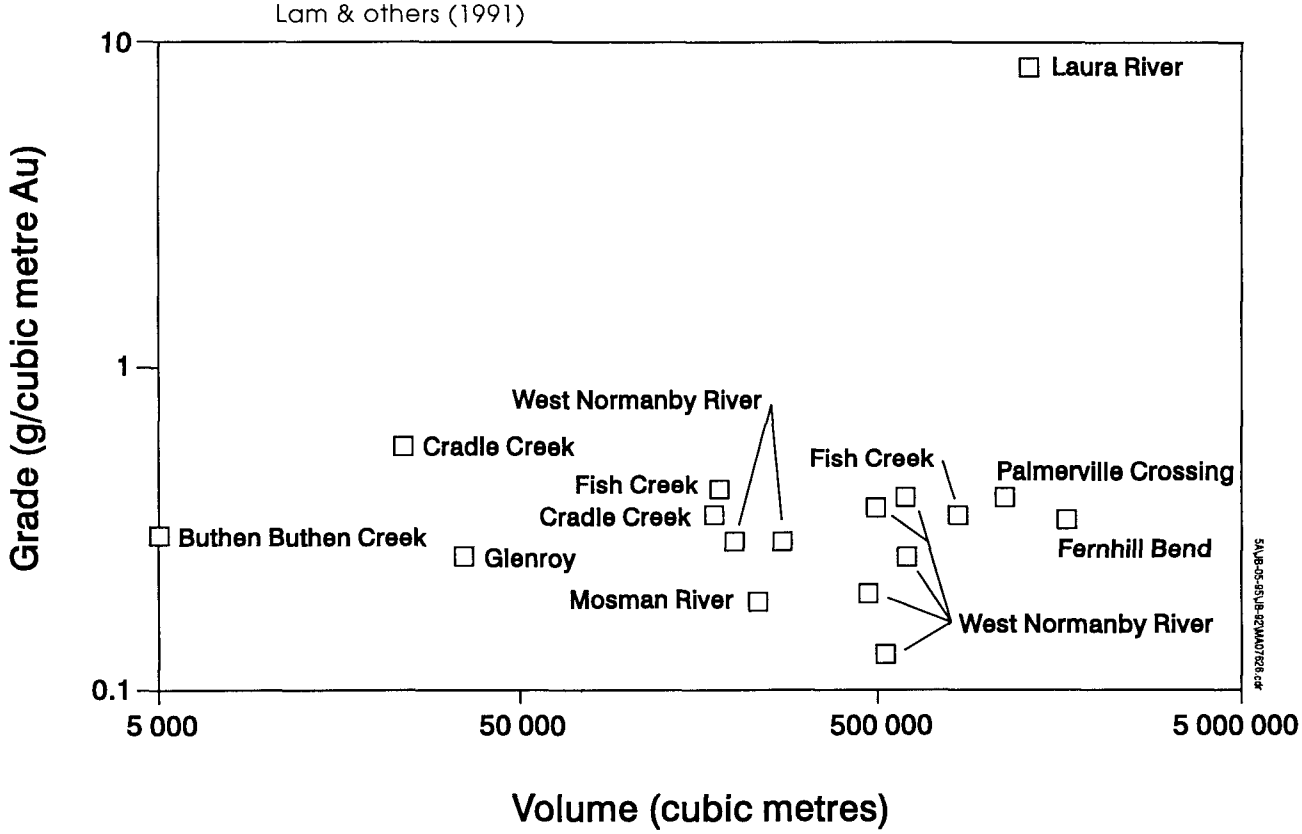
Deposits range from high grade "bonanzas" to low grade, non-economic disseminations. Unlike lode gold deposits, small placer deposits can be worked at a low cost, making them attractive to individuals, syndicates and small mining companies. Figure 26 shows grades and volumes of some known alluvial gold resources in the CYPLUS area. The CYPLUS area produced $2 223 934 of gold bullion in 1992/93; most of this production came from alluvial mining.

Equivalent/ related deposit types:

/ various types of lode gold deposits, alluvial placer tin and titanium deposits.

References:

Cox & Singer (1986)
Culpeper & Burrows (1992)
Culpeper & others (1992b)
Denaro (1993)
Denaro & Morwood (1992b,c)
Denaro & others (1992)
Denaro & others (1993)
Eckstrand (1984)
Lam & Genn (1993)
Lam & others (1991)



Known resources

Figure 26. Grade-volume diagram, alluvial placer gold deposits.

ANTIMONY (Sb)

Model SbA: Syntectonic Sb-Au deposits

Commodities, by products and trace metals: Antimony, gold.

Geological setting: Turbidite sediments; local mafic volcanics, ultramafics, granitic rocks, lamprophyre dykes; tend to occur in separate domains from Au-quartz veins, or on domainal boundaries which truncate Au-quartz veins.

Structural control: Veins are localised in secondary brittle shears associated with larger, often regionally significant, shear zones. Veins isolated into structural and lithological domains by post-mineralisation faulting.

Age: Host rocks Proterozoic to Palaeozoic. Mineralisation probably Palaeozoic.

Deposit description: Stibnite veins, pods and disseminations in or adjacent to brecciated or sheared fault zones. Vein deposits contain stibnite in pods, lenses, kidney forms and pockets (locally); may be massive or occur as streaks, grains and bladed aggregates in sheared or brecciated zones with quartz and calcite. Disseminated deposits contain streaks or grains of stibnite in host rock with or without stibnite vein deposits.

Veins, especially those associated with higher grade pods of stibnite, tend to be discontinuous and exhibit marked pinching and swelling within the host shears. Preferential enrichment occurs in dilation or tension gashes, cross fractures, and within shears crossing more competent rock types. Veins are generally steeply dipping and range from a few tens of metres to kilometres in length. Buck and ribbon quartz, together with local comb quartz, are the main quartz types. Mineralogy comprises stibnite + quartz ± pyrite ± calcite. Stibnite typically constitutes 10 to 30% of the veins, often as lamellar bands in ribbon quartz. Other sulphides generally comprise <1% of deposits and include arsenopyrite ± cinnabar ± chalcopyrite ± sphalerite ± galena ± pyrrhotite. Other minerals may include free gold, chlorite, Ag sulphosalts and scheelite. Extent and intensity of alteration are wall rock and fracture dependent. Alteration comprises proximal carbonate + quartz + sericite + pyrite ± arsenopyrite and peripheral chlorite + carbonate ± pyrite ± sericite.

Antimony mineralisation may be younger than, and superimposed on, Au-quartz mineralisation.

Geochemical signature: Sb + Fe + As + Au + Ag; Hg + W + Pb + Zn may be useful in specific cases. Residual soils directly above deposits are enriched in antimony. Yellow to reddish kermesite and white cervantite or stibiconite (antimony oxides) may be useful in exploration.

Known deposits: Six Mile workings, Cocoa Creek, Uncle Sandy; a number of significant antimony deposits occur in the Hodgkinson Formation near the Mitchell River, immediately south of the CYPLUS area.

Assessment criteria:

1. Distribution of known mineralisation.
2. Regional shear zones and faults.

Assessment: **Area SbA1 (Map 3)**

Antimony bearing quartz lodes occur in faults and shear zones along the contact of the Coen Metamorphics and Kintore Adamellite. The veins fill joints which trend 110° and 150°. Lodes bifurcate and are transected by numerous steep faults, with negligible or small displacement. Lodes are variable in shape, with frequent "pinches" and "swells" due to faulting. In places, the lodes give way to stockworks or irregular veinlets. Mineralisation in the oxidised zone (to 15m depth) comprises stibnite, valentinite and stibiconite. Below the oxidised zone, mineralisation is finer grained, of lower grade, and more randomly distributed. Stibnite is generally

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associated with gold and silver in a fluorite-pyrite gangue; chalcopyrite may also be present.

Kimba Mining Pty Ltd considered the deposits to have characteristics indicative of epithermal deposits (Beard, 1971). However, they are likely to be variants (probably at higher levels) of the mesothermal Au-quartz veins common in the Coen Inlier.

The potential for antimony is limited as the ore occurs in shoots averaging about 5% antimony, interspersed with low grade mineralisation of about 1.5% antimony. There is a low resource potential for small Sb-Au-quartz veins with a certainty level of C.

Area SbA2 (Map 4)

Antimony mineralisation occurs in gold-bearing quartz veins in a north-north-east trending belt of acid to intermediate volcanics and intercalated sediments of the Normanby Formation in the Six Mile area; these rocks are shown as Hodgkinson Formation on the old Cooktown 1:250 000 geological map. Stibnite occurs in small, discontinuous lenses which grade about 38 to 60% Sb. Gold contents are generally low in the stibnite-rich quartz. There is a low resource potential for small Sb-Au-quartz veins with a certainty level of C; deposits are unlikely to be economic.

Area SbA3 (Map 4)

Antimony occurs as stibnite in quartz veins in the Hodgkinson Formation at the Cocoa Creek workings. Dump samples from the old workings assay up to 16% Sb and the lode has been estimated to average 0.1% Sb at the surface. The tailings dump contains 1395t at an average grade of 5.2% Sb. There is a low resource potential for small Sb-Au-quartz veins with a certainty level of C; deposits are unlikely to be economic.

Area SbA4 (Map 4)

An Sb-Au-quartz vein is known to occur at the old Uncle Sandy mine. The lode is a 100 to 300mm wide quartz fissure vein in silicified siltstone and mudstone. No dykes have been mapped in the area. The vein comprises cherty quartz with pyritiferous host rock inclusions to 20mm across. Stibnite appears to be associated more with sheared/brecciated host rock than with quartz and may be concentrated on the vein margins. The only recorded production was 9t of 9% Sb ore and 0.3kg of gold. There is a low resource potential for small Sb-Au-quartz veins with a certainty level of B.

Economic significance: These deposits are more important for their gold content than antimony. Because tonnages are low and grades are generally lower than in the Au-quartz veins, these deposits are not likely to be economic.

Equivalent/ related deposit types: Mesothermal Sb-Au deposits / mesothermal Au-quartz and syntectonic Au-quartz veins; may grade to shallower depth (epithermal) Hg-Au deposits.

References:

Cox & Singer (1986)
Culpeper & Burrows (1992)
Denaro & others (1992)
Golding & others (1990)
Wallis (1993)

BASE METALS (Bm)

Model BmA: Porphyry copper

Commodities, by products and trace metals: Copper, gold, molybdenum.

Geological setting: Rift zones contemporaneous with Andean or island-arc volcanism along convergent plate boundaries. High-level intrusive rocks contemporaneous with abundant

dykes, breccia pipes, faults. Also cupolas of batholiths. Felsic to intermediate (typically porphyritic) intrusive rocks intruding granitic, volcanic, calcareous sedimentary, and other rocks. Associated with extensive hydrothermal features such as sulphides, alteration, veins, stockworks and breccias.

Structural control: Known deposits in Queensland tend to occur along well-defined trends or belts.

Age: Generally late Palaeozoic in far north Queensland.

Deposit description: Chalcopyrite as disseminations and stockwork veinlets in hydrothermally altered porphyry and adjacent country rock.

The porphyry has closely spaced phenocrysts and microaplitic quartz-feldspar groundmass. Mineralisation occurs as disseminated sulphide grains and as stockwork veins in porphyry, along porphyry contact, and in favourable country rocks such as carbonate rocks, mafic igneous rocks and older granitic plutons. The mineralogy comprises chalcopyrite + pyrite ± molybdenite; chalcopyrite + magnetite ± bornite ± Au; assemblages may be superimposed. Gangue minerals include quartz, K-feldspar, biotite, anhydrite, sericite and clay minerals. Late veins of enargite, tetrahedrite, galena, sphalerite and barite occur in some deposits. Alteration zoning (going from bottom, innermost zones outward) is sodic-calcic, potassic, phyllic, and argillic to propylitic. High-alumina alteration occurs in upper parts of some deposits. Propylitic or phyllic alteration may overprint early potassic assemblage.

Green and blue Cu carbonates and silicates occur in weathered outcrops. Where leaching is intense, barren outcrops remain after Cu is leached, transported downwards, and deposited as secondary sulphides at the water table or palaeowater table. Fractures in leached outcrops are coated with hematitic limonite. Deposits of secondary sulphides contain chalcocite and other copper sulphides replacing pyrite and chalcopyrite. Residual soils overlying deposits nay contain anomalous amounts of rutile.

Geochemical signature: Cu + Mo + Au + Ag + W + B + Sr centre; Pb, Zn, Au, As, Sb, Se, Te, Mn, Co, Ba and Rb outer. Locally Bi and Sn form distal anomalies. High S in all zones. Some deposits have weak U anomalies. Deposits are associated with high K, Sr, Ba, metaluminous magmas and are mainly associated with magnetite and/or titanite-bearing, oxidised I-type suites.

Geophysical signature: Electromagnetics may be used to delineate subsurface magnetite-bearing plutons.

Assessment criteria:

1. Epizonal to mesozonal, felsic to intermediate, typically porphyritic intrusions that have extensive related hydrothermal features such as sulphides, alteration, veins, stockworks and breccias.
2. Alteration related to hydrothermal activity is commonly zoned.
3. Metal and mineral zonation tends towards concentric patterns, but may be complex and somewhat irregular.
4. Extensively developed favourable structures such as stockworks, fractures, fault systems and breccias.

Assessment: **Area BmA1 (Map 1)**

Minor copper mineralisation is common in the southern part of the Cape York - Oriomo Inlier. Mineralisation occurs mainly as chalcopyrite (partly oxidised to malachite and azurite) in quartz-veined and hydrothermally altered fracture zones in late Palaeozoic welded tuff and porphyritic microgranite.

Occurrences have been reported from Hammond, Horn, Booby, Goods, Thursday and Possession Islands, Pai Bai Tud Islet, and Peak Point and some of the tin lodes on the mainland. Galena, sphalerite and chalcopyrite are common accessory minerals in porphyry-hosted Au-base metal sulphide-quartz veins in the area, particularly on Horn and Possession Islands.

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A 21m wide silicified zone in porphyritic microgranite at King Point on Horn Island contains very minor galena and malachite; a sample assayed up to 80ppm Cu. Small patches of malachite occur in a 0.3m wide zone of shattered welded tuff on Pai Bai Tud Islet, north of Friday Island. Joint-controlled quartz veins in clay-sericite altered rhyodacite at Peak Point, on the mainland, contain chalcopyrite and malachite. Copper staining occurs almost continuously for 1.6km along the south-west coast of Goods Island. The mineralisation comprises malachite and chrysocolla staining on fractures and joints in kaolinised and silicified ignimbrite. Away from joint planes, the ignimbrite is virtually unmineralised and the overall copper content is low. Chalcopyrite, malachite and azurite occur on joints and in some quartz veins for a distance of 150m in silicified and fractured dacitic ignimbrite on the north-west coast of Hammond Island. Minor arsenopyrite, galena and sphalerite are associated with the mineralisation. The ignimbrite is intruded by porphyry dykes. Chalcopyrite is disseminated in a 46m long by 6m wide zone in a body of tonalite along its contact with welded tuff on the north-east coast of Hammond Island. Joints and quartz veins in the volcanics near the contact are malachite-stained. A 3m wide, silicified breccia zone in stockworked, chloritised and silicified dacitic ignimbrite on Possession Island is malachite-stained but the overall copper content is very low. Malachite, azurite and ?bornite form veins and patches in a 60m long by 6m wide zone of chloritised and silicified ignimbrite on Possession Island.

Exploration of the islands by CRA Exploration Pty Ltd in 1966 and Noranda Australia Ltd in 1969 indicated that there are extensive alteration zones with minor copper mineralisation throughout the southern islands. Assay results for these zones were generally disappointing. Copper results were low, but some samples had high Ag and Pb.

Geologically, the area is permissive for the occurrence of porphyry copper deposits. Known copper occurrences may be distributed around the margins of a possible caldera structure which is broadly coincident with the boundary of Area BmA1. There is a moderate resource potential for small to medium porphyry copper deposits with a certainty level of C. Any deposits in the area are likely to occur at depth beneath the Torres Strait Volcanics.

Area BmA2 (Map 1)

Minor copper occurrences have been reported from Moa and Badu Islands. Malachite staining occurs with wolframite in quartz veins in a porphyritic microgranite dyke at Coconut Point on Badu Island. Chalcopyrite, malachite and galena occur in wolframite-bearing quartz lodes on Moa Island.

Geologically, the area is permissive for the occurrence of porphyry copper deposits. There is a low resource potential for small to medium porphyry copper deposits with a certainty level of B. Any deposits in the area are likely to occur at depth beneath the Torres Strait Volcanics.

Economic significance:

Porphyry copper deposits have potential as large tonnage/low grade resources. Economic deposits may contain 25 to 1000Mt at grades of 0.3 to 1.0% Cu.

Equivalent/ related deposit types:

/ base metal skarns, epithermal veins, polymetallic replacement deposits, volcanic hosted massive sulphides.

References:

Cox & Singer (1986)
Denaro (1993)
Eckstrand (1984)

Model BmB: Cu and Zn-Pb skarn deposits

Commodities, by products and trace metals: Copper, lead, zinc, silver, gold.

Geological setting: Miogeosynclinal sequences intruded by felsic to intermediate plutons; continental margin late orogenic magmatism. Copper mineralisation associated with tonalite to monzogranite intruding thick, pure and/or impure carbonate rocks or calcareous clastic rocks. Lead-zinc mineralisation associated with granodiorite to granite, diorite to syenite. Deposits are mainly associated with magnetite and/or titanite-bearing I-type suites.

Structural control: Shallow-dipping intrusive/carbonate contacts. Irregularities in contacts and stockwork fracturing at contacts.

Age: Known deposits in far north Queensland are generally associated with Palaeozoic intrusives.

Deposit description: Chalcopyrite or sphalerite-galena in calc-silicate contact metasomatic rocks. Irregular or tabular ore bodies in carbonate rocks and calcareous rocks near igneous contacts or in xenoliths in igneous stocks. Deposits may occur hundreds of metres from intrusive. Associated igneous rocks are commonly barren.

Copper skarns comprise chalcopyrite + pyrite ± hematite ± magnetite ± bornite ± pyrrhotite; molybdenite, bismuthinite, sphalerite, galena, cosalite, arsenopyrite, enargite, tennantite, loellingite, cobaltite and tetrahedrite may be present; Au and Ag may be important products. Lead-zinc skarns comprise sphalerite + galena ± pyrrhotite ± magnetite ± chalcopyrite ± bornite ± arsenopyrite ± scheelite ± bismuthinite ± stannite ± fluorite; Au and Ag do not form minerals.

Alteration in copper skarns comprises diopside + andradite in the centre, wollastonite ± tremolite in the outer zone, and marble in the peripheral zone. Igneous rocks may be altered to epidote + pyroxene + garnet (endoskarn). Retrograde alteration to actinolite, chlorite and clays may be present. Alteration in lead-zinc skarns comprises Mn-hedenbergite ± andradite ± grossular ± spessartine ± bustamite ± rhodonite; late stage Mn-actinolite ± ilvaite ± chlorite ± dannemorite ± rhodochrosite.

Surface expression of copper skarns may be as an Fe-rich gossan with Cu carbonates and silicates. Lead-zinc skarns may form gossans with strong Mn oxide staining.

Geochemical signature: Rock analyses of copper skarns may show Cu-Au-Ag-rich inner zones grading outward to Au-Ag zones with high Au:Ag ratio and outer Pb-Zn-Ag zone. Co-As-Sb-Bi may form anomalies in some skarn deposits. Lead-zinc skarns are anomalous in Zn, Pb, Mn, Cu, Co, Au, Ag, As, W, Sn, F and possibly Be.

Geophysical signature: In some places, regional aeromagnetic and gravity data can be used to locate major faults and buried plutons. Magnetite-rich zones show up as local highs on regional aeromagnetic maps. Contacts between magnetic plutons and nonmagnetic limestone would appear as a magnetic gradient.

Assessment criteria:

1. Thick limestone beds in otherwise carbonate-poor sequences.
2. Close proximity to a magmatic-hydrothermal centre; large, well-mineralised skarns are rarely more than a few hundred metres from their associated intrusions.
3. Calc-silicate skarn mineral assemblage, accompanied by magnetite and various sulphides.
4. Shallow-dipping pluton-limestone contacts.
5. Structural and stratigraphic traps in host rocks.
6. Presence of channelways for ore- forming fluids, for example, fractures, faults, stockworks, breccias and permeable stratigraphic units.
7. Geochemical anomalies including W, Zn, Cu, Pb, Mn or Mo.
8. Aeromagnetic anomalies indicating the presence of plutons and zones rich in magnetite.

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Assessment:

Area BmB1 (Map 2)

Drilling has indicated the presence of subsurface intrusions in the Bolt Head area. Limestone, dolomite and calcareous schist of the Proterozoic Sefton Metamorphics have potential to host base metal-bearing skarn deposits. There is a low resource potential for small Cu, Pb and Zn skarn deposits with a certainty level of B.

Areas BmB2 and BmB3 (Map 4)

These areas in the Chillagoe Formation comprise limestone, muddy limestone, basalt, chert, sandstone, siltstone and mudstone. It is not known if there are any potentially mineralising subsurface felsic plutons in the area. There is a low resource potential for small base metal skarn deposits with a certainty level of B.

Areas BmB4 and BmB5 (Map 4)

Limestone crops out in the Hodgkinson Formation in these areas. There is a low resource potential for small base metal skarn deposits with a certainty level of B.

Economic significance:

Potentially, skarn deposits can be large and high grade and can contain significant quantities of precious metals, particularly silver. No definite skarn deposits have been identified within the CYPLUS area. However, the Red Dome mine, near Chillagoe to the south, is a skarn deposit which is an important Queensland producer of gold and copper.

Historically, numerous small skarn deposits in the Mungana-Chillagoe-Almaden area produced copper, lead and silver.

Equivalent/ related deposit types:

/ porphyry copper, polymetallic replacement, Fe skarn.

References:

Cox & Singer (1986)

Model BmC: Basaltic copper

Commodities, by products and trace metals:

Copper.

Geological setting:

Copper-rich (100 to 200ppm) basalt interlayered with red clastic beds and overlain by mixed shallow marine and continental deposits. Intracontinental rift, continental margin rift. Regional low-grade metamorphism may mobilise copper. Host rocks are subaerial to shallow marine basalt flows, breccias and tuffs, red-bed sandstone, tuffaceous sandstone, conglomerate, tidal facies limestone and black shale.

Structural control:

Synsedimentary faulting may be important. Highly permeable zones — fault and fracture systems, brecciation, rocks with primary permeability.

Age:

Any age.

Deposit description:

Native copper and silver occur as flow-top breccia and amygdule fillings in basalt; fine grains in matrix and shaley partings in clastics; massive replacement of carbonates. Chalcocite and other Cu_2S minerals and locally bornite and chalcopyrite are concentrated in overlying shale and carbonate rocks. Fine-grained pyrite is common but not abundant with copper sulphide minerals. Alteration comprises calcite-zeolite + epidote + K-feldspar; red colouration due to fine hematite.

Geochemical signature:

Cu-Ag-Zn-Cd. Cu:Zn ratio is very high. Au anomalously low.

Assessment criteria:

1. Basalts and basaltic breccias with anomalous copper.
2. Known copper mineralisation in basalt, shale, carbonate sequences.

Assessment: **Area BmC1 (Map 4)**

In this area, copper-mercury mineralisation occurs in narrow, discontinuous lenses of altered basic volcanics and breccias interbedded with silicified sediments of the Chillagoe Formation, near prominent outcrops of limestone. Recent mapping has redefined the extent of the Chillagoe Formation, particularly in the area north of Fairlight Station (Bultitude & Donchak, 1992). Old workings occur at the St George Copper Mines and the Glenroy Copper Mine. A number of other areas with mineralisation have been delineated during exploration. Ore mined in the 1900's assayed up to 30% Cu, 6% Hg and 23.4g/t Au.

Mineralisation comprises chalcopyrite, chalcocite, malachite, azurite, native copper and cinnabar as disseminations and fracture fills and in quartz and calcite veins. Small amounts of chalcocite and native copper occur as primary associates of zeolites in vesicles and veinlets in purple altered basalt. The basalt breccia consists of fragments of vesicular basalt in a chloritic matrix or calcite cement.

Amad N.L. delineated a low-order geochemically anomalous zone with 100 to 200ppm Cu extending over a strike length of 5.6km. Drillhole samples from near old workings at the Glenroy Copper Mine assayed up to 1550ppm Cu; costean samples assayed up to 4470ppm Cu. Copper and mercury mineralisation appear to be stratigraphically restricted to the basalts.

No economic copper mineralisation has been found in the basalts. There is a low resource potential for small basaltic copper deposits with a certainty level of C.

Economic significance: Mineralisation of this style is generally low grade. Economic grades occur where copper has been remobilised into adjacent sediments. It is unlikely that any economic deposits occur within the CYPLUS area.

Equivalent/ related deposit types: Volcanic redbed Cu.

References: Cox & Singer (1986)

Model BmD: Volcanogenic massive sulphide deposits

This grouping includes Cyprus and Besshi-type massive sulphide deposits.

Commodities, by products and trace metals: Copper, zinc, lead, silver, gold.

Geological setting: Cyprus: submarine hot spring along axial grabens in oceanic or back-arc spreading ridges. Hot springs related to submarine volcanoes producing seamounts. Associated with marine, predominantly tholeiitic mafic volcanic sequences (greenstone belts, ophiolite assemblages — tectonised dunite and harzburgite, gabbro, sheeted diabase dykes, pillow basalts) and fine-grained metasedimentary rocks such as chert and phyllite. Regionally associated with Mn- and Fe-rich cherts.

Besshi: Possibly deposited by submarine hot springs related to basaltic volcanism. Ores may be localised within permeable sediments and fractured volcanic rocks in anoxic marine basins. Continental margin and back-arc spreading ridges. Associated with clastic sedimentary rocks and tholeiitic to andesitic tuff and breccia; locally associated with black shale, oxide facies iron formation and red chert.

Structural control: May be adjacent to steep normal faults.

Age: Precambrian to Tertiary; Cyprus deposits mainly Ordovician or Cretaceous; Besshi deposits mainly Palaeozoic and Mesozoic.

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Deposit description:

Cyprus: massive sulphides (60% sulphides) with underlying sulphide stockwork or stringer zone. Sulphides brecciated and recemented. Massive ore comprises pyrite + chalcopyrite + sphalerite ± marcasite ± pyrrhotite. Stringer (stockwork) ore comprises pyrite + pyrrhotite + minor chalcopyrite and sphalerite (cobalt, gold and silver present in minor amounts). Alteration in stringer zone comprises feldspar destruction, abundant quartz, chalcedony and chlorite, and some illite and calcite. Some deposits are overlain by ochre (Mn-poor, Fe-rich bedded sediment containing goethite, maghemite and quartz). Ore generally in pillow basalt or mafic volcanic breccia and diabase dykes below; ores rarely localised in sediments above pillows; may be local faulting. Deposits form massive limonite gossans.

Besshi: thin, sheet like bodies of massive to well-laminated pyrite, pyrrhotite and chalcopyrite within thinly laminated clastic sediments and mafic tuffs. Fine-grained, massive to thinly laminated ore with colloform and framboidal pyrite; ore minerals include pyrite + pyrrhotite + chalcopyrite + sphalerite ± magnetite ± valleriite ± galena ± bornite ± tetrahedrite ± cobaltite ± cubanite ± stannite ± molybdenite; gangue minerals include quartz, carbonate, albite, white mica, chlorite, amphibole and tourmaline. Breccia or stringer ore. Cross-cutting veins contain chalcopyrite, pyrite, calcite, galena, sphalerite. Alteration is difficult to recognise because deposits are generally in strongly deformed metamorphic terrane. Chloritisation of adjacent rocks has been noted in some deposits. Deposits are thin but laterally extensive and tend to cluster in en echelon pattern. Weather to form gossans.

Geochemical signature:

Cyprus: general loss of Ca and Na and introduction and redistribution of Mn and Fe in the stringer zone; Au in stream sediments.

Besshi: Cu, Zn, Co, Ni, Cr, Co:Ni >1.0, Au up to 4ppm, Ag up to 60ppm.

Geophysical signature:

Besshi deposits give excellent electromagnetic and IP anomalies.

Known deposits:

Dianne Copper Mine.

Assessment criteria:

1. Along synvolcanic fractures in successions of submarine volcanic rocks.
2. Within a given district, deposits tend to preferentially occur at a specific stratigraphic horizon.
3. Deposits tend to occur in clusters.
4. Association of basaltic volcanics and Mn/Fe-rich cherts.

Assessment:

Area BmD1 (Map 4)

The Chillagoe Formation was probably deposited in either a continental rift or a back-arc basin with a thinned continental crust (Bultitude & others, 1993). The presence of mafic volcanics, cherts and fine-grained sediments, as well as widespread copper mineralisation, indicate a geological environment conducive to the occurrence of volcanogenic massive sulphide deposits. There is a moderate resource potential for small volcanogenic massive sulphide deposits with a certainty level of B.

Area BmD2 (Map 4)

Volcanogenic massive sulphide deposits are associated with basic volcanic sills or flows of the Hodgkinson Formation.

They comprise predominantly chert/quartzite beds associated with basic volcanic rocks. The tabular shaped ore bodies are >100m long and are capped by ferruginous gossans. Prominent sulphide mineral zones, consisting of pyrite bands replaced by chalcopyrite, sphalerite and galena, generally contain Fe>>Cu>Zn>>Pb and Ag>>Au. Only three deposits (the Mitchell Surprise, Red Hill and Hannahbelle), all of which are immediately to the south of the CYPLUS area, have been mined in the past and workings are confined to the secondary enriched carbonate zone which contained up to 20 to 25% Cu.

The Mitchell Surprise deposit occurs along a south-east trending shear. Mineralisation comprises chalcopyrite replacement of pyrite and, in places, star-shaped exsolutions of sphalerite in chalcopyrite. Diagenetic sulphide-bearing quartz veinlets occur within the sulphide zone and the adjacent wall rocks. A 1m wide, steeply south-west dipping oxidised enrichment zone was mined. Four channel samples collected in 1943 over a 7.5m wide gossanous zone in the bottom crosscut averaged 4.37% Cu, 46g/t Ag and <0.6g/t Au.

At the Hannahbelle, malachite and cuprite were mined from three closely spaced lodes. Channel samples, collected in 1943 from the lodes in the adit, averaged 2.5% Cu, 6.2g/t Ag and 0.62g/t Au. Only rare sulphide minerals were present in the mullock.

Red Hill is on a ridge of metasiltstone near the contact with a thin, chloritised andesitic bed. Discrete lenses of malachite in a kaolinised zone occur in a tightly folded anticline. A 1.5m wide gossanous zone, sampled at 25m depth, assayed 0.7% Cu, 0.6g/t Au and 40.4g/t Ag.

There is a high resource potential for small volcanogenic massive sulphide deposits with a certainty level of C.

Area BmD3 (Map 4)

This area covers interbedded basalt and chert of the Hodgkinson Formation. There are a number of ridges of manganiferous gossan and pyritic quartzite trending north-west through the area. These gossans are anomalous in Cu (up to 800ppm) and Zn. There are geological similarities between this area and that hosting the Dianne Copper Mine. There is a moderate resource potential for small volcanogenic massive sulphide deposits with a certainty level of C.

Area BmD4 (Map 4)

This area covers the Dianne Copper Mine, a volcanogenic massive sulphide deposit of the Besshi-Kieslager type (Murray, 1990).

The Dianne deposit is a stratiform Cu- and Zn-rich massive sulphide body which forms a small, steeply pitching lens within an overturned sequence of interbedded shale and greywacke. The tabular shaped ore body is >150m long and is capped by a ferruginous gossan. Along strike, the massive sulphides grade into a thin pyritic chert and, locally, stratabound pyrite, chalcopyrite and minor sphalerite occur in a sericitic shale. Supergene enrichment has occurred to approximately 100m depth. No stockwork or feeder mineralised zone has been identified. Past mining concentrated on the supergene enriched zone, which contained ores assaying up to 25% Cu and produced ~18 000t of copper.

Gregory & Robinson (1984) concluded from sulphur isotope studies that the ore fluid was dominantly of magmatic origin. A decrease in temperature and fluid mixing with seawater probably initiated precipitation of the ore minerals. No stockwork mineralisation is evident, apart from minor sulphide veining in chert beds in the footwall. The deposit may have been formed distally from the source of the ore fluids.

The area defined is very restricted and covers the known mineralisation only. It has a high resource potential for small volcanogenic massive sulphide deposits with a certainty level of C. Because the stratigraphic control of the mineralisation is uncertain and has not been mapped, the surrounding area has an unknown resource potential.

Area BmD5 (Map 4)

Exploration by Mareeba Mining and Exploration Pty Ltd in 1974 indicated that minor copper mineralisation occurs in the Little Palmer River area. Pyrite, chalcopyrite and copper carbonates occur in a sequence of basic volcanics, chert and pyritic shale of the Hodgkinson Formation. The highest assay result was 308ppm for a gossan sample. There is a low resource potential for small volcanogenic massive sulphide deposits with a certainty level of B.

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Area BmD6 (Map 4)

Chert lenses in the Hodgkinson Formation in this area are of possible exhalative origin, carry anomalous gold and, in some cases, base metals, and are commonly capped by manganese-iron gossans. Some of the cherts are propylitically altered, sheared and brecciated basalts/spilites.

In many respects, the chert lenses are similar to gossanous cherts in the Mount Bennett area (Area BmD3) and could be related to small, volcanogenic massive sulphide deposits. Poorly exposed, carbonaceous, fine-grained sediments between the chert ridges might be potential targets.

There is a low resource potential for small volcanogenic massive sulphide deposits with a certainty level of B.

Area BmD7 (Map 4)

Chert lenses in the Hodgkinson Formation in this area are of possible exhalative origin, carry anomalous gold and base metals, and are commonly capped by manganese-iron gossans. Pyrite is known to occur as disseminated mineralisation and as stratabound, massive sulphide layers in the area. Some of the cherts may be altered basalts/spilites.

There is a low resource potential for small volcanogenic massive sulphide deposits with a certainty level of B.

Economic significance: Important deposits of this type in the Hodgkinson Formation have been mined at the Dianne Copper Mine (in the CYPLUS area) and at the OK and Mount Molloy mines (outside the Cyplus area). The deposits tend to occur as single lenses (150m long by about 10m thick) or as groups of lenses offset by faulting. The deposits are small in size but are amenable to opencut extraction where they occur close to the surface. The Dianne mine produced 18 000t of copper and 1000kg of silver from 70 000t of ore; the OK mine produced 7808t of copper, 102kg of silver and 12kg of gold from 81 544t of ore; and the Mount Molloy mine produced 3863t of copper from 43 600t of ore.

References:

Cox & Singer (1986)
Denaro & others (1992)
Eckstrand (1984)
Lam & Genn (1993)
Lam & others (1991)

Model BmE: Sediment-hosted Zn-Pb

Commodities, by products and trace metals: Zinc, lead, silver, copper.

Geological setting: Marine epicratonic embayments and intracratonic basins with smaller, local restricted basins. Epicratonic embayments and intracratonic basins are associated with hinge zones controlled by synsedimentary faults, typically forming half-grabens. Within these grabens (first-order basins), penecontemporaneous vertical tectonism forms smaller (100 to 10 000km) basins (second-order basins) and associated rises. Smaller third-order basins (tens of kilometres) within the second-order basins are the morphological traps for the stratiform sulphides.

Occur in marine sedimentary rocks, including black (dark) shale, siltstone, sandstone, chert, dolostone, micritic limestone and turbidites. Local evaporitic sections in contemporaneous shelf facies. Volcanic rocks are present locally in the sedimentary basin. Slump breccias, fan conglomerates and similar deposits, as well as facies and thickness changes, are commonly associated with synsedimentary faults.

Structural control: Contrasting sedimentary thicknesses and facies changes across hinge zones. Slump breccias and conglomerates near synsedimentary faults. These faults serve as feeders for the stratiform deposits.

Age: Generally mid-Proterozoic to Carboniferous.

Deposit description: Stratiform basinal accumulations of sulphide and sulphate minerals interbedded with euxinic marine sediments form sheet- or lens-like tabular ore bodies up to a few tens of metres thick, and may be distributed through a stratigraphic interval of 1000m. Some deposits are stratigraphically underlain by a discordant zone of stockwork, vein and disseminated mineralisation. Massive sulphides may grade distally into various exhalite types.

Ore minerals include pyrite, pyrrhotite, sphalerite, galena, barite and chalcopyrite, and minor to trace amounts of marcasite, arsenopyrite, bismuthinite, molybdenite, enargite, millerite, freibergite, cobaltite, cassiterite, valleriite and melnikovite. Sulphides are finely crystalline and disseminated; monomineralic sulphide laminae are typical. Metamorphosed examples are crystalline and massive.

Stockwork and disseminated sulphides and alteration (silicification, tourmalinisation, carbonate depletion, albitisation, chloritisation, dolomitisation) minerals, possibly representing the feeder zone of these deposits, commonly present beneath or adjacent to the stratiform deposits. Some deposits have no reported alteration. Celsian, Ba-muscovite and ammonium clay minerals may be present.

Surface oxidation may form large gossans containing abundant carbonates, sulphates, and silicates of lead, zinc and copper.

Geochemical signature: Metal zoning includes lateral Cu-Pb-Zn-Ba sequence extending outward from feeder zone, or a vertical Cu-Zn-Pb-Ba sequence extending upwards. NH_3 anomalies may be present. Exhalative chert interbedded with stratiform sulphides and sulphate minerals. Peripheral hematite-chert formations. Local (within 2km) Zn, Pb and Mn haloes. Highest expected background in black shales: Pb = 500ppm; Zn = 1300ppm; Cu = 750ppm; Ba = 1300ppm. In carbonates: Pb = 9ppm; Zn = 20ppm; Cu = 4ppm; Ba = 10ppm.

Assessment criteria:

1. The majority of deposits are spatially associated with intracontinental or continental margin basins — usually in thick successions of clastic sedimentary rocks.
2. Second-order basins are prime exploration targets.
3. Second-order basins can be recognised by local lithological facies that are additional or exotic to the regional lithological succession, and by rapid facies changes.
4. Evidence of syndepositional tectonic activity.
5. Evidence of syndepositional geothermal activity — presence of volcanic rocks and chemical sediments of hydrothermal origin in the succession.

Assessment:

Area BmE1 (Map 3)

Graphitic schists of the Strathburn Formation and the Gorge Quartzite (Holroyd Group) are considered to have a low resource potential for small sediment-hosted Zn-Pb deposits with a certainty level of B.

Potential mineralisation is known to occur at the Bustard Lease, where geochemical anomalies (up to 83ppm Cu, 62ppm Pb and 320ppm Zn) coincide with magnetic and electromagnetic anomalies. The EM anomalies are associated with graphitic slate. Surface ironstone which does not appear to be lateritic is developed at one location. The lease has not been fully investigated. Exploration elsewhere in the area has failed to reveal any other anomalous zones.

AGSO's regional stream sediment geochemical surveys have indicated anomalous residual Zn values and a high base metal index (Ba + residual Cu + residual Pb + residual Zn) in this area. The residual Cu and Pb values appear to be normal.

Area BmE2 (Map 3)

Pyritic and pyrrhotitic, carbonaceous shales and graphitic schists in this area are considered to have a low resource potential for small sediment-hosted Zn-Pb deposits with a certainty level of B.

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A regional stream sediment geochemical survey carried out by AGSO gave high residual Cu values and a high base metal index (Ba + residual Cu + residual Pb + residual Zn) in this area. The residual Pb and Zn values are not high.

Area BmE3 (Maps 2 and 3)

This area contains graphite-pyrite-pyrrhotite-bearing schist and has a low resource potential for sediment-hosted Zn-Pb deposits with a certainty level of B.

AGSO regional stream sediment survey data do not indicate anomalous base metals in this area. However, As levels are high and probably reflect the presence of sulphides in the host rocks.

Economic significance: Australian examples of deposits of this type include Mount Isa and McArthur River.

Equivalent/ related deposit types: Sedimentary exhalative Zn-Pb, shale-hosted Zn-Pb / bedded barite deposits.

References:

Cox & Singer (1986)
Culpeper & others (1992b)
Eckstrand (1984)
Ewers & Bain (1992)

Model BmF: Precambrian Cu-Zn volcanogenic massive sulphide deposits

Commodities, by products and trace metals: Copper, zinc, lead, silver, gold.

Geological setting: Submarine basin of rift graben and/or caldera nature; commonly relatively proximal to volcanic source, with evidence of mass flow volcaniclastics, local breccias, felsic domes, dykes and underlying intrusives. Occur in Precambrian greenstone belts: fine to coarse-grained volcaniclastic sediments (commonly of felsic nature), cherty exhalite, shale, massive to bedded pyroclastics (generally calcalkaline felsic), lavas (calcalkaline felsic to tholeiitic mafic), breccias. Distal equivalent cherty, pyritic, banded iron formation and Mn-bearing exhalites.

Age: Precambrian (most commonly Archaean).

Deposit description: One to multiple lens- or sheet-like bodies of conformable massive to bedded sulphides, commonly underlain by stratabound zone of stockwork, pipe, vein and disseminated sulphides. Massive sulphides may grade distally into various exhalite types.

Ores are commonly zoned. The stringer (stockwork) zone comprises pyrite and chalcopyrite (± Au and Ag). The lower stratiform Cu zone comprises pyrite, chalcopyrite, quartz, chlorite, pyrrhotite, minor sphalerite, magnetite, galena, tetrahedrite, arsenopyrite, bornite, carbonates, talc, amphiboles and gold-electrum. The upper stratiform massive zone comprises pyrite, sphalerite, chalcopyrite, pyrrhotite, galena, barite, tetrahedrite-tennantite and bornite.

Alteration is typically zoned. Alteration immediately under the deposits is chlorite-rich ± quartz, carbonates, talc, pyrite and sericite, grading outwards into semi-conformable phyllic (± carbonate), then phyllic. The overlying sequence is relatively unaltered but may show phyllic to propylitic (± carbonate) alteration. Subsequent metamorphic overprinting may change mineral assemblages, but geochemical trends of Na (Ca, Sr) depletion and Fe, Mg, base metal, S enrichment are preserved.

Geochemical signature: Cu-rich to Zn-rich; commonly minor Pb, Ag, Au (more abundant in Zn-rich portions). Local trace Co, As, Sn. Distal exhalites commonly metal-anomalous and rich in Fe (Mn, Si).

Geophysical signature: Magnetic and gravity data are of minimal use in identifying favourable terranes. Magnetite-rich zones can be detected with magnetic surveys, but most zones in this terrane are too small to be picked up by regional surveys.

Assessment criteria:

1. Distribution of Precambrian greenstone belts and Fe-rich exhalites and sediments.
2. Distribution of known base metal mineralisation.
3. Geochemical anomalies.

Assessment:

Area BmF1 (Map 2)

Exploration by Consolidated Mining Industries Ltd in 1969 indicated that greenstone bands in the Sefton Metamorphics have a high copper background; only minor traces of copper mineralisation were found. The company concluded that the greenstone could have an ultrabasic origin because of its high chromium and magnetite content and the occurrence of silicified asbestos veinlets.

At the same time, Kennecott Explorations (Australia) Pty Ltd investigated copper mineralisation at Cook's Prospects Nos 1 and 2, near the West Claudie River. Chalcopyrite, malachite and azurite occur in minor shear zones in greenstone close to a contact with the Kintore Adamellite. A gossan close to the contact of calc-silicate rocks and the Kintore Adamellite carries traces of galena. These occurrences are very limited in size.

The presence of a greenstone belt, as well as iron formation and Mn-rich rocks, in the Sefton Metamorphics indicates a potential for the occurrence of volcanogenic massive sulphide deposits. Exploration has indicated that known copper mineralisation is unlikely to be related to the late Palaeozoic Weymouth Granite. There is a low resource potential for small Precambrian Cu-Zn volcanogenic massive sulphide deposits with a certainty level of B.

Area BmF2 (Map 3)

The Carew Greenstone of the Holroyd Group is a fine to medium-grained, greenish black, equigranular metabasalt/dolerite. It is 500 to 1000m thick and crops out as a folded, sill-like but discordant body within the Astrea Formation. There is a low resource potential for small Precambrian Cu-Zn massive sulphide deposits with a certainty level of B.

Exploration in the Coleman River area has indicated that, in places, associated schists contain traces of sphalerite with pyrite in quartz veins. Gossanous rocks in the area have assayed up to 9.70ppm Au, 760ppm Pb, 160ppm Zn and 1750ppm Ag.

Exploration by Consolidated Mining Industries Ltd in 1968 indicated that copper mineralisation and low-grade nickel are associated with the greenstones; surface samples assayed up to 19% Cu and 0.6% Ni.

Core drilling was carried out at the Potallah No. 1 Prospect. A few thin quartz veins with minor sulphide mineralisation (mainly galena and arsenopyrite) were intersected, but there was no indication of any significant mineralisation.

Drilling was also carried out at the Gossan Prospect, where a stratiform polymetallic massive sulphide body is hosted by a black shale sequence (moderately to strongly magnetic, carbonaceous, pyritic and pyrrhotitic siltstone unit) and associated with basic igneous rocks. Mineralisation is patchy and discontinuous and is confined to a shear zone near the contact with the Kintore Adamellite.

Reconnaissance drilling indicated a 0.7 to 1.8m thick deposit, which is at least 200mX250m in area and contains up to 8.5% total sulphides. Assays of drill samples gave grades of 0.37 to 0.46% Cu, 1.68 to 11.51% Pb, 2.13 to 6.36% Zn, 19.7 to 94ppm Ag and 0.2 to 0.6ppm Au. Primary sulphides include chalcopyrite, galena and sphalerite. The surface expression of the mineralisation is a highly altered, brecciated, leached and partly gossanous rock. In 1978 to 1980, Anaconda Australia Incorporated carried out percussion drilling and calculated an indicated resource of 50 000t of ore with 10% combined copper, lead and zinc sulphides. The deposit is not exploitable on a large scale.

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Recent drilling in the area by BHP Minerals indicated that pyritic shales assay up to 300ppm Zn, magnetite-bearing ultramafics assay 1000 to 2500ppm Ni, and pyrrhotite-bearing graphitic schists assay 100 to 250ppm Zn.

Area BmF3 (Map 3)

Minor copper (malachite and cuprite) and nickel mineralisation occur in an altered ultrabasic rock at the Copper Prospect. The disseminated copper mineralisation has no sizeable potential. The host rocks are of limited extent. Rock chip samples from costeans assayed up to 0.56% Cu. There is a low resource potential for small Precambrian volcanogenic massive sulphide deposits with a certainty level of B.

Economic significance: This deposit type has the potential to form medium to large base metal resources. However, exploration results to date have not indicated any significant resources in the CYPLUS area.

References:

Bruvel & Morwood (1992)
Culpeper & Burrows (1992)
Culpeper & others (1992b)
Ewers & Bain (1992)

TIN (Sn)

Queensland tin producers and explorers, like their counterparts elsewhere, have been seriously affected by the tin export quotas which were introduced by the International Tin Council in the second quarter of 1982. Metal prices and markets continue to depress production in Queensland. In 1992/93, only 79t of tin concentrates, valued at $331 712 was produced in Queensland (up from 71t of concentrates in 1991/92). No tin was produced from the CYPLUS area in 1992/93; Production in 1991/92 was only 0.106t valued at $465.

Model SnA: Tin veins

Commodities, by products and trace metals: Tin, tungsten, molybdenum, bismuth, base metals.

Geological setting: Foldbelts and accreted margins with late orogenic to post-orogenic granites which may, in part, be anatectic. Mesozonal to hypabyssal plutons — intermediate to shallow emplacement levels (cupolas, domes and subvolcanic intrusions), with extensive greisenisation. Extrusive rocks generally are absent; dykes and dyke swarms are common. Most deposits are related to ilmenite series, S-type fractionated granites; some occur in I- or mixed I/S-type provinces.

Structural control: Economic concentrations of tin tend to occur within or above the apices of granitic cusps and ridges; localised controls include variations in vein structure, lithologic and structural changes, vein intersections, dykes and cross-faults. Regional fracture systems are common; mineralisation is generally fracture-controlled.

Age: Palaeozoic and Mesozoic most common; may be any age.

Deposit description: Simple to complex quartz + cassiterite ± wolframite ± base metal sulphide fissure fillings or replacement lodes in or near felsic plutonic rocks. Deposit types include simple veins, sheeted veins, stockworks and breccia-hosted (disseminated) deposits. Mineralisation is typically fracture-controlled, with high fracture density and crosscutting fractures or vein systems indicating multiple events.

There is a close spatial relation to multiphase granites. Specialised biotite and/or muscovite leucogranites are common and pelitic sediments are generally present.

The intrusive rocks have Na_2O/K_2O = <1, low Fe_2O_3/FeO(<1.0, usually 0.5), Fe_{total}/CaO high, and Rb/Sr = 2 to 85 (generally 5 to 10) (Kwak, 1986). Late specialised granites usually have >73% SiO_2 and >4% K_2O, and are depleted in CaO, TiO_2, MgO and total Fe. They are enriched in Sn, F, Rb, Li, Be, W, Mo, Pb, B, Nb, Cs, U, Th, Hf,

Ta and most rare earth elements. They are depleted in Ni, Cu, C, Co, V, Sc, Sr, La and Ba.

Mineralogy is extremely varied. The main minerals that may be present include cassiterite, quartz, muscovite, biotite, K-feldspar, topaz, tourmaline, fluorite, clays, wolframite, arsenopyrite, molybdenite, hematite, scheelite, beryl, galena, chalcopyrite, sphalerite, stannite, bismuthinite, carbonates, pyrite, pyrrhotite, hematite, lepidolite, zinnwaldite, tetrahedrite and silver minerals. Many deposits show an inner zone of cassiterite ± wolframite fringed with Pb, Zn, Cu and Ag sulphide minerals.

Textures present may include brecciated bands, filled fissures, replacement textures and open cavities. Sericitisation (greisenisation) ± tourmalinisation is common adjacent to veins and granite contacts. Other alteration types include silicification, chloritisation and hematisation. An idealised zonal sequence might consist of quartz + tourmaline + topaz, quartz + tourmaline + sericite, quartz + sericite + chlorite, quartz + chlorite, and chlorite.

Iron-rich outcrops may form from weathering of tourmaline and chlorite. Deposits may form topographic highs where silicification is intense and/or extensive.

Geochemical signature: Cassiterite in stream gravels. Sn, As, W and B are good pathfinder elements. Others include F, Be, Zn, Pb, Cu, Ag, Li, Rb and Cs.

Geophysical signature: Magnetic, IP and resistivity anomalies over some sheeted vein systems.

Known deposits: Jeannie River Prospect, Cannibal Creek lodes, Cape York Tinfield, Cooktown Tinfield.

Assessment criteria:

1. Fracture systems in and above the apical portions of specialised granites.
2. Distribution of known primary mineralisation and alluvial deposits.
3. Most prospective areas may be where granite plutons are not exposed or are only partially unroofed.

Assessment: **Area SnA1 (Map 1)**

The Cape York Tinfield has a moderate resource potential for small tin vein deposits with a certainty level of B.

There are 12 known occurrences of primary tin mineralisation in the area. The area delineated has been extended east of the known mineralisation to include similar host rocks in an area with known alluvial cassiterite concentrations. Resource potential has not been assigned for likely deposits beneath laterite cover because any such deposits would not be economic to mine.

Cassiterite-bearing quartz veins, lodes and vein stockworks are associated with Late Carboniferous, fine-grained intrusive porphyry stocks, plugs and dykes within or shallowly underlying acid volcanics. Although the rocks in the area have all been mapped as acid volcanics of the Endeavour Strait Ignimbrite, Taylor (1969) suspected that the rocks with which the tin is associated are all intrusive. The main rock types are quartz-feldspar porphyry, quartz porphyry and silicified greisen; tin mineralisation is associated with all three rock types.

All known occurrences are minor. The largest vein in the field (Holland's Reef) only produced 10.4t of cassiterite concentrates from 142t of ore. Mineralisation occurs as small, iron-stained quartz veins and veinlets along joint fissures. The veins are generally gently or moderately dipping. Stockworks are known to occur in coastal outcrops at Punsand Bay, but overall grades are <0.1% Sn (Taylor, 1969).

Known resources in the area are 1370t at 2.0% Sn at Bluffs Quarry, 1000t at 0.7% Sn at the Fourteen Acres and 200t at 7.2% Sn at the Northern Mine. Deposits of this size might be of interest to small-scale individual miners only. Known deposits have insufficient tonnage or grade to support even a moderate-size mining operation.

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Area SnA2 (Map 1)

This area has a low resource potential for small tin veins with a certainty level of B. Minor cassiterite is known to occur on Horn Island and the area incorporates Area SnA1. Insufficient whole rock geochemical data is available to assess whether or not the granites in the area are sufficiently fractionated to be associated with tin mineralisation.

Area SnA3 (Map 1)

Minor cassiterite has been reported to occur on Moa and Badu Islands. There is a low resource potential for small tin veins with a certainty level of B.

Area SnA4 (Map 2)

Alluvial cassiterite in the Tin Creek and First Stony Point areas, north of the Pascoe River, is probably derived from high-level Carboniferous to Permian granophyric and hybridised acid intrusives and tourmaline-bearing pegmatite veins and greisen veins of the Weymouth Supersuite. There has been no recorded company exploration for primary tin deposits in the area. There is a moderate resource potential for small tin vein deposits with a certainty level of B.

Areas SnA5 and SnA6 (Map 2)

Blevin & Chappell (1992) noted that the ore-element associations of granite-related ore deposits in nearly all eastern Australian Palaeozoic fold belts have tin mineralisation commonly associated with S- and I-type granites that have undergone crystal fractionation and are reduced. The general absence of S-type granites with geochemical trends indicating prolonged fractional crystallisation and specialisation in the northern Coen Inlier limits the likelihood of associated tin mineralisation.

The late Palaeozoic I-type granites of the Weymouth Supersuite are more fractionated than the nearby mid-Palaeozoic S-type granites but chemical analyses indicate that they are not sufficiently specialised to develop economic tin deposits (Knutson & others, 1994). Volcanic rocks in the area are intruded by these granites, indicating that the intrusives are high-level and are only partially unroofed where exposed. There is a low resource potential for small tin veins with a certainty level of B.

Area SnA7 (Map 2)

The Permian I-type Wolverton Adamellite is considered to be the source of alluvial cassiterite concentrations in Granite and Wet Creeks. Chemical analysis of the Wolverton Adamellite supports this conclusion and is consistent with the specialisation expected of tin-bearing granites. The intrusive has high SiO_2 (>76%), K_2O>4%, and enrichment in Sn, Li, Be, W, Pb, Nb, Cs, U, Th and rare earth elements, and depletion in CaO, TiO_2 and MgO relative to other granites in the northern Coen Inlier (Knutson & others, 1994). AGSO's stream sediment geochemical survey has also identified highly anomalous tin values around the Wolverton Adamellite.

The adamellite is typically quartz veined; greisen and pegmatite veining are less common. The only known examples of primary tin mineralisation in the area are a cassiterite-wolframite-quartz greisen vein, a "streaky tin" lode, and potentially mineralised argillic alteration zones near the historical alluvial workings. Dump samples from recent alluvial workings indicate that cassiterite occurs along the margins of quartz veins with greisen alteration selvedges.

There has been little prospecting for primary veins and lodes in the area. There is a moderate resource potential for small tin vein deposits with a certainty level of C.

Area SnA8 (Map 4)

Cassiterite-bearing alluvium occurs in creeks draining north and east from the S-type, Late Permian Barrow Point Stock (Cooktown Supersuite) at Barrow Point. There is a low resource potential for small tin veins with a certainty level of C.

The stock was intruded to relatively high (epizonal) levels in the crust. It comprises the Barrow Point, Starcke and Ninian Bay Granites. The Ninian Bay Granite is the most leucocratic of the three and intrudes the other granites as dykes and pods.

Rock chip samples collected by Ravenshoe Tin Dredging Company Ltd assayed 0.02 to 0.12% Sn (Murdoch & Fleming, 1981).

Area SnA9 (Map 4)

This area covers the I-type Altanmoui Granite of the Altanmoui Range and a number of small outcropping granite intrusions which have been mapped as Altanmoui Granite. Cassiterite veins probably occur in the Altanmoui Granite but no primary mineralisation has been located yet. Limited whole rock geochemical analyses indicate that the granite contains up to 18ppm Sn and is sufficiently fractionated (SiO_2>74%, K_2O>4%) to give rise to tin mineralisation. The adjacent Hodgkinson Formation is also prospective for tin.

Dampier Mining Company Ltd carried out regional stream sediment sampling in the area in 1979 and found that anomalous tin was associated with the Altanmoui Granite. Creeks draining the eastern and southern sides of the range were generally barren of tin (Dampier Mining Company Ltd, 1981b).

Carpentaria Exploration Company Pty Ltd also found anomalous tin in creeks draining the Altanmoui Granite (Fabray, 1982). An area with up to 7790ppm Sn was delineated in the south-western part of the granite outcrop. Soil sampling indicated that the high tin was due to an area of gravelly soil with quartz vein debris. Some patches of higher tin, possibly due to minor quartz veins or greisen zones, were found on or near granite outcrops.

Bultitude (1993) has redefined a small granite intrusion near Wakooka Outstation as the Wakooka Granite. This granite is mineralogically distinct from the Altanmoui Granite. It may be an I-type granite but it is intruded by a pod of finer grained microgranite which probably is S-type. This raises the possibility that the Wakooka Granite is an S-type.

The area is considered to have a moderate resource potential for small tin vein deposits with a certainty level of B. The most prospective areas would be outcropping and subcropping Hodgkinson Formation around the exposed granites.

Area SnA10 (Map 4)

Complex quartz + cassiterite + sulphide veins and stockwork vein swarms occur in the Hodgkinson Formation in the Jeannie River area. They were discovered by Carpentaria Exploration Company Pty Ltd (Lord & Fabray, 1990). There is an inferred resource of 6.7Mt grading approximately 0.8% Sn. This is a significant tin vein deposit and represents a major, previously undiscovered tin province. Exploration ceased in 1986 because of the prevailing low tin price. There is a high resource potential for medium-size deposits with a certainty level of D.

Four main vein systems have been discovered — the Jeannie River, Saddle Hill, Radio Hill and Whitewater Creek prospects. Locally, the metasedimentary rocks of the Hodgkinson Formation strike north and have been deformed by a granite intrusion and associated porphyry dykes and sills. This granite has been mapped as part of the I-type Puckley Granite. It has not been sampled for whole rock geochemistry and may well be an S-type intrusive, probably of the Cooktown Supersuite. The mineralisation appears to be of the deep subvolcanic or plutonic style.

The dykes and sills have a zircon fission track age of 234 ± 34Ma (Late Permian to Middle Triassic). All of the deposits occur within 6km of outcropping Puckley Granite. Tin, tungsten and base metal mineralisation is assumed to be related to the granites, particularly the porphyritic intrusives flanking the Puckley Granite. These intrusives may be a late stage of the Puckley Granite or may be related to a subsurface intrusive source.

The Jeannie River Prospect was discovered in 1979 as a result of a reconnaissance stream sediment survey. At the surface, the prospect is characterised by outcropping gossanous lodes in silicified sandstone, creeks with stream sediments grading 0.14 to 1.1% Sn, a 1.2km by 300m soil anomaly with >250ppm Sn, and a significant, circular magnetic anomaly. The magnetic anomaly is caused by a vein swarm (with abundant pyrrhotite, together with Sn, Cu, As, Pb and Zn mineralisation) covered by alluvium.

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There are three main lode zones at the Jeannie River Prospect — the Leet Zone, Discovery Gossan and Sheahan Zone. The Leet Zone is the most important; drilling to 506m depth has delineated a zone with a strike length of 1300m, width of 0.8 to 5.5 m, and grades of 0.70 to 3.87% Sn.

The lodes trend south-east in a highly sheared and boudinaged sequence of feldspathic sandstone, siltstone and shale; the host rocks trend north. No igneous rocks have been found in the immediate vicinity, even though drillholes have extended to >500m below the surface.

Ore minerals in the veins include cassiterite, pyrite, pyrrhotite, sphalerite, galena, chalcopyrite, arsenopyrite and scheelite, with rare tetrahedrite, stannite, bornite and sulphosalts. Gangue minerals include quartz, chlorite, calcite, muscovite, siderite, tourmaline and axinite.

Wall rock alteration is common close to mineralisation. Silicification, sericitisation and propylitic alteration (calcite, pyrite/pyrrhotite, epidote, chlorite) all occur. Some minor tourmalinisation has also been noted.

The veining sequence is complex and four main phases have been recognised:

1. quartz + K-feldspar + cassiterite;
2. quartz + chlorite + sulphides + cassiterite;
3. quartz + adularia + prehnite + zeolite + alunite + fine acicular cassiterite; and
4. vughy quartz + calcite + pyrite.

There is a metal zonation from an outer lead + zinc zone, inwards and outwards at depth to a zone of copper + arsenic + tungsten. Tin occurs in both zones, but the best grades are in the outer zone. Major mineralised fractures and veins tend to be telescoped, with all the metals occurring together.

At the Saddle Hill Prospect, a narrow zone of mineralised veining and fracturing trends east-south-east for 1.5km. This zone corresponds to a linear soil anomaly of >500ppm Sn. Creeks in the area have stream sediments grading 245 to 744ppm Sn. The mineralised zone occurs adjacent to porphyry intrusives which flank the southern side of the Puckley Granite. The best drillhole intersection was 8m at 0.54% Sn.

The Radio Hill Prospect was delineated by geological mapping and rock chip geochemistry. Lodes trend east-south-east, cutting across quartzite, shale and porphyry intrusives, and contain tin and base metals.

Gossanous lodes at the Whitewater Creek Prospect carry high Sn, Pb, As and Ag contents. The lodes trend north and cut across greywacke and siltstone country rock. Quartz porphyry dykes are associated with the lodes, host some mineralisation, and are propylitically altered. The prospect was first defined as an aeromagnetic anomaly.

Area SnA11 (Map 4)

A number of primary tin mineralisation styles are evident in the Cooktown Tinfield. These include sheeted quartz-tourmaline lodes and veins, greisen veins, greisen alteration zones and argillic alteration zones. Historically, the most important primary deposits were extensive greisen and argillic alteration zones on the margins of granite intrusions. However, quartz-tourmaline veins and lodes were also mined, notably at Mount Amos, Mount Leswell and the Big Tableland. Whole rock geochemistry shows that the granites in the area are highly fractionated and contain relatively high SiO_2, K_2O, Rb, U, B, Cs and MO, low CaO and MgO, and a high Sn content (Bultitude & Champion, 1992).

There is a high resource potential for small tin vein deposits with a certainty level of C. These lode deposits would only be of interest to individual miners or small syndicates; greisen systems such as the Collingwood Prospect would be of more interest to companies.

Although all historical production has come from veins in the S-type granites of the Cooktown Supersuite (mapped as Finlayson Granite on the old Cooktown 1:250 000 geological map), there is some potential for the development of

sheeted vein systems in the overlying Hodgkinson Formation. The vein deposits typically comprise quartz-tourmaline-cassiterite and tourmaline-cassiterite veins and pipes along or close to the granite-metasediments contact.

In 1986, the Shell Company of Australia Ltd discovered a substantial granite and sediment-hosted vein system at Mount Hartley. Rock chip samples of ferruginous tourmaline-arsenopyrite-cassiterite-muscovite-quartz veins in tourmalinised metasedimentary rocks of the Hodgkinson Formation assayed up to 12.8% Sn.

A 100 to 250m wide zone of quartz-tourmaline-cassiterite mineralisation occurs in granite close to the contact with the Hodgkinson Formation at Mount Amos. Lodes within this zone comprise 1 to 2m wide veins and lenses of tourmaline-quartz rock with adjacent silicification and greisenisation. Mineralisation includes cassiterite, arsenopyrite and pyrite, with minor wolframite, molybdenite, native copper, galena and bismuth. The ore bodies are small, pipe-like shoots which are developed where greisenised veins and shears crosscut the lodes. The main concentrations of mineralisation are at the old Phoenician and Dreadnought mines. Similar mineralisation occurs at the Lion's Den workings on the Big Tableland.

Although the old Cooktown 1:250 000 geological map shows that the granite at Cooktown (the Finlayson Granite) is the same as that in the tinfield, recent studies have shown that the granite at Cooktown is more mafic and is poorly fractionated (Bultitude & Champion, 1992); it has little potential for tin mineralisation.

Area SnA12 (Map 4)

This extensive area covers S-type granites of the Whypalla Supersuite (Bultitude & Champion, 1992). There is a moderate resource potential for small tin vein deposits with a certainty level of B. The extent of the area has been based on the favourable geochemistry of the granites, the known lode and alluvial mineralisation, the mapped extent of the S-type granites, and the possible subsurface extent of granite intrusions based on aeromagnetics.

Cassiterite-bearing quartz-greisen veins are known to occur in the Cannibal Creek Granite in the western part of the area. At least 3.5t of cassiterite was produced from these small deposits in the 1880's.

Cassiterite also occurs in quartz-greisen veins in the Hodgkinson Formation at the Cannibal Creek Mine. The veins are associated with two sets of faults: the predominant fault direction is 110°; subordinate faults strike 095°. Numerous old workings were sunk on fault intersections.

The main mineralisation at Cannibal Creek is associated with two steeply-dipping quartz lodes which strike 110°. In 1969, Frost Enterprises Pty Ltd produced 34.1t of cassiterite from 37 515t of ore from a small opencut in the main zone of mineralisation. Within this zone, numerous subparallel mineralised veins are 10 to 12m apart, range from 0.5 to 1.5m in width, and occur up to 30m from the main lodes.

The mineralised veins contain pegmatitic material with minor cassiterite, scheelite, chalcopyrite, pyrite and beryl. There is a later phase of barren white quartz with a well-developed comb texture. The cassiterite is erratically distributed, but generally occurs as coarse to very coarse-grained crystals on vein margins, particularly within muscovite-rich zones. The host metasediments are silicified and greisenised adjacent to the veins. Drilling at the Spring Creek Scheelite Prospect, 3km to the east, intersected the Cannibal Creek Granite at 75m depth. There has been virtually no exploration for primary tin mineralisation outside of the known mineralisation at Cannibal Creek.

Quartz-cassiterite veins could be expected to occur in the Nangee Granite and in the Hodgkinson Formation in the immediate vicinity of the granite, given that the granite is both fractionated and tin-rich.

The Kelly Saint George, Koobaba, Bullhead and Mount Pike Granites, in the eastern part of the area, are high-level contact aureole types, comprising an outer zone of fine-grained porphyritic granite and an inner zone of medium-grained granite. They are fractionated (though probably not to the same extent as the granites in

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Area SnA11), with high tin values in some cases, and they display the characteristics of granites associated with tin mineralisation.

Towards the margins of the intrusions, the granites have been altered to some extent, with the formation of greisenised granite and crosscutting, cassiterite-bearing, tourmaline-rich quartz and quartz-feldspar veins. These veins extend into the intruded Hodgkinson Formation. Fine-grained cassiterite also occurs irregularly within the greisenised granite.

The Stephanie is the only lode tin deposit which has been mined in this part of the area. It occurs on the south-western edge of the Windsor Tableland. Cassiterite is associated with two subparallel quartz veins in a coarse-grained porphyritic granite dyke. The dyke strikes northerly and extends for several kilometres into the sedimentary rocks of the Hodgkinson Formation. It is probably related to the *Koobaba Granite*.

The quartz veins mined are 0.3 to 4.0m wide, strike 120°, dip 80° south-west, and comprise massive white quartz with crystalline vughs. Cassiterite occurs as aggregates up to 100mm long and 10mm wide and as disseminated grains. Minor arsenopyrite, scorodite, cassiterite and granite fragments, and traces of pyrite, chalcopyrite and malachite occur in zones along the vein margins. Minor cassiterite also occurs in potassically altered granite adjacent to the vein margins.

Narrow quartz-cassiterite veins occur in the Hodgkinson Formation east of the junction of Flaggy Creek and the West Normanby River, on the northern edge of the Windsor Tableland. The veins comprise quartz, cassiterite and muscovite, strike 090°, and dip 80° south. Tourmaline is noticeably absent.

Economic significance:

Deposits of this type include the tin lodes of the Herberton - Irvinebank area, west of Cairns, which has been the most prolific tin producing area in Queensland. The Jeannie River Prospect is the most significant example of this type in the CYPLUS area. Figure 27 shows tonnage-grade figures for known resources in tin vein deposits in the CYPLUS area.

Equivalent/ related deposit types:

Cornish type lodes, vein-stockwork tin / tin greisen, tin skarn, replacement tin, alluvial placer tin.

References:

Cox & Singer (1986)
Culpeper & others (1992b)
Denaro (1993)
Denaro & Morwood (1992a,b,c)
Denaro & others (1992)
Eckstrand (1984)
Krosch (1985)
Kwak (1986)
Lam & Genn (1993)
Lam & others (1991)
Lord & Fabray (1990)
Martin (1979, 1980a)
Taylor (1969)

Model SnB: Tin greisen deposits

Commodities, by products and trace metals:

Tin, tungsten, molybdenum, bismuth, base metals.

Geological setting:

These deposits occur in foldbelts of thick sediments + volcanic rocks deposited on stable cratonic shields or accreted margins. Deposits are associated with specialised biotite and/or muscovite leucogranites (most commonly leucocratic S-types, but also A-types and leucocratic I-types) which generally postdate major folding and were intruded in a mesozonal plutonic to deep volcanic environment.

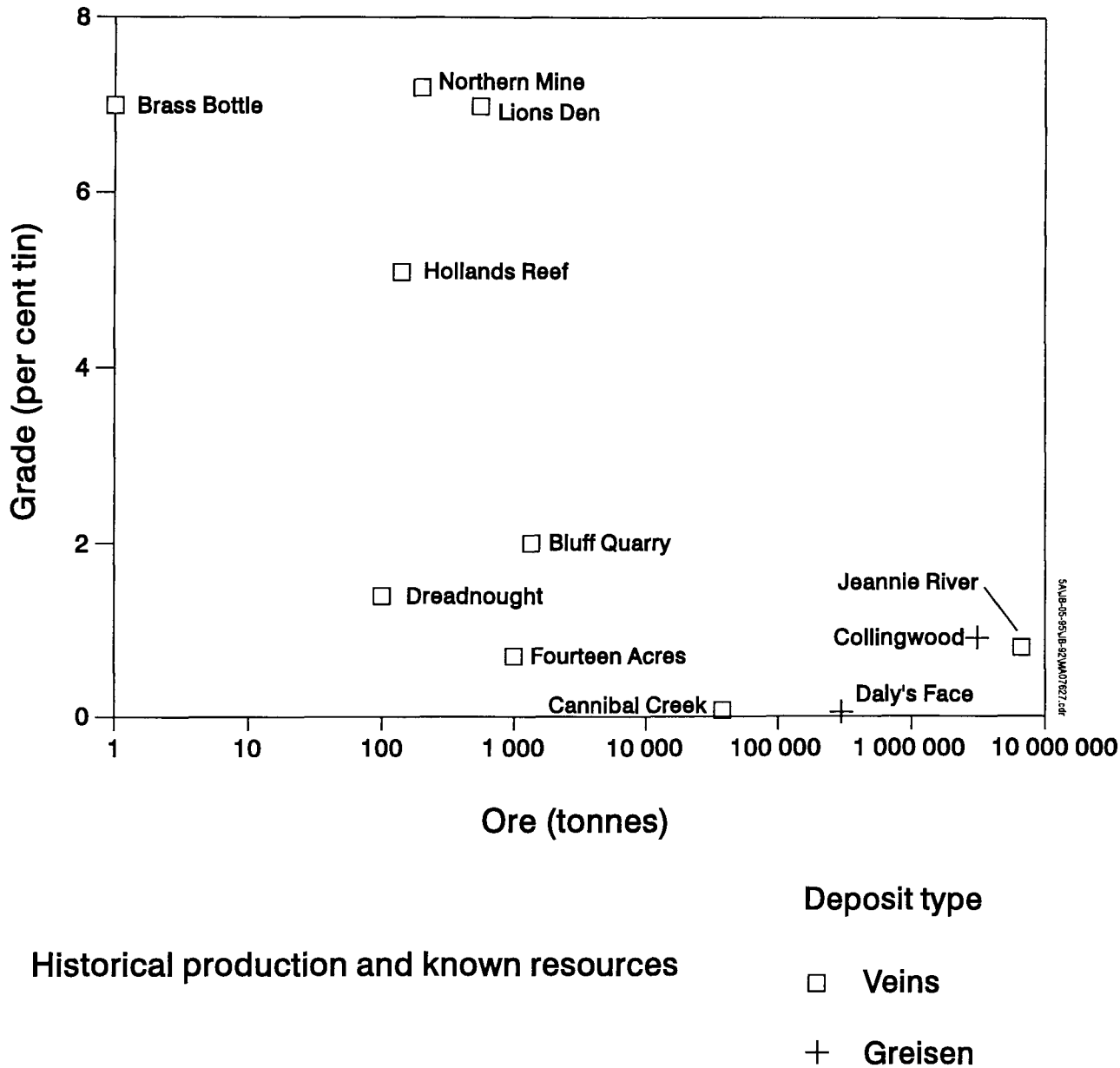

Figure 27. Grade-tonnage diagram, tin vein and greisen deposits.

Tin greisens are generally post-magmatic and associated with late fractionated melt.

Structural control: Greisen lodes are located in or near cupolas and ridges developed on the roof or along the margins of granites and in associated breccia masses and dykes. Faults and fractures may be important ore controls.

Age: May be any age; tin mineralisation is temporally related to later stages of granite emplacement.

Deposit description: Deposit types include disseminated cassiterite and cassiterite-bearing veinlets, sheeted veins, stockworks, lenses, pipes and breccia in greisenised granite and in country rock replacements (exogreisens). The most common deposit forms are disseminated cassiterite in massive greisen and quartz veins and stockworks. Pipes, lenses and tectonic breccia are less common. Mineralisation is generally fracture-controlled, with high fracture density and crosscutting fractures or vein systems indicating multiple events. An important parameter in the formation of large deposits appears to be a closed system in which the intruded rocks lack significant fracturing.

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The intrusive rocks have Na_2O/K_2O = <1, low Fe_2O_3/FeO (<1.0, usually 0.5), Fe_{total}/CaO high, and Rb/Sr = 2 to 85 (generally 5 to 10) (Kwak, 1986). Late specialised granites usually have >73% SiO_2 and >4% K_2O, and are depleted in CaO, TiO_2, MgO and total Fe. They are enriched in Sn, F, Rb, Li, Be, W, Mo, Pb, B, Nb, Cs, U, Th, Hf, Ta and most rare earth elements. They are depleted in Ni, Cu, C, Co, V, Sc, Sr, La and Ba.

Granite textures may include miarolitic cavities, equigranular textures, aplitic textures and porphyritic textures. The granites generally are non-foliated.

Distinctive accessory minerals include topaz, fluorite, tourmaline and beryl. Other possible minerals include wolframite, albite, microcline, chlorite, arsenopyrite, pyrite, pyrrhotite, chalcopyrite, sphalerite, molybdenite, bismuth, bismuthinite and kaolinite. There is a general zonal development of cassiterite + molybdenite, cassiterite + molybdenite + arsenopyrite + beryl, wolframite + beryl + arsenopyrite + bismuthinite, Cu-Pb-Zn sulphides + sulphostannates, quartz veins ± fluorite, calcite, pyrite.

Incipient greisen (granite) comprises muscovite ± chlorite, tourmaline and fluorite. Greisenised granite comprises quartz + muscovite + topaz + fluorite ± tourmaline; the original granitic texture is preserved. Massive greisen comprises quartz + muscovite + topaz ± fluorite ± tourmaline. Tourmalinisation, albitisation, potassic alteration and hydrothermal-supergene kaolinisation may be locally prominent. Tourmaline can be ubiquitous as disseminations, concentrated or diffuse clots, or late fracture fillings. Greisen may form in any wallrock environment, producing exogreisens; typical assemblages are developed in aluminosilicates.

Geochemical signature: Cassiterite, topaz and tourmaline in streams that drain exposed tin-rich greisens. Sn, W, F, Be, Zn, Pb, Cu, Ag, Li, Rb, Cs and B.

Geophysical signature: IP anomalies from sulphides in greisen.

Known deposits: Cooktown Tinfield (Collingwood Prospect, Mount Poverty, Daly's Face).

Assessment criteria:

1. Specialised granites; closed systems particularly favourable.
2. Plutonic environment.
3. Distribution of known primary mineralisation and alluvial deposits.
4. Most prospective areas may be where granite plutons are not exposed or are only partially unroofed.

Assessment: **Area SnB1 (Map 4)**

The Cooktown Tinfield has a high resource potential for small to medium-size tin greisen deposits with a certainty level of D. The known deposits are not massive greisens, as such, but are zones of vein-controlled greisenisation associated with the apical portions of S-type granites of the Cooktown Supersuite. These granites are highly fractionated and are geochemically suitable for the development of tin deposits. Known examples include greisen systems at Mount Poverty and the Collingwood Tin Prospect. Zones of weathered greisen and associated argillic alteration were important sources of cassiterite in the early days of the field because they are amenable to hydraulic sluicing (for example, the Collingwood Face, Daly's Face, Home Rule). These deposits comprise greisenised and argillised granite with disseminated cassiterite and stanniferous quartz-tourmaline veins and pockets. The grade of mineralisation is erratic, but 0.9kg/m^3 was the average grade of cassiterite in early workings (Martin, 1979). The most prospective areas for hard rock greisen deposits are where the granite is still capped by the Hodgkinson Formation.

The Collingwood Tin Prospect was discovered by the Shell Company of Australia Ltd in 1979. Geological investigations indicated a resource of 4.035Mt at 0.73% Sn (29 616t of contained tin). The prospect is a subsurface, granite-hosted, mineralised greisen vein system. Underground drilling indicated probable reserves

of 3 106 980t at 0.90% Sn (27 833t contained Sn) or 2 027 609t at 1.00% Sn (20 330t contained Sn) (Miezitis & McNaught, 1987).

The prospect was discovered via a soil tin anomaly developed on the overlying Hodgkinson Formation. Narrow cassiterite veins and cassiterite-bearing veins were found on joints in the metasedimentary rocks. Drilling and geophysical testing indicated a substantial tin system in the underlying granite.

Three types of endogranitic tin mineralisation have been recognised at Collingwood: steep siliceous sheeted veins, albitic veins, and flat-lying greisen (Jones & others, 1990). Most of the cassiterite is associated with en echelon zones of siliceous, sheeted quartz-tourmaline and greisen veins.

Alteration ranges from quartz-muscovite to quartz-tourmaline to quartz-albite. Alteration minerals include secondary quartz, muscovite (sericite), green biotite and tourmaline. Associated minerals include chlorite, fluorite, apatite, cassiterite and sulphides (chalcopyrite, bornite, chalcocite, pyrite, arsenopyrite, stannite, sphalerite and bismuthinite). Mineralisation extends over a strike length of 950m and has a vertical extent of 50 to 130m. Albitic veins within the siliceous vein system are generally small but some are up to 2m wide and have an irregular distribution. They crosscut the siliceous zone and contain the highest grade mineralisation. Flat-lying greisen zones are confined to small cupolas and irregularities in the granite/sediment contact.

Oxygen and hydrogen isotope studies of granite and greisen from the prospect have indicated that similar fluids were responsible for both pervasive alteration of the granite and fracture-controlled tin mineralisation (Golding & others, 1990). Re-equilibration of magmatic fluids with the cooling granite prior to deposition of vein minerals was inferred. Cassiterite-bearing greisen at the Sandhills Prospect, near Mount Hartley, contains 14 963 loose cubic metres at 0.74kg/m^3 cassiterite and 28 416 loose cubic metres at 0.66kg/m^3. The deposit is a 300m long by 150m wide by 4.5m deep zone of eluvium and weathered greisenised granite.

A small greisenised granite deposit at Mount Poverty contains an inferred resource of 20 000m^3 of erratic tin mineralisation. The best result from core drilling was 21m at an average grade of 0.42% Sn; most assay results were <0.1% Sn. The greisen seams comprise quartz + muscovite + chlorite. Some of the chloritic greisen contains appreciable chalcopyrite as blebs and stringers. Greisenised, chloritised and silicified granite also occurs at Mount Misery. Greisen occurs as near-vertical, sheet-like bodies in shear zones with included subvertical veins. Cassiterite, chalcopyrite, arsenopyrite, sphalerite and pyrite occur in the greisen zones and chalcopyrite and pyrite occur in altered granite; tourmaline is an ubiquitous accessory mineral. Although drilling confirmed the presence of a granite cupola, the amount of greisen associated with the cupola is small. Fracture or shear related wall rock alteration (dominantly greisen) has been superimposed on a background of earlier pervasive alteration and is located in the upper 50m of the roof zone. The mineralisation style is probably similar to that at Collingwood, but the granite and associated mineralisation are at about 400m depth.

Area SnB2 (Map 4)

This extensive area covers S-type granites of the Whypalla Supersuite (Bultitude & Champion, 1992). There is a moderate resource potential for small tin greisen deposits with a certainty level of B. The extent of the area has been based on the favourable geochemistry of the granites, the known lode and alluvial mineralisation, the mapped extent of the S-type granites, and the possible subsurface extent of granite intrusions based on aeromagnetics. Greisenisation is known to occur associated with tin vein mineralisation in the area.

Economic significance:

Although most massive greisens are not economic as primary deposits, rich placer deposits form by weathering and erosion. The greisen vein system at the Collingwood Prospect is the most significant lode tin resource in the CYPLUS area. Weathered greisen and argillic alteration systems may be economic for sluicing operations (Daly's Face and Home Rule in the Cooktown Tinfield). Figure 27 shows tonnage-grade for known resources in tin greisen deposits in the CYPLUS area.

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Equivalent/ related deposit types: / tin veins, alluvial placer tin.

References:

Cox & Singer (1986)
Golding & others (1990)
Jones & others (1990)
Krosch (1985)
Kwak (1986)
Martin (1979,1980a)
Miezitis & McNaught (1987)

Model SnC: Porphyry tin

Commodities, by products and trace metals: Tin, base metals, silver.

Geological setting: Deposits occur in Palaeozoic foldbelts cut by subduction-generated high-level stocks and cogenetic volcanic rocks. The subvolcanic stocks are emplaced 1-3km beneath or within the vents of terrestrial stratovolcanoes.

Age: May be any age.

Deposit description: Subvolcanic intrusive complexes contain disseminated, veinlet- and breccia-controlled fine-grained cassiterite in quartz porphyry and adjacent rocks. The intrusions most closely associated with mineralisation are strongly altered and brecciated quartz porphyry. Host rocks include intermediate to acid porphyry stocks (quartz latite, dacite, rhyodacite) and cogenetic calc-alkaline pyroclastics and lavas (quartz latite to rhyodacite).

Mineralisation is breccia-controlled and centred on stocks emplaced in the inner, deeper regions of volcanoes. There is a close relationship between disseminated cassiterite and sericitic alteration. Late, fracture-controlled quartz + cassiterite and quartz + cassiterite + sulphide veins occur within or near the margins of intrusive centres.

Minerals include cassiterite, quartz, pyrite, pyrrhotite, stannite, chalcopyrite, sphalerite and arsenopyrite. Late veins commonly carry complex sulphostannates and silver minerals.

Pervasive alteration and porphyry tin mineralisation predate tin-silver veins. There may be a concentric zoning, grading from a central quartz + tourmaline core (minor disseminated cassiterite) outward to sericite + tourmaline, sericite (closely related to disseminated cassiterite) and propylitic alteration. Argillic alteration may be present in the upper parts of some systems.

Geochemical signature: Cassiterite may be concentrated in nearby placer deposits. Sn + B centre; Sn, Ag, Pb, Zn, As, Sb, Cu, Ba in outer zone.

Known deposits: None known in north Queensland.

Assessment criteria:

1. High-level intrusive complexes (particularly quartz porphyries) with cogenetic pyroclastics and lavas.
2. Distribution of known primary mineralisation and alluvial deposits.

Assessment: **Area SnC1 (Map 1)**

The Cape York tinfield is the highest level tinfield in Australia. Several of the characteristics of the known mineralisation indicate that there is a moderate resource potential for small to medium-size porphyry tin deposits with a certainty level of B.

The deposits are in a high-level volcanic setting. The host rocks are predominantly quartz porphyries. The known vein mineralisation, which has accompanying sericitic alteration, could represent the outer sericitic alteration zone of a porphyry tin system. Clay-sericite alteration and copper mineralisation at Peak Point could represent the upper argillic alteration zone which occurs in some deposits of this type.

In porphyry tin systems, potentially economic ore is associated with veins and with hydrothermal breccias. Taylor (1969) indicated that breccia (porphyritic rhyolite fragments in an iron oxide and cassiterite matrix) occurs at Bluffs Quarry. It is likely that breccia is more widespread than indicated by investigations to date. If porphyry tin mineralisation does occur at Cape York, the main mineralised zone could be at depths of up to 500m. Tin-polymetallic veins and breccia pipes might also be expected to occur in the area.

Areas SnC2 and SnC3 (Map 1)

On the basis of geological environment, these areas have a low resource potential for small to medium-size porphyry tin deposits with a certainty level of B. Porphyry tin systems could be coeval with, but concealed beneath, volcanic rocks in the areas.

Areas SnC4 and SnC5 (Map 2)

On the basis of geological environment, these areas have a low resource potential for small to medium-size porphyry tin deposits with a certainty level of B. Porphyry tin systems could be coeval with, but concealed beneath, volcanic rocks in the areas.

Economic significance: Potential bulk tonnage/low grade deposits.

Equivalent/ related deposit types: / tin veins, tin polymetallic veins, alluvial placer tin.

References:
Cox & Singer (1986)
Denaro (1993)
Taylor (1969)

Model SnD: Tin skarn deposits

Commodities, by products and trace metals: Tin, tungsten.

Geological setting: Orogenic belts; inner sides of continental margin magmatic arcs, continental rifts; granite emplacement generally late (post-orogenic).

Structural control: Contacts and roof pendants of batholith and thermal aureoles of apical zones of stocks that intrude carbonate rocks. Mineralised skarns may or may not develop at intrusive contact with carbonate rocks. Major skarn development up to 300m from intrusion controlled by intrusion-related fractures, cross-cutting veins and felsic dykes.

Age: May be any age.

Deposit description: Tin, tungsten and beryllium minerals in skarns, veins, stockworks and greisens near granite-limestone contacts. Massive, sheet, vein and pipe replacements controlled by lithology and structure.

Generally associated with thick, pure and/or impure carbonate sequences intruded by felsic igneous rocks, especially leucocratic biotite and/or muscovite granite; specialised phase or end members are common. Geochemically, Na_2O/K_2O is <1.0 and may be as low as 0.4, Fe_2O_3/FeO is low (<1.0), Fe_{total}/CaO is high, and Rb/Sr is 2.0 to 85.0 and generally 5.0 to 10.0 (Kwak, 1986). Deposits are

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most likely to be associated with ilmenite series, S-type (and A-type) granites; some occur in I- or mixed I/S-type provinces.

The host rocks are contact metamorphosed equivalents of relatively pure limestone beds, impure limestones and calcareous to carbonaceous pelites (skarn, calc-silicate rock and biotite-pyrite hornfels).

Mineralogy of deposits generally comprises cassiterite ± minor scheelite ± sphalerite ± chalcopyrite ± pyrrhotite ± magnetite ± pyrite ± arsenopyrite ± fluorite. Much tin may be in silicate minerals and be metallurgically unavailable.

Deposits include granoblastic skarns, wrigglite (chaotic laminar pattern of alternating light (fluorite) and dark (magnetite) lamellae), stockworks and breccia.

Magnesian skarns contain forsterite, diopside, spinel, garnet, vesuvianite, humite minerals, borate minerals; retrograde cassiterite, tourmaline, phlogopite, tremolite, talc, chlorite, calcite, borate minerals, fluorite, sellaite, serpentine, pyrrhotite, arsenopyrite, pyrite, chalcopyrite, magnetite, stannite, scheelite, quartz, siderite. Calcic skarns contain garnet (grossular-andradite), clinopyroxene, vesuvianite, wollastonite, cassiterite; retrograde tourmaline, axinite, cassiterite, fluorite, magnetite, Be minerals, pyrrhotite, chalcopyrite, scheelite, malayaite, sphalerite, arsenopyrite, datolite, epidote, amphiboles, quartz, calcite.

Greisenisation (quartz + muscovite + topaz ± tourmaline, fluorite, cassiterite, sulphides) occurs near granite margins and in cusps. Topaz-tourmaline greisens are also known. Idocrase + Mn-grossular-andradite ± Sn-andradite ± malayaite occur in skarn. Commonly significant greisen retrogression of intrusive coincident with retrogression of skarn. Late stage phases include amphibole + mica + chlorite and mica + tourmaline + fluorite. Distal replacements have less calc-silicates and more carbonates and sulphides.

Geochemical signature: Erosion of lodes may lead to the deposition of tin placer deposits. Sn, W, F, Be, Zn, Pb, Cu, Ag, Li, Rb, Cs, Re, B. Specialised granites characteristically have SiO_2>73%, K_2O>4%, and are depleted in CaO, TiO_2, MgO and total Fe. They are enriched in Sn, F, Rb, Li, Be, W, Mo, Pb, B, Nb, Cs, U, Th, Hf, Ta and most rare earth elements. They are depleted in Ni, Cu, Cr, Co, V, Sc, Sr, La and Ba.

Geophysical signature: Magnetic anomalies over magnetite-bearing ore.

Known deposits: Mount Garnet area (immediately south of CYPLUS area).

Assessment criteria:

1. Distribution of calc-silicate and/or relatively thick carbonate-rich rocks in areas with suitable intrusives.
2. Exposed or subsurface plutons with suitable geochemistry.
3. Pluton/limestone contacts and irregularities in contact.
4. Stockwork fracturing along pluton/limestone contact.
5. Distribution of known mineralisation, including tin veins and greisen.

Assessment:

Area SnD1 (Map 2)

Drilling has indicated the presence of subsurface intrusions in the Bolt Head area. Limestone, dolomite and calcareous schist of the Proterozoic Sefton Metamorphics have a low resource potential to host small tin skarn deposits with a certainty level of B.

Areas SnD2 and SnD3 (Map 4)

These areas in the Chillagoe Formation comprise limestone, muddy limestone, basalt, chert, sandstone, siltstone and mudstone. It is not known if there are any potentially mineralising subsurface felsic plutons in the area. There is a low resource potential for small tin skarn deposits with a certainty level of B.

Areas SnD4 and SnD5 (Map 4)

Limestone crops out in the Hodgkinson Formation in these areas. There is a low resource potential for small tin skarn deposits with a certainty level of B.

Equivalent/ related deposit types: / tungsten skarns, tin greisen and veins, alluvial placer tin deposits.

References: Cox & Singer (1986)
Krosch (1985a)
Kwak (1986)

Model SnE: Alluvial placer tin

Commodities, by products and trace metals: Tin, gold, heavy minerals (ilmenite, rutile, zircon, monazite).

Geological setting: Alluvial deposits derived from Palaeozoic to Cainozoic accreted terranes or stable cratonic foldbelts that contain highly evolved granite plutons or their extrusive equivalents. Tectonic stability during deposition and preservation of alluvial deposits.

Age: Commonly late Tertiary to Holocene, but may be any age.

Deposit description: Cassiterite and associated heavy minerals occur as silt- to cobble-size nuggets concentrated by the hydraulics of running water in modern and fossil stream beds.

Concentrations generally occur in moderate to high-level alluvium, where stream gradients lie within the critical range for deposition of cassiterite (for example, where stream velocity is sufficient to result in good gravity separation but not enough so that the channel is swept clean). Deposits may occur as deep leads (for example, beneath Tertiary basalt flows).

Economic placers are generally within a few (<8) kilometres of the primary sources. Any type of cassiterite-bearing tin deposit may be a source. The size and grade of the exposed source may have little relation to that of the adjacent alluvial deposit.

Cassiterite tends to concentrate at the base of stream gravels and in traps such as natural riffles, potholes, and bedrock structures transverse to the direction of water flow. The richest placers lie virtually over the primary source. Streams that flow parallel to the margin of a tin-bearing granite are particularly favourable for placer tin accumulation.

Concentrates may contain cassiterite, magnetite, ilmenite, zircon, monazite, allanite, xenotime, tourmaline, columbite, garnet, rutile and topaz. The cassiterite becomes progressively coarser as the source is approached. Euhedral crystals indicate close proximity to the source.

Geochemical signature: Anomalously high amounts of Sn, As, B, F, W, Be, Cu, Pb and Zn. Panned concentrate samples are the most reliable method for detecting alluvial cassiterite.

Known deposits: Wolverton Prospect, Cooktown Tinfield, Palmer Goldfield, Cape York Tinfield.

Assessment criteria:

1. Streams draining known or potentially mineralised areas.
2. Distribution of alluvial deposits, including abandoned stream channels.
3. Proximity to source rocks.

Assessment: Only deposits in which tin is likely to be the major commodity are discussed here. Alluvial placer gold and titanium deposits, where cassiterite may be a potential by product, are discussed under "GOLD" and "TITANIUM".

Area SnE1 (Map 1)

Cassiterite has been mined from alluvium in the Laradeenya Creek area near Cape York, and has been shed from nearby quartz vein systems. Eluvial deposits have been mined near the lodes. There is a moderate resource potential for small alluvial tin deposits with a certainty level of C. These deposits might be suitable for mining by individuals or small syndicates.

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In 1968, Consolidated Mining Industries delineated a inferred resource of 14.5 x 10^6m^3 at 474g/m^3 cassiterite and 9.2 x 10^6m^3 at 192 g/m^3 cassiterite within an area of 20.7km^2 of shallow alluvium along Laradeenya Creek and its tributaries (Hughes, 1970a). Unfortunately, the sampling and assay methods used make these results suspect. Data concerning the grain size and nature of the alluvium are lacking.

Follow-up work by Cominco (Hughes, 1970b) and Jimbilly Pty Ltd (Layden, 1983) indicated that grades are generally subeconomic, except along present day drainages. Jimbilly Pty Ltd calculated an indicated resource of 448 000m^3 grading 310g/m^3 cassiterite for Booty and Laradeenya Creeks. Sampling indicated that cassiterite is present over the full 1 to 7m deep alluvial profile. Lateral sampling indicated higher grades within Recent creek systems as a result of reconcentration of heavy minerals. Jimbilly concluded that the deposits could not be economically mined.

In 1981, Halekka Pty Ltd carried out hand auger and reverse circulation drilling and concluded that tin concentrates do not reach the grades and volumes necessary for economic mining (McDonald, 1982). The highest grade intersected was 852g/m^3 cassiterite (70% Sn). Attempts to test the deeper sections of the alluvials for deep leads were unsuccessful because hard laterite layers were encountered at shallow depths.

Area SnE2 (Map 2)

In the Stony Point tinfield, cassiterite was patchily distributed in thin deposits overlying the Kangaroo River Volcanics. The alluvium is derived from granophyric intrusives to the south-east. The cassiterite mined in the past was coarse-grained and slightly waterworn. There is a low resource potential for small tin deposits with a certainty level of C. Broken Hill Pty Company Ltd estimated that <1t of cassiterite remains in known workable areas (Broken Hill Proprietary Company Ltd, 1962).

Area SnE3 (Map 2)

Cassiterite-bearing alluvium occurs in the headwaters of Tin and Densley creeks and other tributaries of Sandy Creek. The alluvium is restricted in extent, shallow, and contains a high proportion of boulders. Deposits in the upper reaches of the creek may be eluvial. The cassiterite is probably derived from veins in granophyric and hybridised intrusive rocks.

There is a moderate resource potential for small alluvial tin deposits with a certainty level of C.

Area SnE4 (Map 2)

This area covers Granite and Wet Creeks, near the Archer River north of Coen. Historically, alluvial deposits in this area have produced 333.5t of cassiterite concentrates.

Detrital cassiterite concentrations in Granite and Wet Creeks correspond to outcrops of the Permian Wolverton Adamellite and to its derived alluvial outwash material. Moderately to highly anomalous cassiterite concentrations (50 to several thousand ppm) occur in streams and creek systems draining this intrusion. Lower concentrations, with local, anomalously high concentrations, occur in older Cainozoic deposits. There is a high resource potential for small alluvial tin deposits with a certainty level of D.

In the 1980's, Wolverton Tin Pty Ltd referred to the area as the "Wolverton Prospect" and estimated that there was 5.2Mm^3 of alluvium in Granite and Wet Creeks suitable for dry mining by excavator and trucks and 2.25Mm^3 of lower grade material in Wrights and Ringtail Creeks suitable for bucket-wheel dredging. Partially exposed palaeoplacer deposits were estimated to contain >50Mm^3, but grades were not known. Following further sampling, the overall potential resource of the area was estimated as up to 4.1Mm^3 of alluvium at 1.13kg/m^3 cassiterite. This includes an indicated resource of 198 000m^3 at 0.89kg/m^3 cassiterite in the Wet Creek drainage basin.

Area SnE5 (Map 4)

A total of 254kg of cassiterite concentrates has been mined from rich, thin patches in alluvium in creeks draining north and west of the Barrow Point Stock at Barrow Point. There is a low resource potential for small alluvial tin deposits with a certainty level of C.

Ravenshoe Tin Dredging Company Ltd investigated the potential of the area in 1981. samples of alluvium were panned but only a trace of black sands was recorded. The concentrates assayed 0.03 to 0.14% Sn.

Area SnE6 (Map 4)

Creeks draining the Altanmoui Granite carry some cassiterite. There is a low resource potential for small alluvial tin deposits with a certainty level of C.

Drilling across Altanmoui Creek by Dampier Mining Company Ltd delineated a 500m wide by 40m deep zone of alluvium carrying cassiterite grades ranging from a trace to 46g/m^3 (Dampier Mining Company Ltd, 1981a, 1981b). Creeks draining the eastern and southern sides of the Altanmoui Range are generally barren of cassiterite.

Carpentaria Exploration Company Pty Ltd found anomalous tin in the headwaters of Wakooka Creek (Fabray, 1982).

Area SnE7 (Map 4)

Pan concentrates from creeks draining the Jeannie River Prospect contain 0.14 to 1.1% Sn (Lord & Fabray, 1990). The alluvial potential of this area has not been assessed by exploration targeting alluvial tin. There is a moderate resource potential for small tin deposits with a certainty level of B.

Area SnE8 (Map 4)

Large resources of alluvial cassiterite occur in an abandoned stream channel extending west from Waterfall Creek to Trevethan Creek. In 1967, Eastern Prospectors Pty Ltd calculated an inferred resource of 0.95Mm^3 of alluvium at an average grade of 482g/m^3 cassiterite. In 1978, Serem Australia Pty Ltd assessed the deposits and calculated overall indicated resources as 2.1Mm^3 at an average grade of 383g/m^3, comprising 0.9Mm^3 of wash at an average grade of 759g/m^3 cassiterite and 1.2Mm^3 of overburden. Serem worked the area in 1979 and probably into the 1980s; only a small part of the available resource was treated. There is a high resource potential for a medium-size alluvial tin deposit with a certainty level of D.

Area SnE9 (Map 4)

The Kings Plains Prospect was first recognised on air photographs by K.G. Lucas and was subsequently confirmed by ground examination by K.G. Lucas and L. Cutler during geological mapping of the Cooktown 1:250 000 Sheet area by the Bureau of Mineral Resources and the Geological Survey of Queensland. The prospect is a former channel of the Annan River and was first described by Best (1962). Investigations by the Bureau of Mineral Resources and Queensland Department of Mines indicated that the ancestral Annan River valley is deeply incised and is at least 50.3m deep in places. The alluvium is stanniferous, the best grades being concentrated at depths of >30.5m. Mungumby Creek (and therefore the Big Tableland) may have been a major contributor of the cassiterite. There is a high resource potential for a medium-size alluvial tin deposit with a certainty level of D.

In 1965, Eastern Prospectors Pty Ltd drilled 304 scout holes in the Kings Plains area. Samples were assayed and basement contour maps were prepared. The inferred resource was calculated to be 128Mm^3 at 119g/m^3 cassiterite, suitable for dredging over a depth of 42.7m.

M.H. Wood assessed the Kings Plains deposit as a dredging proposition in 1975. The inferred resource was calculated to be 87Mm^3 at an average grade of 130g/m^3 cassiterite (cutoff 77g/m^3). The eastern section of the deposit is the richest (42Mm^3 at an average grade of 160g/m^3 cassiterite). It was concluded that the deposit may be physically dredgeable but the grade is too low to be economic.

From 1977 to 1983, Triako Mines N.L., in a joint venture with Serem (Australia) Pty Ltd and Buka Minerals N.L., investigated the potential of the Kings Plains deposit

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for a dredging or gravel pumping operation. Percussion drilling indicated the presence of two mineralised horizons in the wash, separated by a zone with very low grades. The best grade intersected was 10m of wash at 267g/m^3 cassiterite. The alluvium deepens to the west, with an accompanying lowering in grade.

Norminco Pty Ltd applied for ML 40070 over the prospect in June 1993.

Area SnE10 (Map 4)

The Cooktown Tinfield has been the major producer of alluvial cassiterite in the CYPLUS area. Cassiterite is found in recent stream channel alluvium, in eluvial and colluvial deposits shed from stanniferous lode systems, in alluvial terraces adjacent to the main streams, in perched terraces well above present stream levels, in older, ferruginous gravels on high tablelands such as Mount Poverty, Mount Hartley and the Big Tableland, and in deep leads below Tertiary basalt flows. Most deposits are too small or of subeconomic grade for major company operations. Smaller alluvial and colluvial deposits containing up to 1Mt of wash offer potential for sluicing operations by individual miners and syndicates. There is a high resource potential for small alluvial tin deposits with a certainty level of D. Most of the prospective area is now within the Wet Tropics World Heritage area.

The main centres of production were Rossville, Mount Poverty, Upper Romeo, Shiptons Flat, Grasstree, Big Tableland, Little Tableland, Mount Hartley, Mount Finlayson, Tabletop and Mount Amos.

The Annan River, from its headwaters down to the Helenvale area, is known to contain alluvial cassiterite at subeconomic grades. Sampling along the Helenvale Flats by the Annan Dredging Syndicate in 1956 returned a trace to 520g/m^3 of heavy minerals; approximately 30% of the concentrates was ilmenite. From Helenvale to Scrubby Creek, the alluvium contained up to 4.15kg/m^3 of concentrates. Auger hole samples from Nunn's Forks returned 890g/m^3 of cassiterite and ilmenite concentrates. Twenty holes on the flats at Little Forks averaged 297g/m^3.

Auger holes drilled by Carpentaria Exploration Company Pty Ltd at Banana Flats and the Leswell Creek terraces failed to reach basement (>10 m); no cassiterite was found.

Triako Mines N.L. carried out a feasibility study on dredging and/or gravel pumping alluvial tin deposits along the Annan River. Maps were prepared showing previous exploration results, but nothing further was reported.

Vimaction Pty Ltd carried out stream sediment sampling along the Annan River and its tributaries. A number of small alluvial tin deposits of reasonable grade were found in the upper reaches of the river. There is a potential for larger, lower grade deposits in the lower reaches.

Alluvial cassiterite is also known to occur in the Mount Misery, Mount Boolbun North and Mount Boolbun South areas. The rugged topography and limited access of these areas has meant that there has been little mining activity or prospecting.

Alluvial flats along Mungumby Creek, at the base of the Big Tableland, contain an indicated resource of 595 125m^3 at 0.20kg/m^3 cassiterite or 434 760m^3 at 0.43kg/m^3.

Alluvial flats along Mount Hartley Creek, below Mount Hartley, contain indicated resources of 381 440m^3 at 0.18kg/m^3 in the lower terraces and 453 125m^3 at an unknown grade in the upper terraces.

Older, high-level alluvium occurs in the headwaters of Granite Creek, between Mount Hartley and Mount Amos. Shallow, gravelly clay upslope from the present stream grades up to 10kg/m^3 cassiterite (average 1.5kg/m^3). Cassiterite occurs in pisolitic, lateritised clay on low ridges and alluvial terraces.

Carpentaria Exploration Company Pty Ltd examined clayey slopewash and colluvial deposits at Grasstree Pocket and inferred a resource of 1Mt at an average grade of 138g/t cassiterite.

Cassiterite-bearing wash occurs as deep-leads below basalt, much of which is deeply weathered, in the Shiptons Flat - Bairds Creek area.

Dominion Mining N.L. calculated that there is an inferred resource of 96 449m^3 of eluvium at a grade of 0.55kg/m^3 cassiterite (0.2kg/m^3 cutoff) at the Just In Time claim on Mount Hartley.

New Consolidated Gold Fields (Australia) carried out hand boring on Bloomfield Flat (the coastal flat immediately north of the mouth of the Bloomfield River) in 1957. Samples assayed nil to 130g/m^3 cassiterite. The company concluded that small pockets of cassiterite exist in the area but the deposits lack sufficient depth and grade to be economic.

In 1977, Tennyson Minerals N.L. sampled the tidal portion of the Bloomfield River (an 8km long and 37 to 305m wide stretch from 1km downstream of the Bloomfield Falls to the river mouth). Surface gravels were sampled using a portable floating suction dredge and sluiced to produce pan concentrates; concentrates assayed 0.09 to 3.92% Sn. The company suspected that very fine-grained cassiterite was being lost through the sluice box. The results of reverse circulation drilling in the bed and banks of the river were discouraging (approximately 1.12% heavy minerals with up to 1650ppm Sn). In 1979, a larger suction dredge was used to obtain bulk samples to 3 to 4m depth at four locations. Alluvium at the base of the rapids below the falls returned 138g/m^3 heavy minerals. Alluvium 300m downstream of the rapids returned 256g/m^3, including fine-grained specks of gold. Sites further downstream returned 41 to 103g/m^3, with some fine gold. It was concluded that grades were not high enough to be economic.

Area SnE11 (Map 4)

This area covers Cannibal and Granite Creeks and their tributaries and the Mount Windsor Tableland area. At least 2260t of cassiterite has been produced from alluvial deposits in the area. There is a moderate resource potential for small alluvial tin deposits with a certainty level of C.

Early production came from rich deposits of shallow alluvium along Cannibal and Granite Creeks and their tributaries and of eluvial soil. Both waterworn and crystalline cassiterite, ranging from minute grains to slugs of up to 0.5kg were recovered. Cassiterite is known to occur along Pinnacle and Gum Creeks.

More recently, Cannibal and Granite Creeks were mined by Buddha Gold Pty Ltd, Frost Enterprises Pty Ltd, Mirrajong Pty Ltd and Rosella Mining Pty Ltd. Alluvium from Nine Mile and Tin Creeks was hauled to a processing plant at the Adams mine. Alluvial tin was also mined along Fiery Creek.

Exploration by Northern Mining Syndicate in 1974 indicated that Tin Creek contained a resource of 383 000m^3 of stanniferous wash at grades of 694g/m^3 cassiterite and that Nine Mile Creek contained 76 500m^3 at 683g/m^3 cassiterite. Alluvial cassiterite has been mined from the Windsor Tableland area since 1890. It is derived from cassiterite-bearing quartz veins, greisen lodes, aplite and pegmatite dykes, and stanniferous granite. Large quantities of granitic alluvium have been sluiced along Piccaninny Creek and its tributaries. Mining has also been carried out along Campbell Creek, Flaggy Creek, and the headwaters of the West Normanby River.

In 1965, G. Hopgood noted minor alluvial tin occurrences in the headwaters of the Palmer River (Prospect Creek and its tributaries) (Vance, 1965). Planet Metals Ltd found traces of cassiterite in the headwaters of Piccaninny Creek in 1969 (Planet Metals, 1969).

In 1978, Westco Mining Pty Ltd calculated that the Mountaineer lease, at the junction of Flaggy Creek and the West Normanby River, contained 54 000m^3 of stanniferous wash at grades of up to 0.75kg/m^3 cassiterite (McGain, 1982). Westco Mining recognised three main types of cassiterite-bearing alluvium in the headwaters of the West Normanby River, namely:

1. Recent alluvium comprising sandy wash with very minor cassiterite;
2. reworked, granite-derived sandy wash which is fairly clayey. The top 0.5m of silty material contains the most cassiterite but is very low grade. This alluvium is fairly extensive and reaches thicknesses of 5m or more;

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3. older alluvium comprising granite-derived sandy wash, with granite boulders to several metres in diameter, overlain by more recent sandy alluvium. The old granite wash is up to 4.5m thick and cassiterite is concentrated in the bottom 0.5m.

No mining has been carried out in the area since 1986. It is likely that there are still resources available to support small-scale mining operations should the tin price improve significantly.

Economic significance:

Because cassiterite has a high density and is reasonably resistant to abrasion, alluvial deposits are an important source. Almost all cassiterite production from the CYPLUS area has come from alluvial deposits and important resources (for example, the Wolverton Prospect) are known to exist. Unfortunately, significant production is unlikely to occur until the tin price improves and market restrictions are lifted.

Figure 28 shows volume/grade for known resources of alluvial tin deposits in the CYPLUS area. Treatment of alluvial ores is by trommels or screens, followed by jigs or other gravitational separation equipment, with a final clean up on tables or, for small-scale operations, in a Willoughby streaming box. Other heavy minerals of value, particularly gold, are recovered in this last stage.

Equivalent/ related deposit types:

/ alluvial placer gold, alluvial placer titanium, tin veins, tin greisen deposits, porphyry tin.

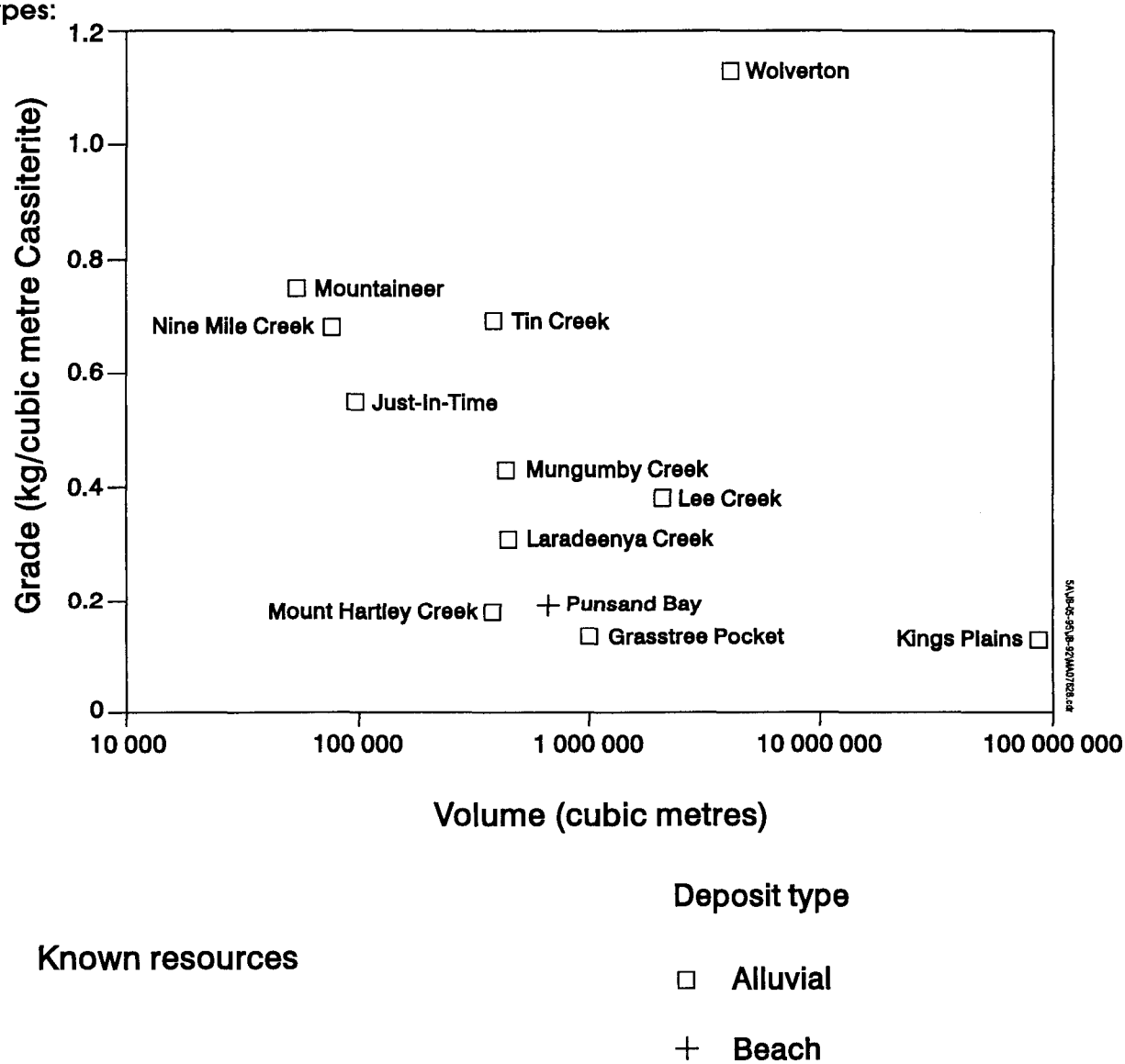

Figure 28. Grade-volume diagram, tin placer deposits.

References:

Best (1962)
Cox & Singer (1986)
Denaro (1993)
Denaro & Morwood (1993a,b,c)
Denaro & others (1992)
Krosch (1985)
Lam & Genn (1993)
Lam & others (1991)
Martin (1979,1980a)

Model SnF: Shoreline placer tin

Commodities, by products and trace metals: Tin, ilmenite, zircon, rutile, monazite.

Geological setting: Beach deposits, receiving sediment from areas with primary tin mineralisation.

Age: Quaternary.

Deposit description: These are heavy mineral concentrations formed by beach processes and include beach placer and beach ridge deposits. Surf action, primarily during storm activity, removes the lighter fraction, leaving elongate 'shoe-string' ore bodies of black sand parallel to the beaches. These deposits may be buried by later beach accretion.

Geochemical signature: Cassiterite in pan concentrates.

Known deposits: Punsand Bay.

Assessment criteria:

1. Suitable beach environments in areas near known primary tin mineralisation.

Assessment:

Area SnF1 (Map 1)

Cassiterite has been mined from beach sands in the Punsand Bay area near Cape York, and has been shed from nearby quartz vein systems. There is a low resource potential for small beach placer deposits with a certainty level of C.

Fine to very coarse-grained cassiterite occurs on the beach and in a marine conglomerate under low coastal dunes. There are no large, workable deposits.

Investigations of beach sand placer deposits along Punsand Bay by Consolidated Mining Industries Ltd indicated inferred resources of 0.66Mm^3 at 193g/m^3 cassiterite for the Lady Luck lease area. Sampling of test pits and auger holes along Punsand Beach failed to delineate any economic alluvial deposits occur in this area (Hughes, 1970a).

Area SnF2 (Map 1)

This area comprises beach ridges along the shore of Simpson Bay. Beach sands in this area might be expected to carry anomalous amounts of cassiterite draining from Laradeenya and Paterson Creeks. There is a low resource potential for small deposits with a certainty level of B.

Area SnF3 (Map 2)

Beach placer and dune deposits in the First Stony Point area have a low resource potential for small tin deposits with a certainty level of B.

Economic significance: Deposits of this type are generally too low grade to be of any economic significance.

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Equivalent/ related deposit types: / shoreline placer titanium.

References: Denaro (1993)

TUNGSTEN (W)

Model WA: Tungsten veins

Commodities, by products and trace metals: Tungsten, molybdenum, bismuth; gold, silver and zinc are trace metals.

Geological setting: Collisional environments, inner sides of continental margin magmatic arcs, continental rifts. Causative granitic plutons emplaced late in tectonic cycle or anorogenic. Belts of granitic plutons derived from remelting of continental crust. Country rocks generally metamorphosed to greenschist facies.

Structural control: Mineralisation tends to occur near igneous contacts and above irregularities in contacts (for example, cupolas). Structural (fault) control to focus fluids.

Age: Commonly Palaeozoic or younger.

Deposit description: Wolframite, scheelite, molybdenite, and minor base metal sulphides in quartz vein swarms in tensional fractures associated with epizonal felsic intrusions (monzogranite to granite stocks) intruding sandstone, shale and metamorphosed equivalents. Kwak(1986) suggests that, in the intrusive rocks, Na_2O/K_2O is 2.0 to 2.5, Fe_2O_3/FeO is low (0.3 to 0.6), Fe_{total}/CaO is <1, and Rb/Sr is 0 to 4.0.

Deposits comprise massive quartz (with minor vughs, parallel walls and local breccia) and swarms of parallel veins crosscutting granitic rock or sedimentary rocks near contact. Minerals include wolframite, scheelite, molybdenite, bismuthinite, pyrite, pyrrhotite, arsenopyrite, bornite, chalcopyrite, cassiterite, beryl and fluorite.

Pervasive albitic alteration occurs in the deepest levels of mineralised systems. Pervasive to vein-controlled potassic alteration occurs at higher levels. In upper levels, vein selvedges comprise muscovite or zinnwaldite (greisen). Chloritisation and tourmalinisation are also common.

Geochemical signature: Wolframite persists in soils and stream sediments. W, Mo, Sn, Bi, As, Cu, Pb, Zn, Be, F.

Known deposits: Bowden Mineral Field, Spring Creek lodes.

Assessment criteria:
1. Contact zones associated with suitable intrusives.
2. Distribution of known tungsten mineralisation.

Assessment: **Area WA1 (Map 1)**

Wolframite occurs in joint-controlled quartz lodes on Moa Island. The main deposits are at Eet Hill, Blue Mountains (Mount Augustus) and near Kubin Village. The lodes occur in the Carboniferous Badu Granite and in hornfelsed Torres Strait Volcanics close to the granite contact. Few chemical analyses of the Badu Granite are available to assess its suitability in terms of the tungsten vein model.

Total recorded production from Moa Island was 100.6t of wolframite concentrates. Wolframite has also been found at several other places on Moa Island and on adjacent islands (Badu Island, Portlock Island, North Possession Island). There is a high resource potential for small wolframite-quartz vein deposits to occur on these and other islands in the area with a certainty level of C.

The near-vertical, wolframite-bearing quartz lode at Eet Hill is >300m long, averages 2.1m in width, and strikes 105°. It fills a well-defined fissure in coarse-grained Badu Granite and hornfelsed Torres Strait Volcanics. A number of other subparallel lodes occur within 1km of the Eet Hill lode.

In 1971, Torres Strait Wolfram Pty Ltd excavated an adit for 30m along the lode. The company described the lode as chloritised quartz with pyrite, arsenopyrite, chalcopyrite, marcasite and wolframite; chloritic and sericitic alteration occur along the vein margins (Davidson, 1972). Halekka Pty Ltd identified the following minerals in the lode in the adit: wolframite, huebnerite, ferberite, scheelite, cuprotungstite, pyrite, galena, chalcopyrite, malachite, azurite, chalcocite (suspected), cassiterite (suspected), bismuthinite (suspected) and fluorite (Barron, 1982). The lode is oxidised to 10m depth and a 30m depth of the lode is exposed in the workings. Samples from the workings and mullock assayed <10ppm to 2.47% WO_3, 280ppm to 8.5% Cu, 40ppm to 0.5% Zn, 1 to 160ppm Ag, 15 to 60ppm Pb, 50ppm to 0.13% Bi, 4 to 52ppm Mo and 35 to 285ppm Sn.

The Blue Mountains workings are on a well-defined, 2 to 3m wide quartz lode which strikes 070° to 105°. The lode appears to intersect the Eet Hill lode and trends obliquely west-north-west away from it. At Kubin, four or five, sheared and recrystallised, subparallel wolframite-bearing quartz veins strike north and dip 15° to 30°E in welded tuff close to the contact with a fine-grained granite.

Much of the wolframite production from Moa Island came from eluvial and colluvial deposits shedding from the quartz lodes. Eluvial wolframite has also been reported to occur on Badu Island, but no mineralised quartz veins have been found.

Wolframite occurs in a milky quartz vein along the contact of a 6m wide, fractured acid dyke and the Badu Granite on North Possession Island. Wolframite has been mined from floaters of greisenised granite on Portlock Island. The wolframite content of the greisen was approximately 0.5 %; 27kg of wolframite was produced.

Area WA2 (Map 1)

Wolframite, and possibly scheelite, have been reported to occur in the Horn Island Goldfield (Levy & Storey, 1990). Minor fluorite occurs in veins and breccias in late Palaeozoic volcanic and granitic rocks on Horn and Possession Islands and may be associated with tin-tungsten mineralisation. There is a low resource potential for small tungsten vein deposits with a certainty level of B.

Area WA3 (Map 2)

Wolframite-quartz veins occur in the Proterozoic Sefton Metamorphics in the Bowden Mineral Field, near the Pascoe River. The deposits are close to the contact with the Early Permian Weymouth Granite and granophyre and hybrid granitic rocks. There is a moderate resource potential for small tungsten vein deposits with a certainty level of C. The area shown is based on the distribution of the Sefton Metamorphics and the subsurface extent of the granites, as indicated by aeromagnetics. Much of the area is covered by sandstone and conglomerate of the Yam Creek beds.

Most of the quartz veins have been emplaced along the schistosity of the metamorphics, but some are discordant. Wolframite is commonly associated with arsenopyrite, galena, pyrite and bismuthinite. Minor scheelite and tungstite occur with the wolframite. The wallrock schists exhibit intense greisenisation and tourmalinisation. Total production from the Bowden field was 70.3t of wolframite concentrates. Investigations by Utah Development Company from 1978 to 1980 indicated that the veins are too widely spaced to provide a resource amenable to bulk mining (Meates, 1979).

Areas WA4 and WA5 (Map 2)

The late Palaeozoic I-type granites of the Weymouth Supersuite are more fractionated than the nearby mid-Palaeozoic S-type granites but chemical analyses indicate that only some samples are sufficiently specialised for the development of economic tungsten deposits (Knutson & others, 1994). Volcanic rocks in the area are intruded by these granites, indicating that the intrusives are high-level and are

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only partially unroofed where exposed. AGSO stream sediment geochemical survey results indicate anomalous tungsten in areas near the known mineralisation of the Bowden Mineral Field (Area WA3). There is a low resource potential for small tungsten veins with a certainty level of B.

Area WA6 (Map 4)

Wolframite shoad has been found near a ?porphyry dyke along the contact between the Hodgkinson Formation and the Altanmoui Granite in the Altanmoui Range. Wolframite-quartz veins probably occur in places in the granite and intruded sediments. There is a moderate resource potential for small tungsten vein deposits with a certainty level of B.

Area WA7 (Map 4)

A total of 18.7t of wolframite has been recovered from quartz veins on Noble Island. The mineralisation occurs as a stockwork of regular quartz veins over an area of approximately 2.4ha. The veins are 1 to 30mm wide, strike predominantly south-east and more randomly north to north-east, and dip 60° to 70° east. Historically, production only came from depths to 1.8m and mineralisation may be limited to shallow depths.

The stockwork is along joints in heavily fractured, isoclinally folded, interbedded sandstone and shale of the Hodgkinson Formation. Graded bedding is common in the sandstone. The rocks are silicified in the northern part of the island.

Wolframite occurs as small, bladed crystals evenly distributed in the quartz veins. Locally, the veins contain up to 5% wolframite and arsenopyrite, and 75% of the veins contain some wolframite. Cassiterite occurs with the wolframite, but not in economic amounts. Pyrite is irregularly distributed in the wall rocks, generally within 150mm of veins. Some veins contain cavities due to leaching of wolframite to form tungstite. Malachite and scorodite staining have been reported and scheelite may also occur. Alkane Exploration N.L. reported vein assays of up to 0.04ppm Au, 2.4% W (average 1190ppm), 5700ppm Sn (average 535ppm), and 1.16% As (average 3940ppm) (Odins & others, 1987). Ore mineralisation is restricted to the quartz veins.

Wolframite and quartz-wolframite vein debris occur embedded in coral at the foot of peaks on the island. Talus slopes in the same area may contain grades of 3.5kg/m^3 wolframite. There are no outcropping igneous rocks. Mineralisation may be related to a subsurface pluton of the Altanmoui Granite.

There is a moderate resource potential for small tungsten vein deposits with a certainty level of C.

Area WA8 (Map 4)

Only two occurrences of wolframite are known in the Cooktown Tinfield. There is a low resource potential for small tungsten vein deposits with a certainty level of C.

A wolframite-bearing quartz-tourmaline lode at Mount Hartley trends 135° to 160° and dips 45° to 82° southwest. It is up to 1.5m wide (average 0.3 to 0.6m) and occurs in medium to coarse-grained porphyritic biotite-tourmaline granite and fine-grained granite, close to the contact with the Hodgkinson Formation. The wolframite is very coarse (to 50mm) and occurs as bands of blady crystals near the vein margins. Arsenopyrite, chalcopyrite, pyrite, chalcocite and covellite also occur in the quartz. The host granite is silicified, greisenised, tourmalinised and foliated. Holes drilled by Dominion Mining N.L. intersected zones of up to 1.2m assaying up to 0.12% W, 800ppm Cu and 200ppm Bi (Kinnane, 1981).

At the Clearwater tungsten prospect, near Romeo Creek, wolframite, scheelite and cassiterite occur in sheeted quartz-tourmaline and quartz-feldspar veins in argillised and unaltered microgranite and granite. Silicification and greisenisation occur in granite adjacent to the veins. The veins occur in two main systems which are up to 25m wide, strike 135°, and dip 70° to 80° north-east. The Shell Company of Australia Ltd carried out detailed exploration at the prospect. Rock chip samples assayed up to 0.76% Sn and 1.8% W. Drilling results gave an inferred resource of 2Mt at 0.1% W to 50m depth (Truelove, 1982).

Area WA9 (Map 4)

Scheelite occurs in quartz-greisen veins in schistose and tourmalinised metasediments of the Hodgkinson Formation in the Spring Creek - Mount Hurford area. The vein systems are associated with a subsurface intrusion of Cannibal Creek Granite. They were discovered by Frost Enterprises Pty Ltd in 1968, who produced 24.8t of scheelite concentrates from 17 235t of ore at head grades of 0.15 to 0.34% WO_3. There is a high resource potential for small tungsten vein deposits with a certainty level of C.

The main occurrences are in the Spring Creek area and comprise subparallel, vertically-dipping composite quartz lodes which strike approximately 110° within a 1km long zone. Scheelite occurs as coarse-grained crystals and aggregates, commonly on quartz vein margins but also within muscovite-rich portions of the veins. Scheelite is also abundant as disseminations within tourmalinised host rocks.

The Keddie Lode, one of the larger lodes, is a mineralised zone comprising six, parallel, vertically-dipping, 0.2 to 0.5m wide muscovite-quartz veins. The lode was mined from an opencut measuring 150m long by 50m wide. The veins contain pegmatitic quartz, muscovite and scheelite, with minor cassiterite, chalcopyrite, pyrite, beryl, and selvedges of tourmalinised host rock. Several drillholes have intersected the Keddie lode to a depth of 35m, with no accompanying zones of significant mineralisation, and the Cannibal Creek Granite at 43 to 75m depth (McConnell, 1983; McConnell & Carver, 1984).

Area WA10 (Map 4)

Thermal aureoles in the Hodgkinson Formation surrounding S-type granites of the Whypalla Supersuite have a moderate resource potential for small wolframite-quartz vein systems with a certainty level of B.

Although deposits of this type are common to the south (for example, Mount Carbine), only minor occurrences are known within the CYPLUS area.

Economic significance:

Quartz-wolframite veins at Mount Carbine (immediately south of the CYPLUS area, in the Mossman 1:250 000 Sheet area) were an important source of tungsten in Queensland up until the mine closed in 1987. Mount Carbine was one of the largest, lowest grade wolframite mines in the world, with reserves of 28Mt at an average grade of 0.1% WO_3, using a cutoff grade of 0.03% WO_3 (Dash & Cranfield, 1993).

Taking into account the currently depressed tungsten market, the enormous resources available world-wide, and the large deposits awaiting development in other countries, there is little incentive for tungsten exploration and mining in Queensland at present. No tungsten was produced in Queensland in 1992/93.

The principal ore minerals of tungsten are scheelite ($CaWO_4$, with about 70 to 80% WO_3) and wolframite ($(Fe,Mn)WO_4$, with about 76% WO_3), which is an isomorphous series with the end members ferberite and huebnerite. Ideal specifications for readily saleable wolframite concentrates are: >65.00% WO_3, <0.50% Sn, <0.2% As, <0.05% Mo, <1.00% S, <0.50% CaO, <0.05% P, <18% Fe in ferberite, and <18% Mn in huebnerite. Ideal specifications for scheelite concentrates are: >65% WO_3, <0.20% Sn, <0.20% As, <5.00% Mo, 1.00% S, 18% CaO, and <0.05% P.

At Mount Carbine, a photometric ore sorting process was used to sort the wolframite-bearing quartz from the darker coloured host sediments.

Equivalent/ related deposit types:

/ tin veins, tungsten skarn.

References:

Cox & Singer (1986)
Dash & Cranfield (1993)
Denaro (1993)
Denaro & others (1992)
Krosch (1985)
Kwak (1986)

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Lam & Genn (1993)
Lam & others (1991)
Levy & Storey (1990)

Model WB: Tungsten skarn deposits

Commodities, by products and trace metals: Tungsten, molybdenum, bismuth, copper, zinc.

Geological setting: Orogenic belts; syn to late orogenic. Deep emplacement of intrusives, with extensive hornfelsing. Commonly formed in a deeper, higher temperature and more reduced environment than copper and zinc-rich skarns.

Structural control: Contacts and roof pendants of batholith and thermal aureoles of apical zones of stocks that intrude carbonate rocks.

Age: May be any age.

Deposit description: Scheelite in calc-silicate contact metasomatic rocks. Generally associated with thick, pure and/or impure carbonate sequences intruded by felsic igneous rocks, especially I-type quartz monzonite, tonalite and granodiorite. In the intrusive rocks, Na_2O/K_2O is 2.0 to 2.5, Fe_2O_3/FeO is low (0.3 to 0.6), Fe_{total}/CaO is <1 , and Rb/Sr is 0 to 4.0 (Kwak, 1986). Intrusives are coarse-grained, porphyritic and generally unaltered, but border phases may be argillised, greisenised or tourmalinised. Intrusive-carbonate contacts tend to be shallow dipping. Aplite and pegmatite dykes are common.

The host rocks are contact metamorphosed equivalents of relatively pure limestone beds, impure limestones and calcareous to carbonaceous pelites (skarn, calc-silicate rock and biotite-pyrite hornfels).

Mineralogy of deposits generally comprises scheelite ± molybdenite ± pyrrhotite ± sphalerite ± chalcopyrite ± bornite ± arsenopyrite ± pyrite ± magnetite ± traces of wolframite, fluorite, cassiterite and native bismuth. Sulphide content is low.

The deposits can be divided into reduced and oxidised types. Reduced types contain hedenbergite-rich clinopyroxene, grossular-andradite-spessartine-almandine garnet, wollastonite, vesuvianite, scheelite; retrograde hornblende, biotite, scheelite, carbonate, fluorite, quartz, pyrrhotite, magnetite, pyrite, chalcopyrite, molybdenite, Bi minerals, sphalerite, chlorite, plagioclase. Oxidised types contain diopside-hedenbergite, andradite-rich garnet, vesuvianite, wollastonite, scheelite; retrograde amphibole, chlorite, epidote, quartz, magnetite, hematite, calcite, plagioclase, fluorite, pyrite, pyrrhotite, bismuthinite, chalcopyrite, molybdenite. Oxidised skarns tend to form at shallower depths, with more oxidised host rocks; reduced skarns form at greater depths and/or with more reduced host rocks. Prograde skarn forms at 500° to 800°C; retrograde stage generally forms at 300° to 500°C.

Deposits are massive, sheet and vein replacements, and may grade into copper and molybdenum skarns. Stockwork quartz veining is not extensive, and is more abundant in the intrusive than in the skarn. Breccia pipes, intrusive and shatter breccias are absent. The most common deposit forms are as: essentially stratiform units tens to hundreds of metres away from an intrusive contact; semiconcordant to discordant bodies immediately adjacent to an intrusive contact; and xenoliths and pendants within a plutonic phase. Local endoskarns may be developed in the intrusive.

The main alteration minerals are diopside-hedenbergite and grossular-andradite. Spessartine and almandine are late stage minerals. There may be an outer barren wollastonite zone and an inner zone of massive quartz. Contact phases may be locally argillised, greisenised or tourmalinised.

Geochemical signature: Scheelite tends to be preserved in stream sediments and soils. W, Mo, Zn, Cu, Sn, Bi, Be, As.

Known deposits: Watershed Prospect.

Assessment criteria:

1. Distribution of calc-silicate and/or relatively thick carbonate-rich rocks in areas with suitable intrusives.
2. Extensive hornfels zone adjacent to an exposed pluton or overlying a buried one.
3. Shallowly dipping pluton/limestone contacts and irregularities in contact.
4. Stockwork fracturing along pluton/limestone contact.
5. Distribution of known mineralisation, including tungsten veins.

Assessment:

Area WB1 (Map 2)

Drilling has indicated the presence of subsurface intrusions in the Bolt Head area. Limestone, dolomite and calcareous schist of the Proterozoic Sefton Metamorphics have a low resource potential to host small tungsten skarn deposits with a certainty level of B.

Area WB2 (Map 2)

Fine-grained disseminated scheelite and molyscheelite occur in weakly mineralised skarns which trend 160° in the Proterozoic Holroyd Metamorphics in the Yoohoo Creek area. The skarns comprise marble and diopside±tremolite±epidote±calcite±vesuvianite±garnet rocks, which probably represent altered and pegmatite-contaminated calcareous sedimentary rocks. Patches of massive scheelite and scheelite in chloritic zones are present in places. Quartzofeldspathic gneiss and quartz-muscovite pegmatite are common and may represent injections of magma from the Kintore Granite (Willett, 1979). The metamorphic grade of the host rocks is upper greenschist facies with superimposed contact hornblende hornfels facies.

It is not known whether the mineralisation is related to the Kintore Granite or the adjacent Permian Wolverton Adamellite. However, because minor wolframite mineralisation is known to occur in the Wolverton Adamellite, it is more likely that the deposits are related to that intrusion.

Australia and New Zealand Exploration Company concluded that metasomatism is too restricted for the widespread development of calc-silicate skarns and that the mineralisation is nowhere present in significant concentrations (Willett, 1979). There is a low resource potential for small tungsten skarn deposits with a certainty level of C.

Areas WB3 and WB4 (Map 4)

These areas in the Chillagoe Formation comprise limestone, muddy limestone, basalt, chert, sandstone, siltstone and mudstone. It is not known if there are any potentially mineralising subsurface felsic plutons in the area. There is a low resource potential for small tungsten skarn deposits with a certainty level of B.

Areas WB5 and WB6 (Map 4)

Limestone crops out in the Hodgkinson Formation in these areas. There is a low resource potential for small tungsten skarn deposits with a certainty level of B.

Area WB7 (Map 4)

In this area, scheelite is known to occur as disseminated grains in calc-silicate rocks of the Hodgkinson Formation within thermal aureoles related to S-type granites of the Whypalla Supersuite. Scheelite also occurs in quartz-greisen veins in calc-silicate rocks and granite and as veins in the calc-silicate rocks. There is a high resource potential for small to medium-size tungsten skarn deposits with a certainty level of D.

The Watershed tungsten prospect comprises steeply westerly dipping, stratabound lenses of calc-silicate rock in the hinge zone area of a megafold. Scheelite occurs as fine to coarse-grained disseminations in the host rock and as coarse crystals in quartz-calcite veins. The host rocks are porous and calcareous arenites and conglomerates within predominantly arenite units of the Hodgkinson Formation. Within the calc-silicate rocks, the scheelite is accompanied by minor pyrite,

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pyrrhotite, arsenopyrite, fluorite, sphalerite, chalcopyrite and molybdenite. Scheelite-bearing veins are generally <100mm wide and contain coarse-grained scheelite, which is generally concentrated along vein margins but also occurs within muscovite-rich portions of the veins. Pyrrhotite and arsenopyrite are commonly associated with the vein scheelite. Vein mineralisation comprises much of the higher grade mineralisation in the deposit. High-grade disseminated haloes occur adjacent to veins. Resources have been reported as 14Mt at 0.3% WO_3 (Miezitis & McNaught, 1987).

Economic significance:

Skarns are the most common type of economic tungsten deposits and account for an estimated 30% of world production (Eckstrand, 1984). Size is highly variable and grade generally ranges from 0.4 to 2.0% WO3.

Scheelite ores are concentrated by grinding; the coarse fraction is treated by tabling and the fine fraction by flotation. Primary concentrates are then roasted and treated with hydrochloric acid to remove calcite and apatite. A final flotation stage removes sulphides.

Equivalent/ related deposit types:

/ tin-tungsten skarns, zinc skarns, tungsten veins.

References:

Cox & Singer (1986)
Denaro & Morwood (1992b)
Denaro & others (1993)
Eckstrand (1984)
Krosch (1985)
Kwak (1986)
Lam & Genn (1993)

MOLYBDENUM AND BISMUTH

Traces of molybdenite (± bismuth minerals) occur in quartz, quartz-wolframite and quartz-cassiterite veins in the Torres Strait, Cape Weymouth and Barrow Point areas, and in the Cooktown Tinfield. In all cases, mineralisation is related to late Palaeozoic granitic intrusions.

Molybdenite also occurs with wolframite in quartz veins at the Grand Final lease, near Coen. Mineralisation is within the mid-Palaeozoic Lankelly Granite.

The CYPLUS area has an unknown potential for the occurrence of economic molybdenum or bismuth deposits. There is little data available and there has been no exploration for such deposits. The most promising areas would be in the Torres Strait and northern Coen Inlier, where high-level felsic igneous rocks indicate a potential for porphyry Cu (?+Mo) deposits.

URANIUM

The only known uranium mineralisation in the CYPLUS area is at the Tadpole Creek Prospect, near Coen, where secondary uranium minerals (autunite and metatorbernite) occur in silicified mylonite and thin, concordant quartz veins in a shear zone in the Kintore Granite. This mineralisation is not of economic importance.

Uranium exploration has concentrated on sandstone uranium deposits in the Laura and Carpentaria Basins and in smaller, restricted Tertiary basins. Nothing of any importance has been found. There is a low resource potential for sandstone uranium deposits (particularly in the Laura Basin) with a certainty level of B.

Some exploration has also been carried out for unconformity-related uranium deposits in the Coen Inlier. However, in terms of mineral deposit models, there is considered to be no resource potential for deposits of this type; there is no

development of an unconformity surface separating early and middle Proterozoic rocks, and other features of these deposits appear to be absent.

IRON (Fe)

Model FeA: Enriched iron formation

Commodities, by products and trace metals: Iron, manganese.

Geological setting: Deep chemical weathering of sedimentary and volcanogenic iron formation.

Structural control: The grade of metamorphism of the protore (grain size and texture) affects permeability and hence oxidation and weathering. Supergene ores may be localised by irregularities in present or palaeoerosion surfaces.

Age: Host rocks Proterozoic.

Deposit description: Oxidised and chemically enriched residual zones of porous, friable iron formation and earthy hydrated iron oxide; developed on iron formation protore.

These deposits occur as irregular lenses to tabular masses within iron formation protore. Ore mineral assemblages reflect the protore facies from which they were derived. Enriched ore tends to grade into an oxidised and partially leached protore. Ore minerals include hematite, goethite, magnetite, martite, siderite, psilomelane, pyrolusite and hollandite. Associated minerals include quartz, chert, iron silicate, dolomite, and various rock-forming silicates, especially clay minerals.

Associated rocks include unaltered iron formation, shale, siltstone, quartzite, dolomite and other clastic sedimentary and volcaniclastic rocks and their metamorphosed equivalents.

Where derived from volcanogenic iron formation, the protore comprises beds of banded iron-rich rock, typically in volcanic-sedimentary sequences formed in tectonically active oceanic regions. Rock types include mafic to felsic submarine volcanic rocks (pillowed greenstones, intermediate to felsic tuffs and agglomerates) and poorly sorted, deep water clastic and volcaniclastic sediments. Typically banded on centimetre scale, with siliceous (chert) beds interlayered with iron-rich beds. Hematite, magnetite, siderite and quartz are the main minerals.

Geophysical signature: Magnetic anomalies.

Known deposits: Iron Range area.

Assessment criteria:

1. Upper, deeply chemically weathered surface of exhumed Precambrian iron formation.
2. Magnetic anomalies.
3. Oxide facies is the most important economically.

Assessment: **Areas FeA1 and FeA2 (Map 2)**

The Iron Range - Pascoe River area is the only example of this type of mineralisation in the CYPLUS area. Iron-manganese deposits occur in the Larrads Hill (Area FeA1) and Iron Range (Area FeA2) areas. There is a moderate resource potential for small iron ore deposits with a certainty level of D.

The deposits comprise residual iron-manganese cappings over steeply-dipping, stratabound lenses of banded iron formation ("jaspilite" — magnetite and hematite-bearing schist and quartzite) which trend 070° within the Sefton Metamorphics.

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The lenses locally contain traces of gold, possibly confined to small quartz veins in the schist.

They were investigated by the Broken Hill Pty Company Ltd between 1957 and 1962 and contain about 1.0Mt of indicated resources ranging from 54 to 62% iron (including manganese) and 300 000t of inferred resources containing 45 to 55% combined iron and manganese.

BHP identified two types of banded iron deposits in the area. The southern type is in the Lamond Hill area and comprises hematite and quartz with some magnetite and very minor manganese minerals. The northern type is in the Black Hill area and consists of magnetite and quartz with lesser amounts of manganese oxides, rhodochrosite, calcite, pyrite and pyrrhotite. Petrological studies have indicated that most rocks of the ore zones have been derived from ferruginous siltstones by low to medium-grade metamorphism; some of the ore lenses may be metamorphosed basic rocks. The rocks are folded along north-south axes and the banded iron has been subjected to en echelon faulting. Greenstones (altered and metamorphosed basic lavas) occur to the west. It is likely that the protore is of the volcanogenic iron formation type.

Highly oxidised manganese-rich residual cappings form an important part of the ore reserves. These cappings of massive ore may have formed by metasomatic replacement of silica, in iron-formation rocks, by iron and manganese oxides under the influence of meteoric water (Canavan, 1965). Scree has formed by mechanical breakdown of the massive ore and also forms an important proportion of the total resource; it is likely that some enrichment in manganese has resulted from recent precipitation of manganese from solution in surface waters.

The residual capping is approximately 3m thick. Below this is a 15 to 30m thick zone, with a lesser degree of oxidation, which overlies primary magnetite and hematite quartzite. Divisions between the zones are usually sharp.

The residual capping is characterised by low silica (<10%) and an iron plus manganese content of approximately 60%; the iron content ranges from 15 to 47% and the manganese content ranges from 8 to 45%. The main manganese oxides are psilomelane and pyrolusite. Below the surface capping, the manganese content is still significant but the silica content is 20 to 30%.

Economic significance: Deposits of this type are the main source of iron ore in Australia. The deposits at Iron Range are too small, too low grade and too isolated to be of economic significance.

Equivalent/ related deposit types: / sedimentary iron and manganese deposits; volcanogenic iron and manganese deposits; Homestake-type gold deposits and Kuroko massive sulphides are sometimes associated..

References:

Bruvel & Morwood (1992)
Canavan (1965)
Cox & Singer (1986)
Denaro & Morwood (1992a)
Eckstrand (1984)

BAUXITE (Bx)

Model BxA: Laterite type bauxite

Commodities, by products and trace metals: Beneficiated bauxite (for alumina and aluminium metal production), calcined bauxite.

Geological setting: Aluminous laterite formed by surficial weathering of Al-rich silicate rocks on well-drained plateaux in regions with warm-hot and wet climates.

Structural control: Silica content shows a marked relationship to present structural features and, to a lesser extent, to internal drainage patterns. The bauxite deposits are gently folded and considerable erosion has taken place on and around the crests of the folds.

Age: Cainozoic.

Deposit description: Flat to gently dipping surface deposits developed on Cretaceous to Tertiary sediments (particularly the Rolling Downs Group and interbedded kaolinitic clay and quartz sand of the "Weipa beds" and Bulimba Formation. The typical weathering profile is 20 to 35m deep and boundaries are gradational. The profile comprises:

- laterite zone — 0.5m soil, 1 to 5m bauxite, 1 to 2m ironstone;
- mottled zone — characterised by decreasing iron content with depth; stained by red and yellow iron oxides;
- pallid zone — relatively low in free iron oxides;
- saprolite zone — transition between pallid zone and unweathered sediments.

The bauxite is strongly pisolitic and generally loose and friable. Pisolites are <1mm to 20mm in diameter and consist of gibbsite (trihydrate) and boehmite (monohydrate), with minor kaolinite and quartz. They occur in a sandy matrix which, although bauxitic, has a high silica content (up to 12% total silica) in the form of sand and silt sized quartz grains.

Individual deposits are generally of small to medium size, but the more extensive and continuous deposits contain large resources.

Type area: Weipa Peninsula.

Geochemical signature: Al and Ga.

Known deposits: Known deposits are almost entirely restricted to the thicker Cretaceous and Tertiary sediments close to the present coastline. Known resources occur at Weipa, north of Weipa, in the Aurukun area, at Vrilya Point and in the Turtle Head Island - Escape River area.

Assessment criteria:

1. Presence of aluminous lateritic profile.
2. Alumina, silica and iron contents important in determining viability of deposits.

Assessment:

Area BxA1 (Map 1)

The Turtle Head Island - Escape River area has a moderate resource potential for small to medium deposits of lateritic bauxite with certainty level C. Small residuals of aluminous laterite are exposed in cliffs beneath dune sand on the north-east coastline of Turtle Head Island and along the coast from the Escape River south-east to about 1.5km north of Logan Jack Creek. The bauxite is a 0.3 to 5.0m thick, hard, red pisolitic to nodular material and overlies a ferruginous nodular band, grading downwards into partly iron-stained sediments. Pure gibbsite cores are rare within the pisolites and pisolites form a hard, fused mass which is generally very resistant to erosion. Comalco Aluminium calculated inferred resources of 230Mt of red bauxite (Goudie, 1977). The bauxite is too high in iron and silica to be currently commercially exploitable. Enterprise Exploration inferred a resource of 60Mt beneath up to 91m of dune sand on Turtle Head Island. The approximate average grade was reported to be 35 to 40% total available alumina and 12 to 15% silica (Evans, 1960).

A white, low-iron variety occurs in cliff faces on Turtle Head Island and on the mainland from White Beach to Sharp Point and in the headwaters of creeks in the area. Iron has been selectively leached, proportionally increasing silica and alumina. The silica content of this bauxite renders it unsuitable for alumina plant feed,

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but it is ideal for refractory grade bauxite. It occurs in low areas, below the permanent water table (Goudie, 1977).

Areas BxA2 and BxA3 (Map 1)

These areas to the west and southwest of Area BxA1 have a low resource potential for small deposits of lateritic bauxite with a certainty level of B, on the basis of favourable geology and being extensions of Area BxA1.

Area BxA4 (Map 1)

This extensive area east and south-east of Vrilya Point comprises a low, partly dissected and undulating plateau of laterite and bauxitic laterite. It has been assigned a moderate resource potential for small bauxite deposits with a certainty level of C. It is made up of a number of scattered, thin occurrences of bauxite. The average thickness is 1.4m (up to >4.0m) beneath an average 1.4m (up to >4.0m) of overburden. Significant boehmite occurs in the upper portion of the profile, with gibbsite pisolites below. The bauxite is quite strongly cemented and even indurated in places. The deposits do not compare favourably with the Weipa bauxite in terms of tonnage, chemistry, continuity and thickness.

The area was initially investigated by Altarama Search Pty Ltd, which identified a number of separate deposits with individual resources of 0.9 to 16.7Mt at <10% silica and >40% alumina (Clappison, 1972a, 1972b, 1972c). Maximal Mining Corporation Pty Ltd (Morroy, 1983) calculated an overall inferred resource of 100Mt (dry, +1.00mm) grading 44 to 45% total alumina and approximately 7% reactive silica.

Area BxA5 (Map 1)

This area has been assigned a high resource potential for small to medium bauxite deposits with a certainty level of C on the basis of a map in Evans (1975). The area is held under mining lease by Comalco Aluminium Ltd.

Area BxA6 (Maps 1 and 2)

This area extends between the Ducie and Jackson Rivers. It has a high resource potential for medium size bauxite deposits with a certainty level of B. Aluminium Laboratories Ltd calculated an inferred resource of 150Mt at 12.5% silica and 52% alumina for an area near the Dulhunty River. The southern part of the area is held under mining leases by Comalco Aluminium Ltd and Alcan South Pacific Pty Ltd. Resource figures for individual areas within these leases are confidential.

Area BxA7 (Maps 1 and 2)

This area between the Wenlock and Ducie Rivers has a high resource potential for small to medium bauxite deposits with a certainty level of B. Aluminium Laboratories Ltd calculated that there is an inferred resource of 150Mt at 12.5% silica and 52% alumina (Aluminium Laboratories Ltd, 1962). CRA Exploration Pty Ltd investigated an area at the head of Ling Creek (a right bank tributary of the Wenlock River) and calculated an indicated resource of 46.7Mt at >9% silica and 54% alumina (CRA Exploration Pty Ltd, 1972). This deposit comprises 0.7m of sandy soil over 1 to 4m of pisolitic bauxite. The occurrence of silica throughout the pisolites and the high clay content of the deposit reduce the potential for beneficiation.

The area is held under mining leases by Comalco Aluminium Ltd and Alcan South Pacific Ltd. For a part of its lease, Comalco calculated an inferred resource of 80.1Mt of unbeneficiated bauxite at 18.3% SiO_2, 49.4% Al_2O_3 and 7.7% Fe_2O_3 and 55.6Mt (+25 mesh fraction) at 16.0% SiO_2, 49.5% Al_2O_3 and 9.9% Fe_2O_3.

Area BxA8 (Map 2)

This extensive area between Albatross Bay and Port Musgrave has a high resource potential for large bauxite deposits with a certainty level of D. Most of the southern half is held under mining leases by Comalco Aluminium Ltd and Alcan South Pacific Ltd. It includes Comalco's bauxite mining operation at Andoom.

Aluminium Laboratories Ltd drilled five ore bodies in the headwaters of the Pine River and calculated an overall inferred resource of 57.1Mt at <7.5% silica and >45% alumina (Aluminium Laboratories Ltd, 1962); these deposits are now held by Alcan. Comalco's Andoom Mine provides approximately 70% of the bauxite treated at Weipa.

Area BxA9 (Map 2)

This small area at Duifken Point is held under mining lease by Comalco Aluminium Ltd and has a high resource potential for small bauxite deposits with a certainty level of C.

Area BxA10 (Map 2)

This area has a moderate resource potential for small bauxite deposits with a certainty level of B. It comprises a number of scattered remnants of aluminous laterite. CRA Exploration investigated one of these remnants and delineated an indicated resource of 1.4Mt at >9% silica and 54% alumina (CRA Exploration Pty Ltd, 1972). The company concluded that the deposit was not economic.

Area BxA11 (Map 2)

This area covers Comalco Aluminium Ltd's mining operation at Weipa. Comalco has total bauxite reserves of 248Mt (at >50% Al_2O_3) and a total resource of 3700Mt on its ML 7024. Most of this resource is likely to be in Areas BxA11 and BxA8. BxA11 has a high resource potential for large bauxite deposits with a certainty level of D.

Area BxA12 (Map 2)

This area south of Weipa has a high resource potential for small to medium bauxite deposits with a certainty level of C. Almost all of it is covered by a mining lease held by Comalco Aluminium Ltd. Austral Pacific Mining Corporation investigated two areas adjacent to this lease. The "ER Area" contains small areas of low grade pisolitic bauxite which form an overall inferred resource of 0.7Mt at <12% silica and >35% alumina. The "HR Area" averages 2.4m of bauxite with a maximum depth of 4.6m and contains an inferred resource of 14.5Mt at <15% silica and >35% alumina. The indicated resource is 7Mt at 7.5% silica and 44% alumina.

Area BxA13 (Map 2)

This area lies between Weipa and Aurukun and has a high resource potential for small to medium bauxite deposits with a certainty level of C. It is currently covered by mining leases held by Comalco Aluminium Ltd and Aluminium Pechiney Holdings Pty Ltd. Exploration has delineated a number of areas with indicated resources of 0.3 to 44.4Mt at grades of <8 to 10% silica and >40 to 50% alumina (Rawlins, 1973; Tipperary Land and Exploration Corporation, 1971).

Area BxA14 (Map 2)

This area to the east of Area BxA13 has been assigned a moderate resource potential for small bauxite deposits with a certainty level of B. Evans (1975) indicated that it comprises partially eroded, cemented, ferruginous pisolitic laterite which is bauxitic in places.

Area BxA15 (Map 2)

This area lies between the Watson and Archer Rivers, south of Aurukun, and has a high resource potential for small to medium bauxite deposits with a certainty level of C. It is held under mining lease by Aluminium Pechiney Holdings Pty Ltd. Tipperary Land and Exploration Corporation identified individual areas with inferred resources of 3.4 to 14.5Mt at grades of approximately 10% silica and 40 to 50% alumina (Tipperary Land and Exploration Corporation, 1971). The overall inferred resource for the area is at least 300Mt.

Area BxA16 (Map 2)

This area has a low resource potential for small bauxite deposits with a certainty level of B. Evans (1975) indicated that it comprises cemented ferruginous laterite which is bauxitic in places.

Area BxA17 (Maps 2 and 3)

This area on the southern side of the Archer River has a high resource potential for small to medium bauxite deposits with a certainty level of B. Tipperary Land and Exploration Corporation carried out exploration in the area and delineated inferred resources of 128Mt of pisolitic aluminous material. Indicated resources in three areas drilled were 16Mt at 52% alumina and 10.4% reactive silica (MacGeehan, 1972). The bauxite comprises an upper boehmite-rich zone and a

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lower zone consisting of gibbsite pisolites cemented by kaolinite. Bauxite is confined to areas where Tertiary arkosic sediments have been deeply weathered.

Areas BxA18 to BxA24 (Maps 2 and 3)

These areas have a low resource potential for small bauxite deposits with a certainty level of B. They are areas where ferruginous laterite is developed on the Late Cretaceous to Early Tertiary Bulimba Formation. Aluminous laterite is known to occur in places but there has been little exploration for bauxite deposits.

Economic significance:

Practically all of the world production of newly smelted aluminium metal is derived from bauxite, using the Bayer sodium hydroxide digestion process to form alumina. The alumina is smelted using the Hall-Heroult electrolytic method to provide chemically pure metal. Aluminium has low density, high electrical and thermal conductivity, corrosion resistance, and good malleability. It is commonly used in packaging, electrical goods, automotive and marine fabrication, and in light weight structural applications in the building industry. Small amounts of bauxite are processed for use as abrasives, refractories, and in chemical uses including water treatment, antiperspirants, and even as a leavening agent in bread.

The term "bauxite" is used for naturally occurring mixtures of aluminium monohydrate (boehmite or diaspore) and trihydrate (gibbsite), including impurities such as clay, free silica, iron hydroxides and titanium oxides. The grade of bauxite is variable, but bauxite must contain >45% Al_2O_3 to form a useable ore. The raw ore is beneficiated by simple wet screening to remove the fine clay and silica fraction. Ore grade parameters for the beneficiated product are generally loss on ignition after drying at 100° to 110°C, total percentage Fe_2O_3, total percentage SiO_2 and total percentage TiO_2. Table 9 lists the specifications for bauxite, according to its three main uses (Jones, 1993). Special parameters relating to the Bayer process include total chemical alumina, total available alumina, trihydrate alumina and reactive silica. Most bauxite is sold by long term contract. Calcined bauxite, used in refractories, cements, abrasives and chemicals, is sometimes sold by open market quotes.

The Weipa bauxite mine is one of the largest bauxite deposits in the world and is the world's largest single bauxite mining and shipping centre. It is the most significant deposit associated with deep weathering profiles in Queensland. It provides all of Queensland's bauxite production, which is 8 to 10% of Australian production. Australia produces 40% of the world's bauxite. Australia is the principal alumina producing country and the alumina refinery at Gladstone is the largest in the world. The Weipa mine is of vital importance to the economy of the Peninsula and Queensland. Production in 1992/93 was valued at $218 009 296.

Equivalent/ related deposit types:

/ laterite type kaolin.

References:

Cox & Singer (1986)
Culpeper (1993)
Denaro (1993)
Evans (1975)
Jones (1993)
Schaap (1990)

Table 9. Bauxite specifications.

Chemical content	Bauxite Uses		
	Metal production	Refractory (calcined)	Abrasive (calcined)
Al_2O_3	50-55%	min. 84.5%	80-88%
SiO_2	0-15%	max. 7.5%	4-8%
Fe_2O_3	5-30%	max. 2.5%	2-5%
TiO_2	0-6%	max. 4%	2-5%

KAOLIN (Ko)

Model KoA: Laterite type kaolin

Commodities, by products and trace metals: Kaolin, silica sand, heavy minerals (anatase, zircon, leucoxene, rutile, ilmenite, sphene, magnetite, monazite).

Geological setting: Pallid zone of aluminous laterite formed by surficial weathering of Al-rich silicate rocks on well-drained plateaux in regions with warm-hot and wet climates. Economic deposits are related to sandy clay sediments with underlying clayey sand aquifers. The best quality clays occur below the water table.

Age: Cainozoic.

Deposit description: Kaolin occurs in the pallid zone of the bauxitic laterite profile developed on the Weipa beds. Deposits are continuous clay lenses which are approximately 2 to 3km long, 300m wide and 4.5m in average thickness, and trend south-westerly. They overlie a shallow quartz sand aquifer. Top and bottom contacts are sharp.

The kaolin is mostly a white massive deposit with a dry bulk density of 1.5. It tends to become laminated towards the bottom of deposits. Quartz grains are randomly distributed throughout the kaolin, although there is some increase with depth. Vughs, cracks, fractures and iron staining are common. The fractures are slickensided and are coated with a thin brown, yellow or red crust of iron oxides. Blue-grey and pink mottling are also associated with the fractures.

The crude ore contains 70 to 90% kaolinite, 5 to 20% quartz sand, 0.1 to 0.3% hematite, 1.2 to 1.6% anatase and 1 to 3% muscovite. Accessory minerals include zircon, tourmaline, leucoxene, rutile, ilmenite, goethite, sphene, siderite, magnetite, apatite, monazite, andalusite, staurolite, spinel and halloysite.

Studies of the kaolin deposits at Weipa have indicated that the kaolin was laid down as a clay. The purity of the kaolin probably is a result of alterations which occurred during the formation of the laterite profile.

Type area: Weipa.

Known deposits: Weipa, Pennefather River, Skardon River.

Assessment criteria:

1. Presence of aluminous laterite profile.
2. Known kaolin mineralisation.

Assessment: This assessment has been restricted to areas with known kaolin mineralisation. There is potential for kaolin to occur wherever bauxite occurs but, because the distribution of the necessary sandy clay units (with underlying sand aquifers) is not known, these areas are considered to have unknown potential.

Area KoA1 (Maps 1 and 2)

This area around the Skardon River has a high potential for large kaolin deposits with a certainty level of D. The bauxitic section of the profile has been eroded in parts of this area, leaving a thin ironstone layer overlying the kaolin. Venture Exploration N.L. has delineated resources of 27Mt of raw kaolin with 15 to 50% <2μm kaolinite on its mining lease. There is approximately 8Mt of shippable kaolin averaging 32% <2μm kaolinite. The aluminium and iron contents are reportedly lower than the clay at Weipa and silica sand is a potential by product of processing.

Area KoA2 (Map 2)

Extensive kaolin deposits are reported to occur in the Pennefather River - Mapoon area. Comalco Aluminium currently hold Exploration Permits over the area and are actively investigating the kaolin potential. The area has been assigned a high resource potential for large kaolin deposits with a certainty level of B.

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Area KoA3 (Map 2)

This area covering the Weipa Peninsula has a high resource potential for large kaolin deposits with a certainty level of D. A lease held by Comalco Aluminium Ltd has proved and probable reserves of 17.8Mt, with a further 5.7Mt of possible ore available. Total resources may be as high as 50Mt. Paper coating grade kaolin is currently being mined from this area.

Economic significance:

Kaolin is a soft, fine, white clay composed mainly of kaolinite. It is used as a paper coater and filler, in the manufacture of ceramics and refractories, and as a filler in plastics, rubber, paints, insecticides, fertilisers, cosmetics and textiles. Other uses include absorbents, adhesives, cement, crayons, detergents, enamels, food additives, medicines and plaster.

Queensland produces one third of Australia's total kaolin, the majority coming from Weipa. At Weipa, paper coating grade kaolin is mined from areas where the overlying bauxite has been removed. Production in 1992/93 was valued at $20 726 799.

The kaolin product comprises kaolinite plus a small amount of anatase. It is characterised by a high brightness and an extreme fineness, with the average grainsize of the kaolinite crystals being around 0.2µm. The crude kaolin is turned into a slurry and degritted at a classification plant, and the slurry is pumped to the process plant where it is put through a high gradient magnetic separator and chemically leached to remove iron oxides and increase brightness. Finally, the slurry is dewatered, spray dried and shipped in bulk.

Silica sand is a potential by product of processing the kaolin.

Equivalent/ related deposit types:

/ laterite type bauxite.

References:

Cooper (1993c)
Culpeper (1993)
Sawers & Cooper (1985)
Schaap (1990)

SILICA (Si)

Model SiA: Silica sand dunes

Commodities, by products and trace metals:

Silica, ilmenite, zircon.

Geological setting:

Quaternary dunefields on east coast of Cape York Peninsula. Older dunes are formed by aeolian processes or progradation of sand barriers and foreshore dunes. Deep leaching of older sand masses has created a soil profile with a deep, white A_2 horizon of pure silica sand. This soil profile has been reworked to form active dunes of silica sand.

Age:

Quaternary.

Deposit description:

Silica sand occurs in high, transgressive, Pleistocene to Holocene dunefields averaging about 3km wide and reaching up to 15km inland, with average thicknesses from 25 to 30m.

Economic deposits generally are apical portions of active elongate parabolic dunes, formed by aeolian reworking of older, stabilised dunes in areas exposed to the prevailing south-easterly winds. Reworking leads to a reduction in iron and heavy mineral contents.

The sand consists almost entirely of quartz, with up to 0.75% (generally <0.05%) heavy minerals content. Most is not of glass quality because of light iron staining.

Dunes formed by wind action have grains winnowed by natural sorting into a narrow size range.

Type area: Cape Flattery.

Known deposits: Several known in Cape York Peninsula, but the most important are Cape Flattery and Shelburne Bay.

Assessment criteria:

1. Mapped extent of Quaternary dunefields.
2. Heavy mineral content.
3. Presence of reworked dunes.

Assessment: Only deposits in which silica sand is likely to be the major commodity are discussed here. Deposits of heavy mineral sands, where silica may be a potential by product, are discussed under "HEAVY MINERALS".

Area SiA1 (Map 1)

High quality sand suitable for glass manufacture occurs along the west coast of Newcastle Bay. There is a high resource potential for large silica sand deposits with a certainty level of C. Minsands Exploration Pty Ltd and A.O. (Australia) Pty Ltd drilled 32 holes to an average depth of 6m (Cooke, 1975). Seven samples contained 0.5% heavy minerals. These results were insufficient to reach any conclusions on the heavy mineral potential of the area.

Area SiA2 (Map 1)

High quality sand suitable for glass manufacture overlies bauxitic laterite on Turtle Head Island and from Sharp Point to Sadd Point. There is a high resource potential for large silica sand deposits with a certainty level of C.

The dunes on Turtle Head Island are up to 91m deep. Comalco Aluminium Ltd delineated a probable resource of >30Mt of high purity sand. Chemical analyses of samples gave 99.70 to 99.78% SiO_2, 0.011 to 0.014% Fe_2O_3, 0.04 to 0.06% Al_2O_3, 0.026 to 0.064% TiO_2, <0.01% CaO, <0.01% MgO, <0.001% Cr_2O_3 and 0.10 to 0.15% loss on ignition.

Area SiA3 (Map 1)

Extensive, shallow, windblown dunes of white sand extend inland for up to 10km in the Orford Bay - Orford Ness area. There is a moderate resource potential for large deposits with a certainty level of B. The deposits are unlikely to be economic because processing would be required to remove heavy minerals from the sand (White, 1991). The dunes are now within the Jardine River National Park.

Atarama Search Pty Ltd carried out hand auger and vacuum drilling of the dunes and adjacent beach sand in 1970. No significant concentrations of heavy minerals were found in the beach profiles. The heavy mineral content (mainly ilmenite and rutile) of the dune sands was generally <1% (Clappison, 1972d).

In 1974, A.O.G. Minerals Pty Ltd evaluated beach sands in the area. Beaches were hand auger sampled at approximately 2km spacing and six small heavy mineral deposits were found. All were thin, surficial concentrations and the total potential resource of five deposits was only 500m^3 of sand. One hole drilled to 3m depth in the coastal dunes returned <0.15% heavy mineral concentrates. The potential for significant deposits in the inland dunes was considered to be slight (Berman, 1975).

Area SiA4 (Map 1)

Extensive, shallow, windblown dunes of white sand extend inland for up to 9km in the Red Cliffs area. There is a moderate resource potential for large silica sand deposits with a certainty level of B. These dunes were drilled by Altarama Search Pty Ltd in 1970 and 1971 but the company did not consider the sand to be sufficiently pure for use as silica sand.

Altarama Search Pty Ltd found thin concentrations of heavy minerals in dune sands at the northern end of Shelburne Bay (Clappison, 1972d). Currumbin Minerals Pty Ltd drilled hand auger holes on present beaches in the Red Cliffs area and intersected sand with up to 0.43% heavy minerals from near the base of the frontal dunes. Heavy mineral contents decreased seawards (Jack, 1990a).

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Dunes north of Red Cliffs and beaches near Double Point contained only 0.05 to 0.09% heavy minerals. Concentrates comprised 27.5 to 33.6% ilmenite, 18.1 to 41.6% rutile, 22.2 to 38.1% zircon, and 8.7 to 10.2% other minerals. Currumbin minerals concluded that there was little likelihood of finding economic concentrations of heavy minerals in the area.

Area SiA5 (Maps 1 and 2)

The Olive River dunefield extends from the Olive River north to Shelburne Bay and inland for 15km; it covers an area of 550km^2 of a roughly triangular-shaped, low coastal plain. There is a high resource potential for large silica sand deposits with a certainty level of D.

The dunefield overlies Jurassic and Cretaceous quartzose rocks of the Carpentaria Basin. Theories on the genesis of the dunes differ from those for the Cape Flattery - Cape Bedford dunefield, and the Olive River dunes are thought to be much younger. Cape Grenville may have acted as an anchor point for the progradation of a sand barrier, with the resultant accumulation of the field (Cooper & Sawers, 1990).

The field is characterised by active parabolic and elongate parabolic dunes aligned parallel to the prevailing south-east winds and by older stabilised and lateritised dunes. The dunes consist almost entirely of quartz sand; heavy mineral content is 0.024 to 0.206% (mainly ilmenite and zircon).

In the central and northern areas, active parabolic and elongate parabolic dunes, with numerous shallow deflation lakes and swamps, are all well developed on a relatively low interdune sandplain. The north-eastern sector contains well vegetated, hummocky, degraded, older, stabilised and lateritised dunes, with a small area of white, active, elongate parabolic dunes which have been investigated as a source of silica sand. These dunes are over 80m high, and have a central deflation corridor and interdune lakes. Conical Hill and Saddle Hill are about 1.5km long and up to 250m wide. Major dunes in the north and north-west include Round Point and White Point.

In 1967 and 1968, Metals Exploration N.L. delineated a potential resource of 6Mt of high-grade sand with >99% SiO_2 to 12m depth at Shelburne Bay. From 1973 to 1977, A.C.I. delineated >200Mt of good quality glass making sand within 16km of Round Point.

More recent exploration by the Shelburne Silica Joint Venture on ML 5945 proved reserves of 8.76Mt of high quality sand at Conical and Saddle Hills, where a >40m thickness of white sand has been derived from aeolian reworking of well-developed podsolic A_2 horizons. There is 40Mt of probable reserves covered by mining lease tenure. Inferred resources are 143Mt (Cooper, 1993d).

The sand meets specifications for foundry moulding and glass manufacture. Cooper & Sawers (1990) gave a chemical analysis for Conical Hill sand of 99.80% SiO_2, 0.001% Fe_2O_3, 0.037% Al_2O_3, 0.013% TiO_2, 0.0001% Cr_2O_3, <0.01% CaO and <0.01% K_2O. Grainsize range is similar to that of sand currently mined at Cape Flattery.

The main known deposits are protected by a Department of Minerals and Energy Restricted Area.

Area SiA6 (Map 2)

Sand dunes along the western shore of Lloyd Bay have a low resource potential for medium-size deposits with a certainty level of B. These dunes have not been investigated as potential sources of silica sand.

Area SiA7 (Map 2)

A small dunefield in the Cape Direction area has a low resource potential for large deposits with a certainty level of B. These dunes have not been investigated as potential sources of silica sand.

Area SiA8 (Map 4)

Sand dunes in the Ninian Bay area have a low resource potential for large silica sand deposits with a certainty level of C. Dunes along the western side of the Bay

have been investigated and represent a silica sand resource that would require beneficiation to produce a marketable product. The bulk of the sand averages >99.5% SiO_2, but iron and titanium impurities exceed standards for glass manufacturing. There is an estimated 24m depth of sand in the main dune area and 12m in the low dunes. The area investigated is now within the Cape Melville National Park. An extensive area of vegetated dunes occurs to the south and southwest of Ninian Bay; these dunes have not been investigated.

Minsands Exploration Pty Ltd investigated the heavy minerals potential of the coastal dunes at Ninian Bay in 1975 and 1976. Four bulk samples were prepared from drillhole samples. No significant mineralisation was detected and the company concluded that the area has no economic heavy mineral potential (Minsands Exploration Pty Ltd, 1976).

Currumbin Minerals Pty Ltd drilled hand auger holes to 8m depth in low beach dunes and windblown dunes from Ninian Bay south to Saltwater Creek. Results were not encouraging for either cassiterite or heavy minerals. Heavy mineral contents were generally low (average 0.1%), with some irregularly distributed higher contents (up to 0.61%). The heavy mineral concentrates consisted mainly of ilmenite, with minor rutile and zircon (Jack, 1990b).

Area SiA9 (Map 4)

This small area at Red Point has a low resource potential for medium-size deposits with a certainty level of B. There is no information available on the quality or characteristics of the sand.

Area SiA10 (Map 4)

This area around the mouth of the Jeannie River has a low resource potential for large deposits with a certainty level of B. There is no information available on the quality or characteristics of the sand.

Area SiA11 (Map 4)

The Cape Flattery - Cape Bedford dunefield extends from Cooktown north to Lookout Point. It is 55km long, up to 22km wide, and covers an area of 580km^2. There is a high resource potential for large silica sand deposits with a certainty level of D.

The dunefield occupies a low-lying coastal plain, 5 to 10m above sea-level, and formed because of a local abundance of sand derived from Palaeozoic granites and Mesozoic sandstones and exposure to strong onshore winds. Quartz sand drifted north until trapped by the bedrock headlands of Cape Bedford, Cape Flattery and Lookout Point. Transgression of a rising sea in Pleistocene interglacial periods eroded frontal dunes and created a sand source by recycling the existing dunes (Cooper & Sawers, 1990).

The field consists predominantly of white, sharp-featured, active, transgressive parabolic and elongate parabolic dunes, and rounded degraded dunes stabilised by vegetation. The almost unidirectional south-easterly winds have resulted in dunes which are >7km long and only 0.5km wide. The apical sand mound can be up to 90m above the surrounding sand plain. The active dunes consist predominantly of quartz sand; heavy mineral content ranges from a trace to about 0.75% (mainly ilmenite).

Mining is currently carried out at the Cape Flattery Silica Mine, 60km north of Cooktown, where Cape Flattery Silica Mines Pty Ltd has proved reserves of 200Mt under mining lease (Cooper, 1993d); the potential resource in the area would be much greater. The optimum source of white silica sand is the bare apical mounds of the elongate parabolic dunes. The grainsize distribution is particularly suitable for glass manufacture and foundry moulding. Cooper & Sawers (1990) gave a chemical analysis for export quality sand of 99.82% SiO_2, 0.01% Fe_2O_3, 0.05% Al_2O_3, 0.02% TiO_2, <0.01% CaO, <0.01% MgO and 0.10% loss on ignition.

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Area SiA12 (Map 4)

Small, scattered areas of sand dunes occur on the northern side of the Endeavour River. There is a low resource potential for medium-size deposits with a certainty level of B. No information is available on the quality or characteristics of the sand.

Area SiA13 (Map 4)

Extensive deposits of white dune sand occur at Archer Point, south of Cooktown. There is a low resource potential for medium to large silica sand deposits with a certainty level of C.

The sands occupy a 4km by 3km area and form a thin veneer on sedimentary rocks of the Hodgkinson Formation. Martin (1980b) concluded that the fineness of the sand and the large variation in some size fractions render it unsuitable for use in glass making. The average grade is 97.8% SiO_2, 0.7% Fe_2O_3, 0.2% Al_2O_3 and 0.21% loss on ignition, making the sand chemically inferior to that at Cape Flattery.

Economic significance:

Queensland has large reserves of silica, mainly as silica sand in coastal deposits. More than 2Mt of silica sand is produced each year, mainly from the mine at Cape Flattery. The isolated location of deposits in Cape York Peninsula inhibits their use for the Australian market. Their utilisation depends mainly on the demand in south-east Asia. Queensland produces >65% of the total silica sand production of Australia. Silica sand produced at Cape Flattery in 1992/93 was valued at $21 317 096.

Silica sand is the most common of the industrial minerals. It is used in glass manufacture and as moulds and cores in foundry casting. In the chemical industry, sodium silicate produced from silica sand is a starting point for detergents, fillers and extenders in paints, rubber and plastics, for use in adhesives, sealants, in toothpaste, and in making silica gel. It is also an important component in ceramics and ceramic glazes and is a natural abrasive. Other uses include fused silica in optical and laboratory instrument glassware, cement manufacture, water filtration, and as a proppant to increase the permeability of oil and gas-bearing rock formations.

Foundry sand is required to have a grain size envelope between American Foundrymen's Society (AFS) sieve numbers 40 and 270 (425 to 53μm), with the size range being more precisely specified for particular moulding methods, and for either ferrous or non-ferrous metals.

Glass sand specifications require a range from less than No. 16 sieve (1160μm) to No. 140 sieve (106μm). For wet glass making, a fineness down to No. 270 sieve (53μm) can be tolerated.

Chemical specifications for foundry sand and glass sand demand minimum silica contents of 98% and 99.5%, respectively. Glass sand requires iron and other colourant minerals to be <150ppm, or 80ppm for high quality glass. Foundry sand requires low NaCl and $CaCO_3$ contents.

Silica sand is used extensively in the chemical industry to manufacture sodium silicate; high purity sand is specified. In practice, sand suitable for high quality glass manufacture is also suitable for chemical usage.

Equivalent/ related deposit types:

/ beach ridge titanium deposits.

References:

Cooper (1993a,d)
Cooper & Sawers (1990)
Culpeper & others (1992a)
Martin (1980b)
Sawers & Cooper (1985)
White (1991)

HEAVY MINERALS (Hm)

Model HmA: Shoreline placer heavy minerals

Commodities, by products and trace metals: Ilmenite, rutile, zircon, monazite, magnetite, leucoxene, xenotime, garnet, cassiterite, gold.

Geological setting: Well-sorted, medium to fine-grained sediments in dune, beach and inlet deposits, commonly overlying shallow marine deposits. Deposits require a stable coastal region with efficient sorting and winnowing, receiving sediment from deeply weathered metamorphic terranes of sillimanite or higher grade. Heavy minerals are concentrated by beach processes and enriched by weathering.

Age: Commonly Miocene to Holocene.

Deposit description: These are heavy mineral concentrations formed by beach processes and include beach placer, beach ridge and sand dune deposits. Surf action, primarily during storm activity, removes the lighter fraction, leaving elongate 'shoe-string' ore bodies of black sand parallel to coastal dunes and beaches. These deposits are often buried by later beach accretion. The heavy minerals are usually derived from high-grade metamorphic rocks and igneous rocks, or from sedimentary rocks derived from those rocks. Leaching of iron from ilmenite and destruction of labile heavy minerals results in residual enrichment of deposits.

Geochemical signature: High Ti, Zr, Th, U, rare earth elements. Anomalously high amounts of heavy minerals.

Geophysical signature: Gamma radiometric anomalies resulting from monazite content. Induced polarisation anomalies resulting from ilmenite.

Known deposits: Urquhart Point, Vrilya Point, Colmer Point.

Assessment criteria:

1. Appropriate coastal deposits.
2. Known distribution of heavy mineral concentrations.

Assessment: Only deposits in which heavy minerals are likely to be the major commodity are discussed here. Deposits of silica sand, where heavy minerals may be a potential by product, are discussed under "SILICA".

Area HmA1 (Map 1)

This area comprises beach ridges along the shore of Simpson Bay. There is a low resource potential for small deposits with a certainty level of B. Beach sands in this area might be expected to carry anomalous amounts of cassiterite draining from Laradeenya and Paterson Creeks.

Area HmA2 (Map 1)

Beach ridges between Mutee Head and Crystal Creek have a low resource potential for small deposits with a certainty level of B.

Areas HmA3 and HmA4 (Map 1)

White (1991) reported that heavy minerals occur in coastal sands at Vrilya Point. There is a moderate resource potential for small to medium size deposits with a certainty level of B.

Area HmA5 (Map 1)

Linear beach ridges occur parallel to the coastline from the Doughboy River south to Port Musgrave. There is a low resource potential for small deposits with a certainty level of B.

Areas HmA6 and HmA7 (Maps 1 and 2)

A narrow coastal strip of beach ridges extends from Port Musgrave south to Duifken Point. There is a low resource potential for small deposits with a certainty level of

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B. The most prospective area is the old Mapoon Mission site, which may represent a depositional environment similar to that at Urquhart Point.

Area HmA8 (Map 2)

A sizeable deposit of moderately high grade black sand occurs in beach ridges near Urquhart Point. There is a high resource potential for medium size deposits with a certainty level of C. The heavy mineral concentrates contain up to 80% rutile and zircon. Associated Minerals Consolidated Ltd currently holds a mining lease over the deposit.

Area HmA9 (Map 2)

Rutile and zircon occur in beach ridge deposits at the mouth of Norman Creek. These deposits are subeconomic. There is a moderate resource potential for small deposits with a certainty level of B.

Area HmA10 (Maps 2 and 3)

Holocene and Pleistocene beach ridges between Archer Bay and the Holroyd River have a low resource potential for small deposits with a certainty level of B. Altarama Search Pty Ltd drilled hand auger holes in beach sands in the Aurukun area but found no heavy mineral concentrations of any economic significance (Clappison, 1972e).

Area HmA11 (Map 3)

Beach sand and beach ridge deposits between the Holroyd and Nassau Rivers have a low resource potential for small deposits with a certainty level of B. Investigations of the Nassau, Mitchell, Coleman and Holroyd-Kendall River deltas by Latec Finance Pty Ltd in 1970 indicated that minor heavy minerals occur throughout this area but the potential for economic concentrations is extremely low (Barron, 1971).

Areas HmA12 and HmA13 (Map 1)

Beach ridges in the Newcastle Bay area have a low resource potential for small heavy mineral deposits with a certainty level of B.

Areas HmA14 and HmA15 (Map 2)

Beach ridges near the mouth of the Lockhart River have a low resource potential for small deposits with a certainty level of B.

Areas HmA16 and HmA17 (Map 2)

Beach ridges in the Cape Direction area have a low resource potential for small deposits with a certainty level of B.

Areas HmA18 to HmA20 (Maps 2, 3 and 4)

Holocene and Pleistocene beach ridges extend along the coastline from First Red Rocky Point south and around Princess Charlotte Bay to Bathurst Heads. There is a low resource potential for small deposits with a certainty level of B.

Auger hole sampling across beaches and sand banks by Mid East Minerals N.L. generally yielded <0.1% heavy minerals which averaged 65% ilmenite, 30% heavy silicates, and minor rutile and zircon (Zimmerman, 1969). Only at the mouth of the Nesbit River was the heavy mineral content >1% in any holes; here ilmenite formed 92% of the concentrates. Minor sampling of coastal sediments north of the Pascoe River by Consolidated Mining Industries Ltd gave similar results (Hughes, 1972).

Astrik Resources N.L. collected four samples of shoreline sand bank deposits in the Cape Sidmouth area. Assay results were 2100ppm Ce, 1100ppm Y, 360ppm Nb, 0.37% Zr and 1.73% Ti (Pyper, 1989b). There was evidence that economic grades might occur in berms close to the shoreline.

A.O. Australia Pty Ltd investigated low beach ridges around Princess Charlotte Bay in 1975. Hand auger samples returned only low heavy mineral contents. Although heavy mineral contents of 3.1% were recorded in a few places, the minerals present were exclusively magnetite and ilmenite (A.O. Australia Pty Ltd, 1976; Shannon, 1976).

BHP Minerals Ltd drilled two holes in a beach ridge north-east of Lilyvale in 1992. Quartz sand was intersected down to 8 to 12m, followed by an 8 to 14m thickness of coastal clay over Jurassic sandstone. A composite sample contained only 0.06% heavy minerals, comprising 60% zircon, 9% ilmenite, 8% leucoxene, 8% rutile and 15% other minerals (Darby, 1993b).

Areas HmA21 and HmA22 (Map 2)

These areas cover Pleistocene sand dune systems which are up to 3km wide and 100m above sea level. They may be fossil beach ridge systems. There is a high resource potential for a small to medium-size deposit with a certainty level of D.

Alberta Mines N.L. investigated these dunes as sources of silica sand in 1986. Reconnaissance sampling indicated that the sand may be suitable after processing (Frank, 1987).

Peko Wallsend Operations Ltd is currently investigating the dune systems, which are known to carry low grade concentrations of ilmenite, rutile, zircon and leucoxene; resource figures are currently confidential. The inferred resource of silica sand present is 192Mt (Cooper, 1993d).

Areas HmA23 to HmA25 (Map 4)

These beach ridge systems at Bathurst Bay, Cape Bowen and the mouth of the Starcke River have a low resource potential for small deposits with a certainty level of B.

In 1992, BHP Minerals Ltd carried out drilling in Area TiA23. A composite sample from four holes in a strandline 1.8km from the coast contained 0.09% heavy minerals, none of which are of economic interest (Darby, 1993a).

Economic significance:

Heavy mineral sands are Australia's sixth most important mineral export product; Australia is the largest producer in the world. Deposits of this type are the main source of ilmenite, rutile and zircon in Queensland. The only operating mine is on North Stradbroke Island, in south-east Queensland, which is the most important source of rutile, zircon and ilmenite concentrates in eastern Australia. Queensland supplies about half of Australia's production of rutile and one-quarter of zircon and is the second largest producer after Western Australia. The value of mineral sand concentrates produced in Queensland in 1992/93 was $50 033 210.

Ilmenite and rutile are natural ores of titanium. Leucoxene is a greyish white alteration product of ilmenite and consists of finely crystalline rutile. More than 95% of the world's mine production of titanium-bearing minerals is used to manufacture titanium dioxide pigment (titanium white), which is used as a white pigment in paint, rubber, plastics and paper, as well as in textiles, cosmetics, leather and ceramics. Minor quantities of rutile are used directly as coatings for welding electrodes and as a flux in smelter operations. Some ilmenite is used in sand blasting operations, in foundry moulds, and as a weighting agent in oil well drilling muds.

The remaining 4 to 5% of production is mainly used for making titanium metal. Titanium is primarily used in airframe structural parts, space craft, guided missiles and jet engine components. It is used in the industrial market (for its resistance to corrosion and lack of toxicity) in chemical and desalination plants, power station equipment, and food, medical and marine applications.

Zircon is the principal ore of zirconium. More than 90% of the zircon consumed in the western world is used in refractories, foundry sands and ceramics. Zircon is also used in ferroalloys, paint, pharmaceuticals and abrasives, as well as in leather tanning, chemical manufacture, and in the nuclear industry as reactor fuel containers. The chemical and nuclear industries require high-purity zirconium metal and also extract approximately 2% of the neutron absorbing hafnium contained in zircon.

Monazite is a rare earth phosphate. It is the principal ore of thorium and contains up to 30% thorium and variable amounts of the rare earth elements, particularly cerium, lanthanum and yttrium. Monazite from beach sands on the east coast of Australia generally contains about 6% ThO_2. Because of its thorium content, mon-

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azite is mildly radioactive and has potential as a nuclear fuel. Its main use is as a source of rare earth elements which are used in the glass industry for colouring, polishing and for ultraviolet-sensitive spectacle lenses, in the ceramics industry, as catalysts in the refining of petroleum, and as luminescent phosphor coatings for fluorescent lighting and on the screens of colour television tubes. Rare earth elements are also used in specialised permanent magnets with applications in mineral separation, oxygen sensors, microwave ferrites, lasers and hydrogen storage materials. Thorium is used as a nuclear fuel and in catalysts, welding electrodes, refractory moulds, ceramics, fabricated alloys and aero-space parts.

Xenotime is a yttrium phosphate which also contains other rare earth elements such as erbium and cerium, as well as thorium.

Equivalent/ related deposit types: / silica sand dunes, shoreline placer tin.

References:

Cooper (1990a,b)
Cooper (1993b,d)
Cox & Singer (1986)
Culpeper & others (1992a)
Mitchell (1993)
Wallis & Oakes (1990)

Model HmB: Alluvial placer heavy minerals

Commodities, by products and trace metals: Ilmenite, rutile, zircon, monazite, magnetite, leucoxene, xenotime, garnet, tantalite, cassiterite, gold.

Geological setting: Quaternary alluvial deposits derived from high-grade metamorphic rocks and igneous rocks, or from sedimentary rocks derived from those rocks. Deposits accumulate where gradients flatten and river velocities lessen, such as the inside of meanders.

Age: Cainozoic.

Deposit description: Heavy mineral deposits concentrated by the hydraulics of running water in modern and fossil stream channels.

Geochemical signature: High Ti, Zr, Th, U, rare earth elements. Anomalously high amounts of heavy minerals.

Geophysical signature: Gamma radiometric anomalies resulting from monazite content. Induced polarisation anomalies resulting from ilmenite.

Known deposits: River systems known to carry concentrations of heavy minerals include the Palmer, Red, Mitchell, King, Coleman, Alice, Coen, Stewart, Morehead, Laura, Kennedy, Normanby and Lockhart. In most cases, total heavy minerals constitute <1% of the alluvium and the volumes of material available are generally too low for a viable mining operation.

Assessment criteria:

1. Distribution of alluvial deposits, including abandoned stream channels.
2. Known distribution of heavy mineral concentrations.
3. Proximity to source rocks.
4. Radiometric anomalies.

Assessment: Only deposits in which heavy minerals are likely to be the major commodity are discussed here. Alluvial placer gold and tin deposits, where heavy minerals may be a potential by product, are discussed under "GOLD" and "TIN".

Area HmB1 (Map 2)

For most of its course, the Wenlock River gives a strong radiometric response. There is a low resource potential for small heavy mineral deposits with a certainty level of B.

Area HmB2 (Map 2)

The Archer and Coen Rivers give strong radiometric responses. There is a low resource potential for small heavy mineral deposits with a certainty level of B. Magnetite, zircon, garnet and monazite are known to occur in the alluvium of the Archer River. The Coen River is known to carry concentrations of magnetite, ilmenite, monazite and zircon.

Area HmB3 (Map 3)

The Holroyd River gives a strong radiometric response in the Ebagoola 1:250 000 Sheet area. There is a low resource potential for small deposits with a certainty level of B. The available radiometric surveys are inadequate for determining the resource potential of the river in the Holroyd 1:250 000 Sheet area.

Area HmB4 (Map 3)

The Edward and Coleman Rivers give strong radiometric responses in the Ebagoola 1:250 000 Sheet area. There is a low resource potential for small deposits with a certainty level of B. The available radiometric surveys are inadequate for determining the resource potential of the rivers in the Holroyd 1:250 000 Sheet area.

Astrik Resources N.L. investigated the alluvium of the Coleman River in the Musgrave area in 1987. Shallow surface sampling indicated a heavy mineral content of >5%, including a high rare earth element content (Pyper, 1989a). Follow-up drilling downgraded the prospects of the area.

Area HmB5 (Maps 2 and 3)

This area covers Massey, Goanna, Terrible and Balclutha Creeks and the Stewart River. There is a low resource potential for small deposits with a certainty level of B. Shallow surface sampling by several companies has indicated grades of 1 to 4% heavy minerals for alluvial deposits in this area. Monazite and xenotime contents are generally low. More detailed investigations have indicated that overall grades are not as high as indicated by the surface samples.

Area HmB6 (Map 3)

This area covers Dinner and Fifteen Mile Creeks and the Annie River. There is a low resource potential for small deposits with a certainty level of B. Talisman Mining and Exploration Pty Ltd investigated this area in 1988. Reconnaissance exploration indicated that the Annie River is moderately prospective for heavy mineral deposits, but no further work was carried out (Pyper, 1989c).

BHP Minerals Ltd carried out reconnaissance sampling in 1992; samples indicated very low total heavy mineral grades in stream sediments but generally good mineral assemblages. Follow-up drilling results were entirely negative, giving low total heavy mineral grades with unfavourable mineral assemblages (Darby, 1993b). Most holes were in the Lilyvale beds.

Area HmB7 (Map 3)

Radiometric anomalies occur along this stretch of Saltwater Creek. There is a low resource potential for small deposits with a certainty level of B.

Area HmB8 (Maps 3 and 4)

Radiometric anomalies occur along the Morehead River, but are mainly due to K-rich minerals. There is a low resource potential for small heavy mineral deposits with a certainty level of B. Shallow surface sampling by Astrik Resources N.L. indicated that heavy mineral sands in the river contain considerable xenotime. However, drilling and bulk sampling results downgraded the prospects of the area (Pyper, 1989a). The area delineated on Map 3 includes a palaeodrainage system shown on the Ebagoola regolith map.

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Area HmB9 (Map 3)

This area covers the Alice River and its tributaries Crosbie, Moon and Eight Mile Creeks in the Hann River 1:250 000 Sheet area. Alluvium along these streams gives a strong radiometric response, but this response is mainly due to K-rich minerals. There is a low resource potential for small deposits with a certainty level of B. The resource potential could not be delineated as readily in the Rutland Plains 1:250 000 Sheet area because of insufficient detail in the available radiometrics.

Astrik Resources carried out reconnaissance investigations in this area in the late 1980's. High scintillometer readings were noted and xenotime and monazite were found in heavy mineral concentrates. Drilling results indicated that heavy mineral grades were subeconomic and individual deposits were too small to warrant further work (Pyper, 1988).

BHP Minerals Ltd carried out reconnaissance sampling and drilling in the area in 1992. The main target was residual quartzose sand overlying the Bulimba Formation. The Bulimba Formation and Quaternary alluvium were secondary targets.

Reconnaissance stream sediment samples had very low heavy mineral contents, but the concentrates contained high percentages of rutile, monazite and xenotime. The residual sands were found to be up to 6m deep and typically contained 0.1 to 0.3% heavy minerals; most of the heavy minerals are not of economic interest (Darby, 1993c).

Area HmB10 (Map 3)

This stretch of the Palmer River is downstream of the Yambo Inlier and has an anomalous radiometric response, which is mainly due to K-rich minerals. There is a low resource potential for small deposits with a certainty level of B.

Jubilate Pty Ltd identified several areas with anomalous rare earth element mineralisation in 1987. Ilmenite, monazite, zircon and significant xenotime were identified in the concentrates. Preliminary concentrate samples assayed 0.38 to 2.45% cerium, 0.19 to 1.16% lanthanum, 0.07 to 0.32% thorium and 0.07 to 0.77% yttrium (Garside, 1988). Several localities with potential were delineated, including the area east of the King River, the central area drained by Pinnacles and Pine Tree Creeks, and the area immediately east of Artella Lagoon.

Area HmB11 (Maps 3 and 4)

In its headwaters, the Kennedy River has a strong radiometric response which may be due to K-rich minerals rather than monazite. There is a low resource potential for small heavy mineral deposits with a certainty level of B.

Preliminary investigations by Metcalfe Holdings Pty Ltd in 1986 indicated that a 30km long stretch of the river has potential for heavy mineral deposits. The alluvium averages 50m in width and 2.5m in depth. Heavy mineral concentrates contain gold, monazite, xenotime and minor rutile and zircon. Monazite and xenotime comprise 57.8 to 84.4% of the heavy minerals and the monazite:xenotime ratio averages 16.2:1. Subsequent detailed follow-up investigations indicated that economic mineralisation is confined to drainages; little or no reserves occur in terraces (Barron, 1990). The reserves delineated were insufficient to sustain a mining operation.

Economic significance:

Usually, deposits of this type do not contain sufficient resources to constitute major sources of heavy minerals. Potential exists for the supply of small quantities of heavy minerals to local markets, particularly where the heavy minerals can be produced as a by product of gold or tin mining.

Equivalent/ related deposit types:

/ alluvial placer gold, alluvial placer tin.

References:

Cooper (1990b)
Culpeper & others (1992a)

LIMESTONE (Ls)

Model LsA: High-calcium limestone

Commodities, by products and trace metals: Limestone, lime.

Geological setting: Shallow water marine sedimentary sequences or as allochthonous blocks in deeper water sequences. Extensive limestone outcrops occur in the Palaeozoic Chillagoe and Hodgkinson Formations.

Structural control: Deposits are not dependent on structural controls, except as related to uplift and erosion.

Age: Most are Palaeozoic; one Proterozoic example known.

Deposit description: Tend to occur as groups or belts of individual, outcropping limestone lenses within metasedimentary sequences.

Geochemical signature: No characteristic trace metals. Outcrop extents are well known.

Geophysical signature: Seismic techniques may help in determining the subsurface extent of individual lenses.

Known deposits: Melody Rocks, Mitchell River - Palmer River belt, Bolt Head.

Assessment criteria:

1. Presence of unaltered and unmineralised limestone outcrops.

Assessment:

Area LsA1 (Map 2)

Limestone crops out in sea cliffs at Bolt Head in the Temple Bay area. There is a low resource potential for small high-calcium limestone deposits with a certainty level of C. The limestone is coarsely crystalline and schistose, has a stratigraphic thickness of at least 100m, and is part of the Proterozoic Sefton Metamorphics. It is cut by calcite and quartz veins up to 125mm wide. Approximately 5% of the rock consists of quartz veins, thereby adversely affecting the overall grade. Broken Hill Pty Company Ltd estimated that there is only about 25 000t of limestone readily available (Broken Hill Proprietary Company Ltd, 1962). Hand-picked material, free of quartz veins, assayed 53.0% CaO, 1.2% MgO and 2.4% SiO_2. It is unlikely that the total resource would be >1Mt.

Area LsA2 (Map 4)

Six limestone lenses crop out in the Chillagoe Formation in this area north of Palmerville. There is a high resource potential for large high-calcium limestone deposits with a certainty level of B. The limestone is light to dark grey and massive. Chert, sediments and basalt occur interbedded with the limestone lenses. No data are available on the chemical composition of the limestone.

Area LsA3 (Map 4)

This area is a belt comprising numerous outcropping limestone lenses in the Chillagoe Formation. There is a high resource potential for large high-calcium limestone deposits with a certainty level of C.

The limestone normally is light to dark grey, massive and recrystallised in the vicinity of granite intrusives. Chert, sediments and basalt are interbedded with the limestone lenses. Inferred resources are approximately 1500Mt. No data are available on the chemical composition of the limestone.

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Area LsA4 (Map 4)

The Cooktown 1:250 000 geological map shows that limestone crops out at this location; nothing is known of its suitability for industrial use. There is a low resource potential for medium to large deposits of high-calcium limestone with a certainty level of B.

Area LsA5 (Map 4)

Queensland Metals Corporation Ltd currently hold a Mineral Development Licence over the Melody Rocks limestone deposit near Kings Plains. This deposit has a high resource potential for large high-calcium limestone deposits with a certainty level of D.

The limestone occurs as lenses in the Hodgkinson Formation in a 2700m by 700m area, with vertical exposures of up to 120m. Eight bodies are of potential economic interest and five are of major significance. The limestone is light grey, fine-grained and homogeneous. The five major lenses comprise approximately 900 000t/vertical metre of limestone at 55% CaO, <1.0% SiO_2, <0.4% MgO, <0.2% Fe_2O_3 and <0.4% Al_2O_3. Indicated resources are 100Mt of high to chemical grade limestone. The company has carried out feasibility studies on setting up a cement clinker plant at Archer Point. The high quality of the limestone would allow it to be marketed, not only for cement manufacture, but also for the chemical and mineral processing industries or agriculture.

Economic significance:

Limestone is an important mineral commodity and major commercial processes use limestone as a basic raw material. It contains varying proportions of other components such as sand grains, clays, oxides and other carbonates. The type and quantity of these impurities, along with the physical characteristics of the limestone (crystallinity, grainsize, and other features related to the original sedimentary, diagenetic and metamorphic history of the rock sequence), are important factors in the useability of the material in all industrial applications.

The chemical components of limestone which most often control its suitability for particular uses are its content of lime (CaO), silica (SiO_2), alumina (Al_2O_3), iron (Fe_2O_3) and magnesia (MgO). Specifications of other components sometimes need to be met. The physical property most often specified is the grainsize (or crystal size) of the stone.

The main industries in Queensland which consume limestone are the cement industry, the alumina industry, as a flux in the smelting of sulphide ores and iron and steel, the glass industry, users of burnt or hydrated lime, and users of crushed or pulverised limestone. Limestone is used in paper making, as rock dust in coal mines, in sugar mills and water treatment and as a filler and reinforcing pigment in plastics, paint and rubber. The direct value of raw and processed limestone produced in Queensland in 1992/93 was $23 245 365, but this can be multiplied many times when considering the value of the products which rely intrinsically on the use of limestone in their manufacture.

The deposits in the CYPLUS area (especially the Palmer River deposits) are isolated from existing markets. However, they form an important resource for any future development of the Peninsula.

References:

Denaro & Morwood (1992a)
Krosch (1990)
Toth & others (1993)

GEMSTONES (Gs)

Model GsA: ES-diamond model

Commodities, by products and trace metals: Diamonds, zircon, sapphire, garnet.

Geological setting: It is likely that the carbon source for ES-diamonds is within subducting unconsolidated forearc sediments. Diamonds form during active subduction, within a subducting slab which is up to a thousand degrees cooler than the surrounding mantle. The source rocks of oceanic crust and anoxic sediments forming the slab transform according to the prograde facies trend of lawsonite blueschist - eclogite - coesite eclogite - diamond eclogite. The slab is detached and is sampled much later by nephelenite or alkali basalt magmas which pass through on the way to the surface to form dykes and diatremes. Alternatively, the diamonds may be brought to the surface by tectonic excavation.

Age: Proterozoic to Cainozoic. Original ages equal the subduction event. Reset ages may be up to the age of diatreme emplacement or tectonic excavation.

Deposit description: Surface deposits may be high grade but could be small. Diamonds occur in eclogite lenses in prograded blueschist rock suites or within diatremes that have tapped the prograded blueschist/eclogite subduction slab at depth. Aluminous sediments may produce corundum-bearing mineral assemblages.

Geochemical signature: The diamonds appear to be dominantly of eclogitic affinity. Heavy mineral suites indicating a high PT regime. Na_2O 0.1wt% in garnets; TiO_2/Na_2O 2wt% in garnets; garnets may be strongly coloured orange brown to pink. Pyroxenes have 0.1wt% K_2O and elevated Na_2O and Al_2O_3. Elevated levels of Si, Ca, Fe, CO_2, Al, S, C, P, Ti, Ba and N are anticipated as common features of the sedimentary source rocks.

Assessment criteria:

1. Presence of nephelenite or alkali basalt intrusions and diatremes.
2. Topographic depressions and craters.
3. Microdiamonds in stream sediments.
4. May have associated corundum mineralisation.

Assessment:

Area GsA1 (Map 4)

Minor diamonds have been recovered during alluvial mining in the East and West Normanby, Little Palmer and Laura Rivers. Sediments in streams draining the Lakeland Downs area are anomalous in 'diamond indicator' heavy minerals (zircon, picro-ilmenite, chrome diopside, orthopyroxene, brookite, phlogopite, olivine, pyrope garnet, corundum (including sapphire and ruby) and chrome spinel). Exploration has centred on two maar structures (Tom's Hollow and Bull Hollow) which form topographic depressions in the McLean Basalt. These maars comprise bedded pyroclastics, agglomerate and alkaline (leucitite) basalt and are infilled with lacustrine crater sediments. Microprobe analyses have indicated that the spinels and garnets are kimberlitic and that the chrome diopside is probably kimberlitic. Bulk sampling has failed to recover any diamonds from the area.

There is a low resource potential for ES-diamonds with a certainty level of B.

Economic significance: Sapphires and zircons are known to occur in the Lakeland Downs area. These stones do not appear to be present in sufficient quantity or quality to allow an economic mining operation. However, the deposits may be of interest to the fossicker.

The discovery of a diamond-bearing diatreme in the area would be a significant find as no economic deposits of this type have been found in Queensland yet.

Equivalent/ related deposit types: / diamond placer deposits.

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References: Barron & others (1994)
Robertson (1993)

PHOSPHATE

The only known phosphate mineralisation in the CYPLUS area is in the Hodgkinson Formation in the Starcke River and Barrow Point areas; none of these occurrences has economic potential.

There is no potential for economic surface or near-surface phosphate deposits in the CYPLUS area.

COAL (C)

Within the CYPLUS area, coal is known to occur in Carboniferous, Permian and Mesozoic sediments (Denaro & Shield, 1993).

Coal deposits in Carboniferous and Permian strata are generally thin, steeply dipping, disrupted by shearing and faulting, and are of poor quality. They have little potential for economic development.

Better quality coal occurs in the Mesozoic sediments of the Laura Basin, but the seams are generally thin and occur at depth. Only one mineable deposit has been delineated by exploration to date and this deposit is shown on the mineral resource assessment maps. The Carpentaria Basin is considered to have less potential for the occurrence of economic coal deposits than the Laura Basin.

Area C1 (Map 4)

From 1978 to 1986, Utah Development Company delineated an underground coking coal resource in Jurassic sediments at Bathurst Range. A number of seams occur over a 140km^2 area (to maximum 400m overburden). Exploration has concentrated on one major seam (in the Dalrymple Sandstone) which is up to 2m thick and averages 1.6m. Resources have been variously quoted as 15Mt (Miezitis & Bain, 1991), 255Mt (White, 1991), and 157Mt (Queensland Department of Minerals and Energy, 1993). The deposit is currently covered by EPC 463, held by Bathurst Coal and Power Ltd. The coals are medium to low volatile, bituminous coking coal with a moderately high sulphur content (Hawkins & Williams, 1990). The coal can be washed to produce a low ash, high swelling product with good yield (Doyle & others, 1986).

PETROLEUM

The results of petroleum exploration in the CYPLUS area have been summarised by Denaro & Shield (1993). There is potential for petroleum to occur in the Laura and Carpentaria Basins, both of which are underexplored.

Laura Basin

Only five deep wells have been drilled in the basin thus far; all had hydrocarbon shows. Several 3m coal seams were logged in the Dalrymple Sandstone in GSQ Ebagoola 1 and it is this unit (0.82 to 12.90mass % total organic carbon — AMDEL, 1988) which is considered to be the most likely hydrocarbon source. The overlying Gilbert River Formation is more variable with regards to organic carbon and results range from 0.40 to 3.35 mass % (Hawkins & Williams, 1990). The Dalrymple Sandstone and Gilbert River Formation are dominated by a mixture of gas-prone (Type III) and oil-prone (Type II) vitrinite macerals.

The Dalrymple Sandstone is mature for hydrocarbon generation (0.7% Rv) in CBT Marina 1, CON Breeza Plains 1, CON Lakefield 1 and GSQ Ebagoola 1 (Hawkins & Williams, 1990).

The undifferentiated Permian sediments intersected in these wells display a low total organic carbon content and gas-prone (Type III) vitrinite is the dominant organic matter type. However, only 90m have been drilled thus far, and the unit in GSQ Ebagoola 1 is post mature for hydrocarbon generation.

The Dalrymple Sandstone and Gilbert River Formation have facies-controlled stratigraphic plays as fluviatile sandstone beds. The Dalrymple Sandstone has porosity (7 to 22%) and horizontal permeability (0.36 to 189mD) values that are slightly better than those for the Gilbert River Formation (6 to 18% and 1.3 to 106mD, respectively). However, both units are suitable reservoirs. An excellent seal is formed by the mudstones and siltstones of the Rolling Downs Group. Mudstone beds in the Dalrymple Sandstone and Gilbert River Formation may result in a local seal but the lateral continuity of these beds is unknown.

Flushing of reservoir units by meteoric ground water downgrades the hydrocarbon prospectivity of the basin. The reservoir units that are considered to be prospective for hydrocarbons are the same units that are considered to be prospective for ground water. Salt water was recovered from some water bores (the Fairview bores). Therefore, it may be possible that isolated pockets of hydrocarbons have escaped the extensive flushing that has occurred throughout the reservoir units. It is possible that flushing of this magnitude may have been avoided in fault-controlled traps such as those associated with the Palmerville Fault Zone, or anticlinal traps with a vertical closure >70m (Ranneft, 1968). As the basin has not been deeply folded, it is unlikely that many stratigraphic traps have attained this amount of vertical closure.

Other hydrocarbon play types to be considered are the Permian and possible Triassic sediments underlying the basin, and trapped half-graben structures on the western side of the basin. Only the upper 90m has been drilled and contains suitable sandstone and tuffaceous reservoir beds which are post mature for hydrocarbon generation. It is possible that a potential source rock underlies this sequence. A major problem, as with all Queensland Permian basins, is finding a regional seal that has not been eroded during Triassic uplift and erosion.

Carpentaria Basin

The Carpentaria Basin is buried to a sufficient depth to be considered marginally mature for the generation of hydrocarbons. In the case of one recently drilled petroleum well (COM Jackin Creek 1), all sediments below 150m were considered sufficiently mature for the generation of oil (McConachie & others, 1990). Although mature, the Jurassic Garraway/Helby beds and Gilbert River Formation are considered to be generally poor source rocks due to their lack of organic content. The carbonaceous beds and thin coal seams that occur in these units appear to be able to generate only subeconomic localised quantities of hydrocarbons. The overlying Rolling Downs Group has not been buried to sufficient depth to reach maturity for hydrocarbon generation.

The stratigraphic units with the highest prospectivity must be the unknown sequences lying in seismically-resolved grabens underlying the Carpentaria Basin. One such structure, the Olive River Graben has been fully investigated and evaluated. The study was warranted following the discovery of coal-bearing Permian sediments within the graben. Late Permian sandstones and siltstones containing coal stringers were deposited in a high sinuosity depositional environment. A seismic survey carried out in 1989 revealed that the sediments have not been buried to a sufficient depth to have generated oil.

The search continues for these graben structures in deeper areas of the basin such as the Weipa, Western Gulf and Staaten sub-basins. The depocentre of the entire basin lies offshore in the Western Gulf sub-basin and grabens in this region must be considered to be the most prospective.

High quality reservoir beds are abundant within the basin — both the Garraway/Helby beds and the Gilbert River Formation have laterally continuous sandstone beds with low clay contents. The Gilbert River Formation is the lowest unit to cover the entire basin, and must be considered as the primary reservoir target.

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Porosity and permeability measurements obtained from GSQ Weipa 1 indicate very good reservoirs — 12.9 to 25% porosity and 265 to 8000mD permeability for the Gilbert River Formation, and 19.1 to 23.2% porosity and 648 to 1003mD permeability for the Garraway beds (Derrington, 1988). A negative factor to be considered is that both units have been flushed by ground water.

The Permian sediments in the grabens have a high proportion of sandstone. However, not enough is known about their content to fully judge the quality of these reservoirs. A conglomeratic bed underlying these sandstones occurs in the Olive River Graben but its regional extent is unknown.

The Rolling Downs Group forms an excellent regional seal. Facies-controlled localised seals may exist within the Jurassic sandstone units. A seal at the top of the Permian sedimentary sequence, occurring in conjunction with coals and fine-grained carbonaceous beds, has not been fully evaluated.

Jurassic stratigraphic traps of anticlinal drape over basement highs have, from drilling thus far, failed to attain enough vertical closure to avoid flushing by ground water. Pinch-out plays of Garraway/Helby beds against basement highs are yet to be fully evaluated. However, flushing of this unit has been significant and a reasonable vertical closure must be found. Faulting in the basin has been too mild to produce adequate traps.

The Permian contains good source and seal units. Underlying, or possibly interbedded with these units, are potential reservoir beds. It is possible that some graben features have been exposed and eroded during Triassic uplift. However, it appears that, in the case of the Olive River Graben, coal occurs at the top of the Permian (a feature that is easily identifiable on deep seismic). These grabens become mature for hydrocarbon generation only in the depocentres of the major sub-basins and must be further evaluated by drilling.

Therefore, the most prospective regions for hydrocarbon exploration exist in the depocentres of the Weipa, Western Gulf and Staaten sub-basins.

SELECTED BIBLIOGRAPHY

ALUMINIUM LABORATORIES LTD, 1962: Report on AP 53M, Cape York, Australia, 1956–1961. Held by the Department of Minerals and Energy, Queensland as CR865.

AMDEL, 1988: AP 368P, Laura Basin source rock analysis. Held by the Department of Minerals and Energy as CR19194.

AMOS, B.J. & DE KEYSER, F., 1964: Mossman, Queensland., *1:250 000 Geological Series - Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

A.O. AUSTRALIA PTY LTD, 1976: AP 1523M, final relinquishment report, 1975. Unpublished Held by the Department of Minerals and Energy, Queensland as CR5441.

ARNOLD, G.O. & FAWCKNER, J.F., 1980: The Broken River and Hodgkinson Provinces. *In* Henderson, R.A., & Stephenson, P.J. (Editors): *The Geology and Geophysics of Northeastern Australia.* Geological Society of Australia, Queensland Division, Brisbane, 175–189.

BAIN, J.H.C., BLACK, L., BLEWETT, R., BULTITUDE, R., KNUTSON, J., MACKENZIE, D., PAIN, C., WILFORD, J., DOHRENWEND, J., SUN, S.S., TRAIL, D., VON GNIELINSKI, F. & WELLMAN, P., 1992: Cape York Peninsula update. *BMR Research Newsletter* **16**, 18–22.

BAIN, J.H.C., WITHNALL, I.W., OVERSBY, B.S. & MACKENZIE, D.E., 1990: North Queensland Proterozoic inliers and Palaeozoic igneous provinces — regional geology and mineral deposits. *In* Hughes, F.E. (Editor): *Geology of the Mineral Deposits of Australia and Papua New Guinea.* The Australasian Institute of Mining and Metallurgy, Melbourne, 963–978.

BALL, L.C., 1909: Cooktown coalfield. *Queensland Government Mining Journal,* **10**, 182–186.

BARRON, L.M., LISHMUND, S.R., OAKES, G.M. & BARRON, B.J., 1994: Subduction diamonds in New South Wales: implications for exploration in eastern Australia. *Geological Survey of New South Wales, Quarterly Notes,* **94**, 1–23.

BARRON, P., 1971: Final report, AP 845M, north Queensland. Held by the Department of Minerals and Energy, Queensland as CR3804.

BARRON, P.T.C., 1982: AP 3053M, Moa Island, second six monthly report, 22.11.81 to 20.5.82. Held by the Department of Minerals and Energy, Queensland as CR11849.

BARRON, P.T.C., 1990: AP 4403M, Mount Mulgrave, final report for the period ending 22.8.89. Held by the Department of Minerals and Energy, Queensland as CR21285.

BEARD, D., 1971: Report on investigations, AP 720M, north Queensland, for year ending 31.12.70. Held by the Department of Minerals and Energy, Queensland as CR4216.

BERMAN, D.A., 1975: Final report on Authority to Prospect 1448M, Shelburne Bay, Queensland. Held by the Department of Minerals and Energy, Queensland as CR5403.

BEST, J.G., 1962: Alluvial tin prospects in north Queensland. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record, 1962/12.

BLACK, L.P., BULTITUDE, R.J., SUN, S.S., KNUTSON, J. & BLEWETT, R.S., 1992: U-Pb analytical results for granitic rocks from the Coen Inlier, north Queensland. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record,* **1992/64**.

BLAKE, P.R., 1991: The sedimentary provinces of the Cape York Peninsula — Gulf of Carpentaria area. A summary of their geological history and mineral and energy resources. *Queensland Resource Industries Record,* **1991/16**.

BLEVIN, P.L. & CHAPPELL, B.W., 1992: The role of magma sources, oxidation states and fractionation in determining the granite metallogeny of eastern Australia. *Transactions of the Royal Society of Edinburgh: Earth Sciences,* **83**, 305–316.

BLEWETT, R.S., 1991: Regional mapping field database (REGMAP) status for the Coen Inlier, Cape York, 1990-91. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record,* **1991/31**.

BLEWETT, R.S., 1992: The structural and metamorphic geology of the Ebagoola 1:250 000 Sheet (SD54-12), Coen Inlier, Cape York Peninsula. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record,* **1992/67**.

BLEWETT, R.S. & VON GNIELINSKI, F.E., 1991a: Geology of the Coen Metamorphics with special reference to the Coen and Ebagoola shear zones. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record,* **1991/14**.

ISBN 0 7242 5286 1

BLEWETT, R.S. & VON GNIELINSKI, F.E., 1991b: New insights into the structural evolution of the Coen Inlier. *BMR Research Newsletter*, **14**, 14–15.

BLEWETT, R.S., TRAIL, D.S. & VON GNIELINSKI, F.E., 1992: The stratigraphy of metamorphic rocks of the Ebagoola 1:250 000 Sheet area in Cape York Peninsula, north Queensland. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record*, **1992/74**.

BROKEN HILL PROPRIETARY COMPANY LTD, 1962: Final report on Authority to Prospect 86M, Cape York, Queensland. Held by the Department of Minerals and Energy, Queensland as CR724.

BRUVEL, F.J., 1993: A decade of successful gold exploration in Queensland — 1982 to 1992. *Queensland Government Mining Journal*, **94** (July), 10–17.

BRUVEL, F.J., 1994: Gold. Queensland Mineral Commodity Report. *Queensland Government Mining Journal*, **95** (January), 10–23.

BRUVEL, F.J. & MORWOOD, D.A., 1992: Mineral occurrences — Cape Weymouth 1:100 000 Sheet area, Cape York Peninsula, Queensland. *Queensland Resource Industries Record*, **1992/4**.

BULTITUDE, R.J., 1993: Granites of the Cape Melville 1:250 000 Sheet area. *Queensland Geological Record*, **1993/10**.

BULTITUDE, R.J. & CHAMPION, D.C., 1992: Granites of the eastern Hodgkinson Province — their field and petrographic characteristics. *Queensland Resource Industries Record*, **1992/6**.

BULTITUDE, R.J. & CHAMPION, D.C., 1993: New and revised granite units in the eastern part of the Cooktown and northeastern part of the Mossman 1:250 000 Sheet areas, north Queensland. *Queensland Geological Record*, **1993/16**.

BULTITUDE, R.J. & DONCHAK, P.J.T., 1992: Pre-Mesozoic stratigraphy of the Maytown region. *Queensland Resource Industries Record*, **1992/5**.

BULTITUDE, R.J. & REES, I., 1994: Granulite facies rocks in Cape York Peninsula. *Queensland Government Mining Journal*, **95 (1109)**, 17–22.

BULTITUDE, R.J., CRANFIELD, L.C., HEGARTY, R.A., HALFPENNY, R.W., RIENKS, I.P. & DOMAGALA, J., 1985: Summary of results of field work in the Mossman and Atherton 1:250 000 Sheet areas, 1984 field season — RGMP progress report. *Geological Survey of Queensland, Record*, **1985/31**.

BULTITUDE, R.J., DONCHAK, P.J.T., DOMAGALA, J. & FORDHAM, B.G., 1993: The pre-Mesozoic stratigraphy and structure of the western Hodgkinson Province and environs. *Queensland Geological Record*, **1993/29**.

BULTITUDE, R.J., DONCHAK, P.J., DOMAGALA, J., FORDHAM, B.G. & CHAMPION, D.C., 1990: Geology and tectonics of the Hodgkinson Province, north Queensland. *In: Proceedings of the Pacific Rim Congress 1990, III*. The Australasian Institute of Mining and Metallurgy, Melbourne, 75–81.

BULTITUDE, R.J., DONCHAK, P.J., DOMAGALA, J., ROBERTSON, A.D., GRIMES, K.G. & JORGENSEN, P.J., 1991: Geology of the Cooktown 1:100 000 Sheet area, north Queensland. *Queensland Resource Industries Record*, **1991/7**.

BULTITUDE, R.J., GREEN, P.M. & DOMAGALA, J., 1987: Revision of the stratigraphy of the southwestern Hodgkinson Province. *Queensland Government Mining Journal*, **88**, 187–191.

BURROWS, P.E., 1991: Mine production data, Palmer Goldfield (compiled from Annual Reports of the Department of Mines, 1877–1981). *Queensland Resource Industries Record*, **1991/18**.

CANAVAN, F., 1965: Iron and manganese deposits of Iron Range. *In* McAndrew, J. (Editor): *Geology of Australian Ore Deposits*. Eighth Commonwealth Mining and Metallurgical Congress and the Australasian Institute of Mining and Metallurgy, Melbourne, 391–393.

CARR, A.F., 1975a: Pascoe River District, Q. *In* Traves, D.M., & King, D. (Editors): Economic Geology of Australia and Papua New Guinea, 2 — Coal. *Australasian Institute of Mining and Metallurgy, Monograph Series*, **6**, 56–57.

CARR, A.F., 1975b: Little River — Oakey Creek district, Q. *In* Traves, D.M., & King, D. (Editors): Economic Geology of Australia and Papua New Guinea, 2 — Coal. *Australasian Institute of Mining and Metallurgy, Monograph Series*, **6**, 251–252.

CHAMPION, D.C., BULTITUDE, R.J. & CHAPPELL, B.W., 1990a: Geochemistry of late Palaeozoic felsic I- and S-type tin granites of the Mt Surprise - Cooktown area, north Queensland. *Geological Society of Australia, Abstracts*, **25**, 275.

CHAMPION, D.C., CHAPPELL, B.W. & McCULLOCH, M.T., 1990b: Granites from the Hodgkinson Province, north Queensland; origin and implications for crustal evolution: isotopic and geochemical evidence. *Geological Society of Australia, Abstracts* **27**, 17.

CLAPPISON, D.J, 1972a: Annual report on exploration in AP 828M, year ended 31.12.71, Cape York Peninsula, Queensland. Held by the Department of Minerals and Energy, Queensland as CR4100.

CLAPPISON, D.J, 1972b: Annual report on exploration in AP 941M, Cape York Peninsula, Australia, year ended 31.12.71. Held by the Department of Minerals and Energy, Queensland as CR4105.

CLAPPISON, D.J, 1972c: AP 942M, Cape York, report on period ended 30.09.71; annual report on exploration in AP 942M, year ended 31.12.71, Cape York Peninsula, Queensland. Held by the Department of Minerals and Energy, Queensland as CR4106.

CLAPPISON, D.J., 1972d: Final report on exploration in AP 818M, Cape York Peninsula, Queensland. Held by the Department of Minerals and Energy, Queensland as CR4044.

CLAPPISON, D.J., 1972e: Final report on exploration in AP 870M, Cape York Peninsula. Held by the Department of Minerals and Energy, Queensland as CR4047.

COMMONWEALTH DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY, 1993: *Shoalwater Bay Military Training Area, Resource Assessment.* Commonwealth Department of Primary Industries and Energy, Canberra.

CONNAH, T.H., 1958: Summary report. Limestone resources of Queensland. *Queensland Government Mining Journal,* **59**, 743. (Also *Geological Survey of Queensland, Publication,* **292**, 20.

CONNAH, T.H., 1961: Beach sand heavy mineral deposits of Queensland. *Geological Survey of Queensland, Publication,* **302**.

COOKE, D.A., 1975: AP 1519M, Cape York Peninsula, report on joint venture with A.O. (Australia). Held by the Department of Minerals and Energy, Queensland as CR5698.

COOPER, J.A., WEBB, A.W. & WHITAKER, W.G., 1975: Isotopic measurements in the Cape York Peninsula area, north Queensland. *Journal of the Geological Society of Australia,* **22**, 285-310.

COOPER, W., 1990a: Queensland Mineral Commodity Report — rare earths. *Queensland Government Mining Journal,* **91**, 383-389.

COOPER, W., 1990b: Queensland Mineral Commodity Report — mineral sands. *Queensland Government Mining Journal,* **91**, 61-66.

COOPER, W., 1993a: Silica sand. Queensland Department of Minerals and Energy, Mineral Information Leaflet, **3**.

COOPER, W., 1993b: Mineral sands. Queensland Department of Minerals and Energy, Mineral Information Leaflet, **9**.

COOPER, W., 1993c: Kaolin. Queensland Department of Minerals and Energy, Mineral Information Leaflet, **10**.

COOPER, W., 1993d: Queensland Mineral Commodity Report — silica sand. *Queensland Government Mining Journal,* **94** (September), 7-15.

COOPER, W. & SAWERS, J.D., 1990: Cape Flattery and Shelburne Bay silica sand deposits. *In* Hughes, F.E. (Editor): *Geology of the Mineral Deposits of Australia and Papua New Guinea.* The Australasian Institute of Mining and Metallurgy, Melbourne, 1665-1667.

COVENTRY, R.J., HOPLEY, D., CAMPBELL, J.B., DOUGLAS, I., HARVEY, N., KERSHAW, A.P., OLIVER, J., PHIPPS, C.V.G. & PYE, K., 1980: The Quaternary of northeastern Australia. *In* Henderson, R.A., & Stephenson, P.J. (Editors): *The Geology and Geophysics of Northeastern Australia.* Geological Society of Australia, Queensland Division, Brisbane, 375-417.

COX, D.P. & SINGER, D.A. (Editors), 1986: Mineral deposit models. *United States Geological Survey, Bulletin* ,**1693**.

COX, S.F., ETHERIDGE, M.A. & WALL, V.J., 1987: The role of fluids in syntectonic mass transport, and the localisation of metamorphic vein-type ore deposits. *Ore Geology Reviews,* **2**, 65-86.

ISBN 0 7242 5286 1

CRA EXPLORATION PTY LTD, 1972: Preliminary study into the development of the Wenlock River bauxite deposits; AP 881M, feasibility study, Wenlock River bauxite, 1.10.72. Held by the Department of Minerals and Energy, Queensland as CR4431.

CRUIKSHANK, B.I., 1994: Stream sediment geochemistry of the Ebagoola 1:250 000 Sheet area, Cape York Peninsula, north Queensland. *Australian Geological Survey Organisation, Record,* **1994/8.**

CRUIKSHANK, B.I. & BUTROVSKI, D., 1994: *Ebagoola Stream Sediment Geochemical Atlas.* Australian Geological Survey Organisation, Canberra.

CULPEPER, L.G., 1993: Mineral occurrences — Carpentaria and Karumba Basins, Cape York Peninsula, Queensland. *Queensland Geological Record,* **1993/19.**

CULPEPER, L.G. & BURROWS, P.E., 1992: Mineral occurrences — Hann River 1:250 000 Sheet area, Cape York Peninsula, Queensland. *Queensland Resource Industries Record,* **1992/18.**

CULPEPER, L.G., DENARO, T.J., WILLMOTT, W.F., WHITAKER, W.G., BRUVEL, F.J., MORWOOD, D.A. & SHIELD, C.J., 1992a: A review of mineral exploration, Cape York Peninsula, 1969 to 1990. *Queensland Resource Industries Record,* **1992/10.**

CULPEPER, L.G., GARRAD, P.D. & BURROWS, P.E., 1992b: Mineral occurrences — Ebagoola 1:250 000 Sheet area, Cape York Peninsula, Queensland. *Queensland Resource Industries Record,* **1992/14.**

CULPEPER, L.G., DENARO, T.J., MORWOOD, D.A. & BURROWS, P.E., 1994: Mineral occurrences — Butchers Hill, Cooktown, Battle Camp and Kennedy Bend 1:100 000 Sheet areas, Cape York Peninsula, Queensland. *Queensland Geological Record* **1994/12.**

DAMPIER MINING COMPANY LTD, 1981a: AP 2098M, Cape Bowen, Report for six months ended 5th March 1981. Held by the Department of Minerals and Energy, Queensland as CR8992.

DAMPIER MINING COMPANY LTD, 1981b: AP 2098M, Cape Bowen, final report. Held by the Department of Minerals and Energy, Queensland as CR8993.

DARBY, P.R., 1993a: EPM 9078, Kalpower, Cape York, final report. Held by the Department of Minerals and Energy, Queensland as CR24545.

DARBY, P.R., 1993b: EPM 8796 (Violet Vale), 8797 (Lily Vale), final report. Held by the Department of Minerals and Energy, Queensland as CR24546.

DARBY, P.R., 1993c: EPM 8798, 8799, 8800 and 8801, Hann River, final report. Held by the Department of Minerals and Energy, Queensland as CR24434.

DASH, P.H., 1991: A review of mineral occurrence data collection for metallogenic studies. Unpublished thesis submitted for progression to Senior Geologist. Queensland Department of Minerals and Energy, Brisbane.

DASH, P.H. & CRANFIELD, L.C., 1993: Mineral occurrences — Rumula 1:100 000 Sheet area, north Queensland. *Queensland Geological Record,* **1993/17.**

DAVIDSON, C.N., 1972: AP 921M, Moa Island, Torres Strait, report for twelve months ended 31.12.71. Held by the Department of Minerals and Energy, Queensland as CR4121.

DAY, R.W., WHITAKER, W.G., MURRAY, C.G., WILSON, I.H., & GRIMES, K.G., 1983: Queensland geology, a companion volume to the 1:2 500 000 geological map (1975). *Geological Survey of Queensland, Publication,* **383.**

DE HAVELLAND, D.W., 1989: *Gold and Ghosts. Volume 4, Queensland Northern and Northwestern Districts.* Hesperian Press, Carlisle, Western Australia.

DE KEYSER, F. & LUCAS, K.G., 1968: Geology of the Hodgkinson and Laura Basins, north Queensland. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Bulletin,* **84.**

DENARO, T.J., 1993: Mineral occurrences — Torres Strait 1:250 000 Sheet area, Cape York Peninsula, Queensland. *Queensland Geological Record,* **1993/18.**

DENARO, T.J., 1994: Cape York Peninsula Land Use Strategy, Project NR04: Mineral Resource Inventory, project report. *Queensland Geological Record,* **1994/11.**

DENARO, T.J. & CULPEPER, L.G., 1992: The diverse mineral resources of Cape York. *Queensland Government Mining Journal,* **93**(September), 28–36.

DENARO, T.J. & MORWOOD, D.A., 1992a: Mineral occurrences — Temple Bay 1:100 000 Sheet area, Cape York Peninsula, Queensland. *Queensland Resource Industries Record,* **1992/13.**

DENARO, T.J. & MORWOOD, D.A., 1992b: Mineral occurrences — Lockhart River and Cape Sidmouth 1:100 000 Sheet areas, Cape York Peninsula, Queensland. *Queensland Resource Industries Record*, **1992/20**.

DENARO, T.J. & MORWOOD, D.A., 1992c: Mineral occurrences — Wenlock 1:100 000 Sheet area, Cape York Peninsula, Queensland. *Queensland Resource Industries Record*, **1992/21**.

DENARO, T.J. & SHIELD, C.J., 1993: Coal and petroleum exploration, Cape York Peninsula. *Queensland Geological Record*, **1993/15**.

DENARO, T.J., CULPEPER, L.G., MORWOOD, D.A. & BURROWS, P.E., 1993: Mineral occurrences — Coen, Rokeby and Silver Plains 1:100 000 Sheet areas, Cape York Peninsula, Queensland. *Queensland Geological Record*, **1993/9**.

DENARO, T,.J., CULPEPER, L.G., MORWOOD, D.A. & BURROWS, P.E., 1994a: Mineral occurrences — Helenvale 1:100 000 Sheet area, Cape York Peninsula, Queensland. *Queensland Geological Record*, **1994/13**.

DENARO, T,.J., CULPEPER, L.G., MORWOOD, D.A. & BURROWS, P.E., 1994b: Mineral occurrences — Laura 1:100 000 Sheet area, Cape York Peninsula, Queensland. *Queensland Geological Record*, **1994/14**.

DENARO, T.J., MORWOOD, D.A., DUGDALE, J.S. & GARRAD, P.D., 1992: Mineral occurrences — Cape Melville 1:250 000 Sheet area, Cape York Peninsula, Queensland. *Queensland Resource Industries Record*, **1992/1**.

DERRINGTON, E.A., 1988: GSQ Weipa 1 — preliminary lithologic log and composite log. *Queensland Department of Mines, Record*, **1988/10**.

DOMAGALA, J., ROBERTSON, A.D. & BULTITUDE, R.J., 1993:Geology of the Butchers Hill 1:100 000 Sheet area, northern Queensland. *Queensland Geological Record*, **1993/30**.

DONCHAK, P.J.T., BULTITUDE, R.J., ROBERTSON, A.D., HEGARTY, R.A. & HALFPENNY, R.W., 1992: Geology of the Helenvale and Mossman 1:100 000 Sheet areas, northern Queensland. *Queensland Resource Industries Record*, **1992/15**.

DOUTCH, H.F., 1976: The Late Cainozoic Karumba Basin, northern Queensland and southern New Guinea. *BMR Journal of Australian Geology and Geophysics*, **1**(2), 131–140.

DOWLING, K. & MORRISON, G., 1989: Application of quartz textures to the classification of gold deposits using north Queensland examples. *In* Keays, R.R., Ramsay, W.R.H., & Groves, D.I. (Editors): The Geology of Gold Deposits: the Perspective in 1989. *Economic Geology Monograph*, **6**, 342–355.

DOYLE, J., BALFE, P.E., BARTON, C.M., HOLDGATE, G.R., BOLGER, P.F., BLACK, T.M., BOWMAN, R.G. & SUTCLIFFE, G., 1986: Geological setting of deposits. *In* Martin, C.H. (Editor): *Australasian Coal Mining Practice*. Australasian Institute of Mining and Metallurgy, Melbourne, 29–51.

DUGDALE, J.S., 1991: A compilation of mine production data for the Cooktown, Thursday Island and Weipa Mining Districts from Annual Reports of the Department of Mines (1884–1988/89). *Queensland Resource Industries Record*, **1991/1**.

DUNSTAN, B., 1913; Queensland mineral index and guide. *Geological Survey of Queensland, Publication*, **241**.

ECKSTRAND, O.R. (Editor), 1984: Canadian mineral deposit types: a geological synopsis. *Geological Survey of Canada, Economic Geology Report*, **36**.

EVANS, H.J., 1975: Weipa bauxite deposit, Q. *In* Knight, C.L.(Editor): Economic Geology of Australia and Papua New Guinea; 1 — Metals. *The Australasian Institute of Mining and Metallurgy, Monograph Series*, **5**, 959–964.

EVANS, H.J., 1960: AP 116M, final report. Held by the Department of Minerals and Energy, Queensland as CR470.

EWERS, G.R. & CRUIKSHANK, B., 1993: Epithermal gold potential in the northern Coen Inlier. *AGSO Research Newsletter*, **18**, 1–2.

EWERS, G.R. & BAIN, J.H.C. (Editors), 1992: Preliminary map commentary, Australia 1:250 000 basement geology and regolith landforms, Ebagoola (SD54-12), Queensland. *Australian Geological Survey Organisation, Record*, **1992/71**.

FABRAY, J.F., 1982: AP 3173M, Wakooka Creek, report for six months ended April 28, 1982. Held by the Department of Minerals and Energy, Queensland as CR10517.

FORBES, M., 1986: AP 3838M, "Lookout", Cooktown, third six monthly and final report. Held by the Department of Minerals and Energy, Queensland as CR15622.

ISBN 0 7242 5286 1

FRANK, P.H., 1987: AP 4372M, Colmer Point, report for first six months. Held by the Department of Minerals and Energy, Queensland as CR17589.

GAIR, J.E., 1989a: Introduction. *In* Gair, J.E. (Editor): Mineral resources of the Charlotte 1 degree by 2 degree quadrangle, North Carolina and South Carolina. *United States Geological Survey, Professional Paper,* **1462**, 1–6.

GAIR, J.E., 1989b: Criteria for assessment of mineral-resource potential. *In* Gair, J.E. (Editor): Mineral resources of the Charlotte 1 degree by 2 degree quadrangle, North Carolina and South Carolina. *United States Geological Survey, Professional Paper,* **1462**, 51–55.

GARSIDE, F., 1988: Six monthly report, AP 4805M (Cooktown), period ending 2.1.88 and final report. Held by the Department of Minerals and Energy, Queensland as CR19023.

GIBSON, D.L., 1975: Auger drilling, Cape York Peninsula, 1974. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record, **1975/11**.

GIBSON, D.L., POWELL, B.S. & SMART, J., 1974: Shallow stratigraphic drilling, northern Cape York Peninsula, 1973. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record, 1974/76.

GIBSON, D.L., POWELL, B.S., DOUTCH, H.F., SMART, J. & GRIMES, K.G., 1973: Shallow stratigraphic drilling in the Carpentaria and Laura Basin, 1972. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record, **1973/77**.

GINGELL, B., 1956: Geology and mineral potential of Noble Island. Geological Survey of Queensland, Commodity File, **4-6-2**.

GOLDING, S.D., BULTITUDE, R.J., PETERS, S.G., MYERS, I.A. & DOWLING, K., 1990: Stable isotope constraints on genetic models for gold-quartz, antimony-gold-quartz, tin and tungsten-tin mineralisation, Hodgkinson Province, northern Queensland. *In: Proceedings of the Pacific Rim Congress 1990,* **III**, 325–335. The Australasian Institute of Mining and Metallurgy, Melbourne.

GOUDIE, J.C., 1977: Evaluation of bauxite at Escape River up to the end of 1971; SBML 5, Escape River, report on operations during 1972. Held by the Department of Minerals and Energy, Queensland as CR6180.

GREEN, P.M. & BULTITUDE, R.J., 1988: Aspects of turbidite deposition: Hodgkinson Formation, Queensland. *Queensland Government Mining Journal,* **89**, 435–440.

GREENFIELD, W.H., 1911: Sketch map of Cape York Peninsula Gold and Mineral Fields. *Geological Survey of Queensland, Publication,* **233**.

GREGORY, P.W. & ROBINSON, B.W., 1984: Sulphur isotope studies of the Mount Molly, Dianne and O.K. stratiform sulphide deposits, Hodgkinson Province, north Queensland. *Mineralium Deposita,* **19**, 36–43.

GREGORY, P.W., TAYLOR, R.G. & WHITE, A.H., 1980: Mineralisation in the Broken River and Hodgkinson Provinces. *In* Henderson, R.A., & Stephenson, P.J. (Editors): *The Geology and Geophysics of Northeastern Australia.* Geological Society of Australia, Queensland Division, Brisbane, 191–200.

GRIMES, K.G., 1977: Holroyd, Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

GRIMES, K.G., 1980: The Tertiary geology of north Queensland. *In* Henderson, R.A., & Stephenson, P.J. (Editors): *The Geology and Geophysics of Northeastern Australia.* Geological Society of Australia, Queensland Division, Brisbane, 329–347.

GRIMES, K.G. & WHITAKER, W.G., 1977: Walsh, Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

HALFPENNY, R.W. & HEGARTY, R.A., 1991: Geology of the South Palmer River 1:100 000 Sheet area (7865), north Queensland. *Queensland Resource Industries Record,* **1991/6**.

HAWKINS, P.J. & WILLIAMS, L.J., 1990: Review of the geology and economic potential of the Laura Basin. *Queensland Resource Industries Record* ,**1990/2**.

HEINRICH, C.A., 1990: The chemistry of hydrothermal tin (-tungsten) ore deposition. *Economic Geology,* **85**, 457–481.

HIGGINS, N.C., FORSYTHE, D.L., SUN, S-S. & ANDREW, A.C., 1987: Fluid and metal sources in the Mt Carbine tungsten deposit, north Queensland, Queensland. *In: Proceedings of the Pacific Rim 87 Congress; an International Congress on the Geology, Structure, Mineralisation and Economics of the Pacific Rim,* **1**, 173–177. The Australasian Institute of Mining and Metallurgy, Melbourne.

HODGSON, C.J., 1989: The structure of shear-related, vein-type gold deposits: a review. *Ore Geology Reviews*, **4**, 231-273.

HOLTHOUSE, H., 1967: *River of Gold — the Story of the Palmer River Gold Rush*. Angus and Robertson, Sydney.

HUGHES, K.K., 1970a: AP 526M, Cape York area, report on investigations, 1.9.68 to 31.12.70. Held by the Department of Minerals and Energy, Queensland as CR3113.

HUGHES, K.K., 1970b: AP 526M, Cape York Peninsula, final report, 1.1.70 to 31.8.70. Held by the Department of Minerals and Energy, Queensland as CR3343.

HUGHES, K.K., 1972: AP 511M, Lloyd Bay, progress report for period 1.1.71 to 31.12.71. Held by the Department of Minerals and Energy, Queensland as CR4213.

ISHAQ, S., 1985: Gold in Queensland. A review of production, exploration and potential. *Queensland Government Mining Journal*, **86**, 72-77.

JACK, R., 1990a: AP 5971M, east coast of Cape York, final report to 26.9.90. Held by the Department of Minerals and Energy, Queensland as CR22209.

JACK, R., 1990b: EPM 5975, east coast of Cape York, final report. Held by the Department of Minerals and Energy, Queensland as CR22211.

JACK, R.L., 1879a: On the progress of the search for coal in the Cook District. *Geological Survey of Queensland, Publication*, **6**, 1-2.

JACK, R.L., 1879b: Second report on the progress of the search for coal in the Cook District. *Geological Survey of Queensland, Publication*, **7**, 1-3.

JACK, R.L., 1882: Report on the Little River Coalfield, near Cooktown. *Geological Survey of Queensland, Publication*, **11**, 1-4.

JACK, R.L., 1887: Geological observations in the north of Queensland. *Geological Survey of Queensland, Publication*, **35**, 12-16.

JACK, R.L., 1895: Coal near Cooktown. *Geological Survey of Queensland, Publication*, **106**, 1-3.

JACK, R.L., 1922: *Northmost Australia. Three Centuries of Exploration, Discovery and Adventure in and around the Cape York Peninsula, Queensland*. George Robertson and Company, Melbourne.

JACKSON, C.F.V., 1902: Coal in the Cook district. *Queensland Government Mining Journal*, **3**, 510-512.

JONES, M.R., 1993: Bauxite. Queensland Department of Minerals and Energy. Mineral Information Leaflet, **6**.

JONES, T.R., MOELLER, T. & TRUELOVE, A.J., 1990: Collingwood tin deposit. *In* Hughes, F.E. (Editor): *Geology of the Mineral Deposits of Australia and Papua New Guinea*. The Australasian Institute of Mining and Metallurgy, Melbourne, 1549-1555.

KAY, J.R., 1982: A review of metalliferous mineralisation associated with Permian rocks in Queensland. *Queensland Government Mining Journal*, **83**, 353-362.

KAY, J.R., 1985: The exploration potential for copper, lead-zinc and silver in Queensland. *Queensland Government Mining Journal*, **86**, 211-220.

KAY, J.R., 1990: Metalliferous mineralisation in northeast Queensland. A review of the eighties and a view towards the nineties. *In*: *Proceedings of the Pacific Rim Congress 1990*, **III**, 645-654. The Australasian Institute of Mining and Metallurgy, Melbourne.

KINNANE, N.R., 1981: AP 1938M, Cooktown, report for six months to 9.5.81. Held by the Department of Minerals and Energy, Queensland as CR9367.

KNUTSON, J., BULTITUDE, R. & SUN, S.-S., 1994: Granitic rocks of the Coen and Cape Weymouth 1:250 000 Sheet areas, Cape York Peninsula, north Queensland: reconnaissance field, petrographic, and geochemical data. *Australian Geological Survey Organisation, Record*, **1994/9**.

KROSCH, N.J., 1985a: Tin and tungsten potential in Queensland. *Queensland Government Mining Journal*, **86**, 16-25.

KROSCH, N.J., 1985b: Limestone and marble in Queensland. *Queensland Government Mining Journal*, **86**, 65-70.

KROSCH, N.J., 1990: Queensland mineral commodity report — limestone. *Queensland Government Mining Journal*, **91**, 93-102.

KROSCH, N.J. & COOPER, W., 1990: Queensland mineral commodity report — sapphire. *Queensland Government Mining Journal*, **91**, 299-306.

ISBN 0 7242 5286 1

KWAK, T., 1986: Granites associated with W-Sn skarns. *In* Genesis of tin-tungsten deposits and their associated granitoids. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record,* **1986/10**.

LAM, J.S., 1993: A summary of mineral occurrences of the Mossman 1:100 000 Sheet area, north Queensland. *Queensland Geological Record,* **1993/13**.

LAM, J.S. & GENN, D.L.P., 1993: A summary of the mineral occurrences of the South Palmer River 1:100 000 Sheet area, north Queensland. *Queensland Geological Record,* **1993/26**.

LAM, J.S., DENARO, T.J., BURROWS, P.E. & GARRAD, P.D., 1991: A summary of the mineral occurrences of the Maytown 1:100 000 Sheet area (7765), north Queensland. *Queensland Resource Industries Record,* **1991/10**.

LAW, S.R., 1989: Geology of the eastern part of the Mossman and Helenvale 1:100 000 Sheet areas. Results of the 1987 field season. *Queensland Department of Mines Record,* **1989/5**.

LAYDEN, C.E., 1983: AP 2141M, Cape York Tin Prospect, report on activities for the period 12.6.82 to 12.12.82. Held by the Department of Minerals and Energy, Queensland as CR11394.

LEVY, I.W. & STOREY, N.J.M., 1990: Horn Island gold deposit. *In* Hughes, F.E. (Editor): *Geology of the Mineral Deposits of Australia and Papua New Guinea.* The Australasian Institute of Mining and Metallurgy, Melbourne, 1451–1454.

LORD, J.R. & FABRAY, J.F., 1990: Jeannie River Tin Prospects. *In* Hughes, F.E. (Editor): *Geology of the Mineral Deposits of Australia and Papua New Guinea.* The Australasian Institute of Mining and Metallurgy, Melbourne, 1545–1548.

LUCAS, K.G. & DE KEYSER, F., 1965a: Cooktown, Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

LUCAS, K.G. & DE KEYSER, F., 1965b: Cape Melville, Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

LUDINGTON, S., ORRIS, G.J. & COX, D.P., 1992: Methods of resource assessment. *In* United States Geological Survey and Servicio Geologico de Bolivia: Geology and mineral resources of the Altiplano and Cordillera Occidental, Bolivia. *United States Geological Survey, Bulletin,* **1975**, 218–219.

MACGEEHAN, P., 1972: Merapah, AP 549M, completion report. Held by the Department of Minerals and Energy, Queensland as CR4244.

MACKENZIE, D.E. & KNUTSON, J., 1992: Igneous rocks of the Ebagoola 1:250 000 Sheet area, Cape York Peninsula, north Queensland: field, petrographic, and geochemical data. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record,* **1992/75**.

MARTIN, J.E., 1979: Mineral potential of Timber Reserves 141 and 165, Cooktown–Daintree area. Geological Survey of Queensland, Record, 1979/6.

MARTIN, J.E., 1980a: Inspection of tin mining operations, Annan River Tinfield. Geological Survey of Queensland, Record, 1980/3.

MARTIN, J.E., 1980b: Investigation of dune sand at Archer Point, Cooktown. Geological Survey of Queensland, Record, 1980/4.

MCCONACHIE, B.A., FILATOFF, J. & SENAPATI, N., 1990: Stratigraphy and petroleum potential of the onshore Carpentaria Basin, Queensland. *The APEA Journal,* **30**, 149–164.

MCCONNELL, W.D., 1983: AP 2181M, Cannibal Creek, six monthly report ended 9.9.83. Held by the Department of Minerals and Energy, Queensland as CR12587.

MCCONNELL, W.D. & CARVER, R.N., 1984: AP 2181M, Cannibal Creek, six monthly report ended 9.3.84. Held by the Department of Minerals and Energy, Queensland as CR13235.

MCDONALD, L.K., 1982: AP 2960M, "The Tip", six monthly report for the period 30.9.81 to 30.4.82. Held by the Department of Minerals and Energy, Queensland as CR10601.

MCGAIN, A., 1982: Final report on AP 1924M. Held by the Department of Minerals and Energy, Queensland as CR10991.

MEATES, G.R., 1979: First relinquishment report as at 30.12.78 on AP 1889M, Bowden area, north Queensland. Held by the Department of Minerals and Energy, Queensland as CR7645.

MEYERS, N.A., 1969: Carpentaria Basin. *Geological Survey of Queensland, Report,* **34**.

MIEZITIS, Y. & BAIN, J.H.C., 1991: Cape York Peninsula: comments on mineral potential and availability of data as at January 1990. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record,* **1991/74**.

MIEZITIS, Y. & MCNAUGHT, I.S., 1987: Mineral resources and prospectiveness of the proposed world heritage listing of wet tropical rainforests area. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record, 1987/53.

MINSANDS EXPLORATION PTY LTD, 1976: AP 1553M, final and quarterly report for period up to 30th September 1976. Held by the Department of Minerals and Energy, Queensland as CR5796.

MITCHELL, G.C., 1993: Rare earths. Queensland Department of Minerals and Energy. Mineral Information Leaflet, **2**.

MORRISON, G.W., 1988: Palaeozoic gold deposits of northeast Queensland. *In* Morrison, G.W. (Editor): Epithermal and porphyry style gold deposits in north Queensland. *James Cook University of North Queensland, Economic Geology Research Unit, Contributions,* **29**, 11-21.

MORRISON, G.W., 1993: Paleozoic gold deposits of northeast Queensland. *In: Economic Geology of the Charters Towers Region. 1993 Field Conference.* Geological Society of Australia, Queensland Division, Brisbane.

MORROY, H., 1983: AP's 2894M, 2895M, Vrilya Point, report on six months to 15.02.83 and final report. Held by the Department of Minerals and Energy, Queensland as CR11810.

MORTON, C.C., 1924: Geology and mineral occurrences, Pascoe River district, Cape York Peninsula. *Queensland Government Mining Journal,* **25**, 78-83, 129-134.

MURDOCH, R. & FLEMING, G., 1981: AP 2200M, Barrow Point, final report. Held by the Department of Minerals and Energy, Queensland as CR9891.

MURRAY, C.G., 1990: Tasman Fold Belt in Queensland. *In* Hughes, F.E. (Editor): Geology of the Mineral Deposits of Australia and Papua New Guinea; 1 — Metals. The *Australasian Institute of Mining and Metallurgy, Monograph Series,* **5**, 1431-1450.

NEEDHAM, R.S. & DOUTCH, H.F., 1973a: Galbraith, Queensland. , *1:250 000 Geological Series Explanatory Notes, Sheet* **SE/54-3**.

NEEDHAM, R.S. & DOUTCH, H.F., 1973b: Rutland Plains, Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

ODINS, P.A., CORDERY, G.R. & SHEPPARD, N.F., 1987: AP 4414M, Noble Island, second six monthly report for the period 16th March 1987 to 16th September 1987 and final report. Held by the Department of Minerals and Energy, Queensland as CR17095.

OVERSBY, B.S., BLACK, L.P. & SHERATON, J.W., 1980: Late Palaeozoic continental volcanism in northeastern Queensland. *In* Henderson, R.A. & Stephenson, P.J. (Editors): *The Geology and Geophysics of Northeastern Australia.* Geological Society of Australia, Queensland Division, Brisbane, 247-268.

OVERSBY, B.S., PALFREYMAN, W.D., BLACK, L.P., COOPER, J.A. & BAIN, J.H.C., 1975: Georgetown, Yambo and Coen Inliers — regional geology. *In* Knight, C.L. (Editor): Economic Geology of Australia and Papua New Guinea; 1 — Metals. *The Australasian Institute of Mining and Metallurgy, Monograph Series,* **5**, 511-516.

PAIN, C.F. & OLLIER, C.D., 1992: Ferricrete in Cape York Peninsula, north Queensland. *BMR Journal of Australian Geology and Geophysics,* **13**, 207-212.

PARKINSON, G. (Editor), 1988: *Atlas of Australian Resources. Third Series. Volume 5. Geology and Minerals.* Australian Surveying and Land Information Group, Department of Administrative Services, Canberra.

PASSMORE, V.L., 1978: Laura Basin explanatory notes and stratigraphic correlations. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record, 1978/38.

PASSMORE, V.L., 1979: Carpentaria and Karumba Basins explanatory notes and stratigraphic columns. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record, **1979/22**.

PETERS, S.G., 1987: Geology, lode descriptions and mineralisation of the Hodgkinson Goldfield, northeastern Queensland. *James Cook University of North Queensland, Economic Geology Research Unit, Contributions,* **20**.

PETERS, S.G., 1991: Lode controls of the Hodgkinson goldfield, northeastern Queensland. *The Australasian Institute of Mining and Metallurgy, Proceedings,* **296**, 25-36.

ISBN 0 7242 5286 1

PETERS, S.G., 1993: Formation of oreshoots in mesothermal gold-quartz vein deposits; examples from Queensland, Australia. *Ore Geology Reviews*, **8**, 277-301.

PETERS, S.G., GOLDING, S.D. & DOWLING, K., 1990: Melange- and sediment-hosted gold-bearing quartz veins, Hodgkinson Gold Field, Queensland, Australia. *Economic Geology*, **85**, 312-327.

PHILLIPS, G.N. & POWELL, R., 1992: Gold-only provinces and their common features. *James Cook University of North Queensland, Economic Geology Research Unit, Contribution*, **43**.

PINCHIN, J., 1973: A geophysical review of the Carpentaria, Laura, and Olive River Basins. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record, 1973/132.

PLANET METALS, 1969: AP 544M, report on investigation of Mount Windsor Prospect. Held by the Department of Minerals and Energy, Queensland as CR2905.

POWELL, K.A. & SMART, J., 1977: Jardine River - Orford Bay, Queensland. *1:250 000 Geological Series Explanatory Notes*. Bureau of Mineral Resources, Geology and Geophysics, Australia.

PYPER, R., 1988: Combined six month and relinquishment report, AP 5007M, 5010M and 5012M, Alice River, Cape York, for period October 1987 to 22.12.87. Held by the Department of Minerals and Energy, Queensland as CR18462.

PYPER, R., 1989a: Annual reports, AP 5011M, Coleman River, for the period 27.10.87 to 27.04.88, and AP 5008M, Morehead River, for the period 27.10.87 to 27.10.88. Held by the Department of Minerals and Energy, Queensland as CR20257.

PYPER, R., 1989b: AP 5466M, Stewart northwest, partial relinquishment report for the period 29.6.88 to 29.6.1989. Held by the Department of Minerals and Energy, Queensland as CR22199.

PYPER, R., 1989c: AP 5117M, Balclutha Creek, relinquishment report for period 5.7.88 to 5.5.89. Held by the Department of Minerals and Energy, Queensland as CR21600.

QUEENSLAND DEPARTMENT OF MINERALS AND ENERGY, 1993: Queensland resources of black coal, July 1993. *Queensland Government Mining Journal*, **94**(October), 35-42.

RANDS, W.H., 1893: Geological observations in the Cooktown district. *Geological Survey of Queensland, Publication*, **91**, 1-5.

RANNEFT, T.S.M., 1968: Review of Authority to Prospect 135P, Laura Basin, Queensland. Held by the Department of Minerals and Energy, Queensland as CR20182.

RAWLINS, J.N., 1973: Final report on bauxite exploration of AP 838M, Weipa, Queensland, and final report on bauxite exploration south of AP 838M. Held by the Department of Minerals and Energy, Queensland as CR 557.

RICHARDS, D.N.G., 1980: Palaeozoic granitoids of northeastern Australia. *In* Henderson, R.A.,, & Stephenson, P.J. (Editors): *The Geology and Geophysics of Northeastern Australia*. Geological Society of Australia, Queensland Division, Brisbane, 229-246.

RICHARDS, J.R., WHITE, D.A., WEBB, A.W. & BRANCH, C.D., 1966: Isotopic ages of acid igneous rocks in the Cairns hinterland, north Queensland. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Bulletin*, **88**.

ROBERTS, R.G. & SHEAHAN, P.A. (Editors), 1990: *Ore Deposit Models*. Geoscience Canada, Reprint Series 3. Geological Association of Canada.

ROBERTSON, A.D., 1993: Cainozoic volcanism in the Butchers Hill 1:100 000 Sheet area (7866), north Queensland. *Queensland Geological Record*, **1993/12**.

SAWERS, J.D., 1990: Queensland Mineral Commodity Report. Base metals — Cu, Pb, Zn, Ag. *Queensland Government Mining Journal*, **91**, 267-271.

SAWERS, J.D. & COOPER, W., 1985: Some Queensland industrial minerals. *Queensland Government Mining Journal*, **86**, 188-195.

SCHAAP, A.D., 1990: Weipa kaolin and bauxite deposits. *In* Hughes, F.E. (Editor): *Geology of the Mineral Deposits of Australia and Papua New Guinea*. The Australasian Institute of Mining and Metallurgy, Melbourne, 1669-1673.

SHANNON, H., 1976: AP 1520M, final relinquishment report. Held by the Department of Minerals and Energy, Queensland as CR5482.

SHAW, R.D., FAWCKNER, J.F. & BULTITUDE, R.J., 1987: The Palmerville fault system: a major imbricate thrust system in the northern Tasmanides, north Queensland. *Australian Journal of Earth Sciences*, **34**, 69-93.

SHERATON, J.W. & LABONNE, B., 1978: Petrology and geochemistry of acid igneous rocks of northeast Queensland. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Bulletin,* **169**.

SMART, J., 1977a: Weipa, Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

SMART, J., 1977b: Aurukun, Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

SMART, J. & RASIDI, J.S., 1979: Geology and petroleum potential of the Laura Basin, Torres Shelf and Papuan Basin, Queensland. *Queensland Government Mining Journal,* **80**, 267–279.

SMART, J. & SENIOR, B.R., 1980: Jurassic-Cretaceous basins of northeastern Australia. *In* Henderson, R.A. & Stephenson, P.J. (Editors): *The Geology and Geophysics of Northeastern Australia.* Geological Society of Australia, Queensland Division, 315–328.

SMART, J., GRIMES, K.G., DOUTCH, H.F. & PINCHIN, J., 1980: The Carpentaria and Karumba Basins, north Queensland. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Bulletin,* **202**.

SMART, J., MORRISSEY, J.A. & HASSAN, S.E., 1975: Index to drill-hole data — Carpentaria, Laura, and Karumba Basins, Queensland. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record, 1975/167.

SOLOMON, M., GROVES, D.I. & KLOMINSKY, J., 1972: Metallogenic provinces and districts in the Tasman Orogenic Zone of eastern Australia. *Proceedings of the Australasian Institute of Mining and Metallurgy,* **242**, 9–24.

STEPHENSON, P.J., GRIFFIN, T.J. & SUTHERLAND, F.L., 1980: Cainozoic volcanism in northeastern Australia. *In* Henderson, R.A. & Stephenson, P.J. (Editors): *The Geology and Geophysics of Northeastern Australia.* Geological Society of Australia, Queensland Division, Brisbane, 349–374.

TAYLOR, G.F., 1990: The regolith and associated mineral deposits. *In* Hughes, F.E. (Editor): *Geology of the Mineral Deposits of Australia and Papua New Guinea.* The Australasian Institute of Mining and Metallurgy, Melbourne, 1569–1572.

TAYLOR, R.G., 1969: Low-grade tin ores in eastern Australia. *In* Fox, W. (Editor): *A Second Technical Conference on Tin, Bangkok, 1969.* International Tin Council and the Department of Mineral Resources of the Government of Thailand, Volume 1, 357–373.

TIPPERARY LAND AND EXPLORATION CORPORATION, 1971: Aurukun Bauxite Project, AP's 493M and 549M, summary progress report. Held by the Department of Minerals and Energy, Queensland as CR5695.

TOTH, M.I., WILSON, A.B., COOKRO, T.M., BANKEY, V., LEE, G.K. & CASE, J.E., 1993: Mineral resource potential and geology of the White River National Forest and the Dillon Ranger District of the Arapaho National Forest, Colorado. *United States Geological Survey, Bulletin* **2035**.

TRAIL, D.S. & BLEWETT, R.S., 1991: North Queensland Project 1990 reconnaissance of the Coen Inlier, Cape York Peninsula, Queensland. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record,* **1991/99**.

TREZISE, D.L., 1990: Building Stones – A Review of the Queensland Building Stone Industry. *Queensland Resource Industries Review Series.*

TRUELOVE, A.J., 1982: AP 1995M, Mount Romeo area, report on six months to 13.8.82. Held by the Department of Minerals and Energy, Queensland as CR11225.

TRUELOVE, A.J., 1986: AP 3898M, Six Mile Cooktown, combined final report and report for six months ended 23.11.85. Held by the Department of Minerals and Energy, Queensland as CR15316.

VANCE, W.E., 1965: AP 300M, Mount Windsor Tableland, junction of Prospect and Piccaninny Creeks, report for Hillgrove Construction Company. Held by the Department of Minerals and Energy, Queensland as CR1854.

VON GNIELINSKI, F.E. & BLEWETT, R.S., 1992: Regional mapping field data management system (REGMAP) data release for the Ebagoola 1:250 000 Sheet area, Coen Inlier, Cape York Peninsula. *Queensland Resource Industries Record* **1992/3**.

VON GNIELINSKI, F.E., DASH, P.H., ELLIOT, B.G. & EWERS, G.R., 1991: Preliminary mineral occurrence data for Cape York Peninsula. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record,* **1991/78**.

ISBN 0 7242 5286 1

WALLIS, D.S., 1991: Queensland Mineral Commodity Report — antimony. *Queensland Government Mining Journal*, **92**, 167–174.

WALLIS, D.S., 1993a: Antimony in Queensland - A Commodity Review and Metallogenic Study, April 1991. *Queensland Minerals and Energy Review Series.*

WALLIS, D.S., 1993b: Queensland Mineral Commodity Report — copper. *Queensland Government Mining Journal*, **94** (June), 11–26.

WALLIS, D.S., 1993c: Queensland Mineral Commodity Report — lead and zinc. *Queensland Government Mining Journal*, **94** (August), 6–21.

WALLIS, D.S. & OAKES, G.M., 1990: Heavy mineral sands of eastern Australia. *In* Hughes, F.E. (Editor): *Geology of the Mineral Deposits of Australia and Papua New Guinea.* The Australasian Institute of Mining and Metallurgy, Melbourne, 1599–1608.

WELLMAN, P., 1992a: Interpretation of Ebagoola aeromagnetic and gravity data. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record*, **1992/76**.

WELLMAN, P., 1992b: A geological interpretation of the regional gravity and magnetic features of north Queensland. *Australian Geological Survey Organisation, Record*, **1992/77**.

WELLS, A.T., 1989a: Late Permian coal measures beneath the Olive River Basin, Queensland. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Bulletin*, **231**, 171–173.

WELLS, A.T., 1989b: Permian coal measures in the sub-Laura Basin sequence, Little River - Oakey Creek district, Queensland. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Bulletin*, **231**, 179–183.

WHITAKER, W.G., 1975a: Coen and Yambo Inliers — mineralization; *In* Knight, C.L. (Editor): Economic Geology of Australia and Papua New Guinea; 1 — Metals. *Australasian Institute of Mining and Metallurgy, Monograph Series*, **5**, 518–521.

WHITAKER, W.G., 1975b: Mineralization in the Cape York — Torres Strait area. *In* Knight, C.L. (Editor): Economic Geology of Australia and Papua New Guinea; 1 — Metals. *Australasian Institute of Mining and Metallurgy, Monograph Series*, **5**, 799.

WHITAKER, W.G. & GIBSON, D.L., 1977a: Ebagoola, Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

WHITAKER, W.G. & GIBSON, D.L., 1977b: Coen, Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

WHITAKER, W.G. & GRIMES, K.G., 1977c: Hann River,Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

WHITAKER, W.G. & WILLMOTT, W.F., 1968: The nomenclature of the igneous and metamorphic rocks of Cape York Peninsula. Part I — the southern area. *Queensland Government Mining Journal*, **69**, 345–355.

WHITAKER, W.G. & WILLMOTT, W.F., 1969a: The nomenclature of the igneous and metamorphic rocks of Cape York Peninsula. Part II — the Coen-Iron Range area. *Queensland Government Mining Journal*, **70**, 131–142.

WHITAKER, W.G. & WILLMOTT, W.F., 1969b: The nomenclature of the igneous rocks of Torres Strait, Queensland. *Queensland Government Mining Journal*, **70**, 530–536.

WHITE, D., 1991: The mineral wealth and potential of Cape York Peninsula. *The Mining Review*, **15**(5), 2–10.

WILFORD, J.R., 1992: Regolith mapping using integrated Landsat TM imagery and high resolution gamma-ray spectrometric imagery — Cape York Peninsula. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Record*, **1992/78**.

WILLETT, G., 1979: AP 1933M, Coen area, half-year report on exploration program. Held by the Department of Minerals and Energy, Queensland as CR6846.

WILLMOTT, W.F. & POWELL, B.S., 1977a: Torres Strait-Boigu-Daru, Qld. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

WILLMOTT, W.F. & POWELL, B.S., 1977b: Cape Weymouth, Queensland. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Geology and Geophysics, Australia.

WILLMOTT, W.F., WHITAKER, W.G., PALFREYMAN, W.D. & TRAIL, D.S., 1973: Igneous and metamorphic rocks of Cape York Peninsula and Torres Strait. *Bureau of Mineral Resources, Geology and Geophysics, Australia, Bulletin,* **135**.

WITHNALL, I.W., BAIN, J.H.C. & RUBENACH, M.J., 1980: The Precambrian geology of northeastern Queensland. *In* Henderson, R.A., & Stephenson, P.J. (Editors): *The Geology and Geophysics of Northeastern Australia.* Geological Society of Australia, Queensland Division, Brisbane, 109–127.

WYBORN, L. & HEINRICH, C., 1993: Empirical observations on granite-associated gold ± base-metal mineral deposits in the Proterozoic of Australia. Delineating exploration criteria. *AGSO Research Newsletter*, **19**, 3–4.

WYNN, R.G., 1982: AP 2267M, Wenlock, report on exploration activities for the period 7.1.81 to 6.1.82. Held by the Department of Minerals and Energy, Queensland as CR10367.

ZIMMERMAN, D.O., 1969: Final report, AP 519M, east coast, Cape York, Queensland. Held by the Department of Minerals and Energy, Queensland as CR2887.

ISBN 0 7242 5286 1

APPENDIX 1

TENURE DETAILS, CURRENT MINING LEASES, CLAIMS AND MINERAL DEVELOPMENT LICENCES AS AT MARCH 1994

Tenure: MC 2864
Name: Crazy H
Commodities/purpose: Gold
Location: Ten Mile Creek
Status: Granted
Date of application: 05/09/88 **Date granted:** 10/11/88
Major mines/prospects: Ten Mile Creek
Mining activity: Not operating

Tenure: MC 3283
Name: 4 Mile
Commodities/purpose: Gold, silver
Location: Ebagoola Goldfield
Status: Granted
Date of application: 23/05/84 **Date granted:** 20/10/84
Major mines/prospects: Station Creek
Mining activity: Operating mine; small-scale.

Tenure: MC 3315
Name: Tub 1
Commodities/purpose: Gold, silver, tin, tantalum, tungsten, tailings/settling dam, treatment plant
Location: Granite Creek (south of Mount Bennett)
Status: Granted
Date of application: 05/06/86 **Date granted:** 07/10/86
Major mines/prospects: Granite Creek
Mining activity: Not operating

Tenure: MC 3331
Name: Red 1
Commodities/purpose: Gold
Location: Campbell Creek
Status: Granted
Date of application: 15/12/86 **Date granted:** 10/03/87
Major mines/prospects: Red Workings
Mining activity: Not worked recently; contains a low-grade ore stockpile which leaseholder plans to work by hand on an intermittent basis.

Tenure: MC 3419
Name: Mt Amos No. 1
Commodities/purpose: Tin, gold
Location: Mount Amos
Status: Granted
Date of application: 04/12/87 **Date granted:** 02/02/88
Major mines/prospects:
Mining activity: Camp/residence site

Tenure: MC 3420
Name: Mt Amos No. 2
Commodities/purpose: Tin, gold
Location: Mount Amos
Status: Granted
Date of application: 09/12/87 **Date granted:** 02/02/88
Major mines/prospects:
Mining activity: Camp/residence site

Tenure: MC 3425
Name: Dole Money
Commodities/purpose: Gold
Location: Spear Creek
Status: Granted
Date of application: 14/12/87 **Date granted:** 01/03/88
Major mines/prospects: Spear Creek
Mining activity: Little work done in last 2 to 3 years

Tenure: MC 5940
Name: Nelson
Commodities/purpose: Gold
Location: Coen Goldfield
Status: Granted
Date of application: 17/04/90 **Date granted:** 16/07/90
Major mines/prospects: Nelson
Mining activity: Operating mine; small-scale hard rock mine.

Tenure: MC 6168
Name:
Commodities/purpose: Gold, zircon
Location: West Normanby Goldfield
Status: Granted
Date of application: 13/07/90 **Date granted:** 04/12/90
Major mines/prospects: Tatlow Reef
Mining activity: To be surrendered?

Tenure: MC 6255
Name: XJS2
Commodities/purpose: Gold, silver
Location: Starcke No. 1 Goldfield
Status: Granted
Date of application: 27/04/90 **Date granted:** 23/10/90
Major mines/prospects: Cocoa Creek
Mining activity: Part of mining operation based on ML 40063

Tenure: MC 6256
Name: XJS1
Commodities/purpose: Gold, antimony
Location: Starcke No. 1 Goldfield
Status: Granted
Date of application: 03/04/90 **Date granted:** 23/10/90
Major mines/prospects: Cocoa Creek
Mining activity: Part of mining operation based on ML 40063

Tenure: MC 6257
Name: XJS3
Commodities/purpose: Gold, antimony
Location: Starcke No. 1 Goldfield
Status: Granted
Date of application: 27/04/90 **Date granted:** 23/10/90
Major mines/prospects: Cocoa Creek
Mining activity: Part of mining operation based on ML 40063

Tenure: MC 40004
Name: Chance
Commodities/purpose: Gold, silver
Location: Palmer River, east of Palmerville
Status: Granted
Date of application: 10/07/91 **Date granted:** 19/08/91
Major mines/prospects: Palmer River
Mining activity: Little to no current mining activity

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Tenure: MC 40005
Name: Worthwhile
Commodities/purpose: Gold, silver
Location: Palmer River, east of Palmerville
Status: Granted
Date of application: 10/07/91 **Date granted:** 19/08/91
Major mines/prospects: Palmer River
Mining activity: Little to no current mining activity

Tenure: MC 40006
Name: Never Know
Commodities/purpose: Gold, silver
Location: Palmer River, east of Palmerville
Status: Granted
Date of application: 31/07/91 **Date granted:** 05/09/91
Major mines/prospects: Palmer River
Mining activity: Little to no current mining activity

Tenure: MC 40007
Name: About Time
Commodities/purpose: Gold, silver
Location: Palmer River, east of Palmerville
Status: Granted
Date of application: 31/07/91 **Date granted:** 05/09/91
Major mines/prospects: Palmer River
Mining activity: Little to no current mining activity

Tenure: MC 40008
Name: Maria
Commodities/purpose: Gold
Location: Coen Goldfield
Status: Granted
Date of application: 20/03/92 **Date granted:** 15/05/92
Major mines/prospects:
Mining activity: Operating mine; very small scale.

Tenure: MDL 5
Name:
Commodities/purpose: Lime/limestone
Location: Melody Rocks
Status: Granted
Date of application: 11/10/90 **Date granted:** 19/12/92
Major mines/prospects: Melody Rocks Limestone
Mining activity: Limestone resources proved; no current activity.

Tenure: MDL 111
Name:
Commodities/purpose: Tin, gold, silver, copper
Location: Collingwood
Status: Granted
Date of application: 19/09/91 **Date granted:** 01/04/92
Major mines/prospects: Collingwood Tin Prospect
Mining activity: Not operating; care and maintenance.

Tenure: MDL 112
Name:
Commodities/purpose: Tin, gold, silver, copper
Location: Collingwood
Status: Granted
Date of application: 19/09/91 **Date granted:** 01/04/92
Major mines/prospects: Collingwood Tin Prospect
Mining activity: Not operating; care and maintenance.

Tenure: MDL 127
Name:
Commodities/purpose: Tungsten
Location: Head of Desailly Creek
Status: Granted
Date of application: 16/06/92 **Date granted:** 20/10/92
Major mines/prospects: Watershed Grid Scheelite
Mining activity: Extensive exploration of Watershed Prospect; mining has not yet commenced.

Tenure: MDL 131
Name:
Commodities/purpose: Gold, arsenic, silver, copper, lead, zinc
Location: McIlwraith Range
Status: Granted
Date of application: 11/09/92 **Date granted:** 14/12/92
Major mines/prospects: Mullimbidgee
Mining activity: Some testing in 1993; access by helicopter.

Tenure: MDL 132
Name:
Commodities/purpose: Gold, arsenic, silver, copper, lead, zinc
Location: McIlwraith Range
Status: Granted
Date of application: 11/09/92 **Date granted:** 14/12/92
Major mines/prospects: Mullimbidgee
Mining activity: Some testing in 1993; access by helicopter.

Tenure: ML 2796
Name: Collingwood
Commodities/purpose: Tin
Location: Collingwood
Status: Granted
Date of application: 21/11/67 **Date granted:** 11/04/83
Major mines/prospects: Collingwood Tin Prospect
Mining activity: Not operating; adit excavated for underground investigations; care and maintenance.

Tenure: ML 2806
Name: Turner Lease
Commodities/purpose: Silica, monazite, rutile, zircon
Location: Cape Flattery
Status: Granted/renewal
Date of application: 29/06/70 **Date granted:** 01/08/74
Major mines/prospects: Cape Flattery Silica Sand
Mining activity: Current mining operation

Tenure: ML 2807
Name: Eden Lease
Commodities/purpose: Silica, monazite, rutile, zircon
Location: Cape Flattery
Status: Granted/renewal
Date of application: 22/12/70 **Date granted:** 17/10/74
Major mines/prospects: Cape Flattery Silica Sand
Mining activity: Mining reserves

Tenure: ML 2808
Name: Shirley
Commodities/purpose: Tin
Location: Mount Poverty
Status: Granted/renewal
Date of application: 25/06/71 **Date granted:** 02/05/74
Major mines/prospects:
Mining activity: Intermittent mining activity; small-scale, one-man operation.

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Tenure: ML 2810
Name: Dianne
Commodities/purpose: Copper, zinc, silver, cadmium, cobalt
Location: Dianne Copper Mine
Status: Granted/renewal
Date of application: 29/12/65 **Date granted:** 24/04/74
Major mines/prospects: Dianne Copper Mine
Mining activity: Not operating

Tenure: ML 2811
Name: Dianne Extended
Commodities/purpose: Copper, zinc, silver, cadmium, cobalt
Location: Dianne Copper Mine
Status: Granted/renewal
Date of application: 27/09/66 **Date granted:** 24/04/74
Major mines/prospects: Dianne Copper Mine
Mining activity: Not operating

Tenure: ML 2827
Name: Nolan
Commodities/purpose: Tin
Location: Nolans Creek
Status: Granted
Date of application: 18/04/68 **Date granted:** 12/09/89
Major mines/prospects: Nolans Creek
Mining activity: Last worked 1991/92

Tenure: ML 2831
Name: Enterprise 1
Commodities/purpose: Copper, lead, zinc, gold, silver
Location: Dianne Copper Mine
Status: Granted/renewal
Date of application: 03/07/72 **Date granted:** 02/08/73
Major mines/prospects: Dianne Copper Mine
Mining activity: Not operating

Tenure: ML 2832
Name: Enterprise 2
Commodities/purpose: Copper, lead, zinc, gold, silver
Location: Dianne Copper Mine
Status: Granted
Date of application: 03/07/72 **Date granted:** 15/11/73
Major mines/prospects: Dianne Copper Mine
Mining activity: Not operating

Tenure: ML 2833
Name: Enterprise 3
Commodities/purpose: Copper, lead, zinc, gold, silver
Location: Dianne Copper Mine
Status: Granted
Date of application: 03/07/72 **Date granted:** 15/11/73
Major mines/prospects: Dianne Copper Mine
Mining activity: Not operating

Tenure: ML 2834
Name: Enterprise 4
Commodities/purpose: Copper, lead, zinc, gold, silver
Location: Dianne Copper Mine
Status: Granted
Date of application: 03/07/72 **Date granted:** 15/11/73
Major mines/prospects: Dianne Copper Mine
Mining activity: Not operating

Tenure: ML 2835
Name: Peninsula Hope
Commodities/purpose: Gold, silver
Location: Iron Range
Status: Granted
Date of application: 13/03/73 **Date granted:** 06/06/74
Major mines/prospects: Peninsula Hope
Mining activity: Not operating

Tenure: ML 2836
Name: Iron Range
Commodities/purpose: Gold, silver
Location: Iron Range
Status: Granted
Date of application: 13/03/73 **Date granted:** 01/08/74
Major mines/prospects: Iron Range, Woolmill, Iron Clad
Mining activity: Not operating

Tenure: ML 2845
Name: Fiery Creek 2
Commodities/purpose: Gold, tin
Location: Fiery Creek (South Palmer River area)
Status: Granted
Date of application: 10/08/73 **Date granted:** 22/08/74
Major mines/prospects: Fiery Creek
Mining activity: Not operating

Tenure: ML 2846
Name: Tin Creek South
Commodities/purpose: Tin, gold
Location: Tin Creek (The Granites area)
Status: Granted
Date of application: 10/08/73 **Date granted:** 29/08/74
Major mines/prospects:
Mining activity: Not operating

Tenure: ML 2847
Name: Nine Mile Creek
Commodities/purpose: Gold, tin
Location: The Granites area
Status: Granted
Date of application: 10/08/73 **Date granted:** 03/10/74
Major mines/prospects: Nine Mile Creek
Mining activity: Not operating

Tenure: ML 2849
Name: Nancarrow
Commodities/purpose: Loading facilities, stockpile ore/overburden, transport/conveyor/vehicular
Location: Cape Flattery
Status: Granted
Date of application: 03/09/73 **Date granted:** 10/10/74
Major mines/prospects: Cape Flattery Silica Sand
Mining activity: Operating mine

Tenure: ML 2857
Name: Anna
Commodities/purpose: Gold, bismuth, tin, tantalum, tungsten
Location: Palmer River - Dirty Dick Creek
Status: Granted
Date of application: 16/07/74 **Date granted:** 06/03/75
Major mines/prospects: Palmer River
Mining activity: No recent mining activity

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Tenure: ML 2859

Name: Palmer River Kiplings Bend
Commodities/purpose: Gold, ilmenite/leucoxene, monazite, platinum, andalusite, rutile, tin, tantalum, tungsten, yttrium/xenotime, zircon
Location: Palmer River
Status: Granted
Date of application: 09/12/74 **Date granted:** 21/08/75
Major mines/prospects: Palmer River
Mining activity: Recently mined; small-scale operation

Tenure: ML 2860

Name: Palmer River Four Mile Bend
Commodities/purpose: Gold, ilmenite/leucoxene, monazite, platinum, andalusite, rutile, tin, tantalum, tungsten, yttrium/xenotime, zircon
Location: Palmer River
Status: Granted
Date of application: 09/12/74 **Date granted:** 28/08/75
Major mines/prospects: Palmer River
Mining activity: Recently mined with mixed success

Tenure: ML 2861

Name: Palmer River Doughboy
Commodities/purpose: Gold, ilmenite/leucoxene, monazite, platinum, andalusite, rutile, tin, tantalum, tungsten, yttrium/xenotime, zircon
Location: Palmer River (Doughboy Creek junction)
Status: Granted
Date of application: 09/12/74 **Date granted:** 04/09/75
Major mines/prospects: Palmer River
Mining activity: Operating mine

Tenure: ML 2868

Name: Alanby
Commodities/purpose: Workshop/machinery/store
Location: Mount Poverty
Status: Granted
Date of application: 23/08/76 **Date granted:** 11/08/77
Major mines/prospects:
Mining activity: Camp/residence site

Tenure: ML 2874

Name: Last Hit Revived
Commodities/purpose: Gold
Location: Starcke No. 2 Goldfield
Status: Granted
Date of application: 01/06/78 **Date granted:** 21/02/80
Major mines/prospects: Last Hit, Boomerang
Mining activity: Little current mining activity

Tenure: ML 2886

Name: Home
Commodities/purpose: Workshop/machinery/store
Location: Starcke No. 2 Goldfield
Status: Granted
Date of application: 21/05/79 **Date granted:** 15/11/84
Major mines/prospects:
Mining activity: Little current mining activity

Tenure: ML 2887
Name: The Lucky Strike
Commodities/purpose: Gold
Location: Starcke No. 2 Goldfield
Status: Granted
Date of application: 21/05/79 **Date granted:** 01/10/81
Major mines/prospects: Diggings Creek
Mining activity: Little current mining activity

Tenure: ML 2889
Name: Brahma 2
Commodities/purpose: Tin
Location: The Granites
Status: Granted
Date of application: 03/08/79 **Date granted:** 15/09/83
Major mines/prospects: Fiery Creek
Mining activity: Not operating

Tenure: ML 2901
Name: Alice Queen
Commodities/purpose: Gold
Location: Alice River Goldfield
Status: Granted
Date of application: 17/09/80 **Date granted:** 29/04/82
Major mines/prospects: Alice Queen
Mining activity: No mining; some exploration.

Tenure: ML 2902
Name: German Jack
Commodities/purpose: Gold
Location: Alice River Goldfield
Status: Granted
Date of application: 19/09/80 **Date granted:** 29/04/82
Major mines/prospects: German Jack
Mining activity: Operating mine; mainly exploration.

Tenure: ML 2903
Name: Yamba
Commodities/purpose: Gold
Location: Starcke No. 1 Goldfield
Status: Granted
Date of application: 03/10/80 **Date granted:** 24/01/85
Major mines/prospects: Cocoa Creek
Mining activity: Part of mining operation based on ML 40063

Tenure: ML 2907
Name: Eureka
Commodities/purpose: Gold
Location: Alice River Goldfield
Status: Granted
Date of application: 23/10/80 **Date granted:** 03/06/82
Major mines/prospects: Eureka
Mining activity: Operating mine; mainly exploration.

Tenure: ML 2908
Name: Peninsula King
Commodities/purpose: Gold
Location: Alice River Goldfield
Status: Granted
Date of application: 23/10.80 **Date granted:** 03/06/82
Major mines/prospects: Big Blow, Peninsula King
Mining activity: Operating mine; mainly exploration.

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Tenure: ML 2916
Name: Maddens Reef
Commodities/purpose: Gold, silver, copper
Location: West Normanby Goldfield
Status: Granted
Date of application: 13/04/81 **Date granted:** 26/07/84
Major mines/prospects: Maddens Reef
Mining activity: Operating mine; successful, small, lode gold mine.

Tenure: ML 2917
Name: Brothers
Commodities/purpose: Gold, silver, copper, tin
Location: West Normanby Goldfield
Status: Granted
Date of application: 13/04/81 **Date granted:** 26/07/84
Major mines/prospects: The Brothers Mine
Mining activity: No recent mining activity.

Tenure: ML 2918
Name: Hope
Commodities/purpose: Gold
Location: Rocky River
Status: Granted
Date of application: 28/04/81 **Date granted:** 16/05/85
Major mines/prospects: Rocky River
Mining activity: No recent mining activity

Tenure: ML 2934
Name: Louisa
Commodities/purpose: Gold, silver, platinum, tin
Location: Maytown area
Status: Granted
Date of application: 23/12/81 **Date granted:** 27/10/88
Major mines/prospects:
Mining activity: Not operating

Tenure: ML 2935
Name: Thompsons Loop
Commodities/purpose: Gold, silver, platinum, tin
Location: Maytown area
Status: Granted
Date of application: 23/12/81 **Date granted:** 28/01/88
Major mines/prospects: Thompsons Gully
Mining activity: Not operating

Tenure: ML 2936
Name: Nelsons 1
Commodities/purpose: Gold, silver, platinum, tin
Location: Maytown area
Status: Granted
Date of application: 23/12/81 **Date granted:** 28/01/88
Major mines/prospects:
Mining activity: Operating mine

Tenure: ML 2937
Name: Nelsons 2
Commodities/purpose: Gold, silver, platinum, tin
Location: Maytown area
Status: Granted
Date of application: 23/12/81 **Date granted:** 28/01/88
Major mines/prospects:
Mining activity: Operating mine

Tenure: ML 2938
Name: North Palmer 1
Commodities/purpose: Gold, silver, platinum, tin
Location: North Palmer River
Status: Granted
Date of application: 23/12/81 **Date granted:** 28/01/88
Major mines/prospects: North Palmer River
Mining activity: Not operating

Tenure: ML 2939
Name: North Palmer No. 2
Commodities/purpose: Gold, silver, platinum, tin
Location: North Palmer River
Status: Granted
Date of application: 23/12/81 **Date granted:** 28/01/88
Major mines/prospects: North Palmer River
Mining activity: Not operating

Tenure: ML 2940
Name: Milkmans
Commodities/purpose: Gold, silver, platinum, tin
Location: North Palmer River
Status: Granted
Date of application: 23/12/81 **Date granted:** 14/05/87
Major mines/prospects: Milkmans Flat
Mining activity: Mining ceased 3 to 4 years ago; worked both alluvial and lode gold. Now used as a mining camp.

Tenure: ML 2945
Name: Still Persevering
Commodities/purpose: Gold, silver, copper, lead, zinc
Location: Potallah Creek Goldfield
Status: Granted
Date of application: 26/01/82 **Date granted:** 02/08/84
Major mines/prospects: Perseverance
Mining activity: No recent mining activity

Tenure: ML 2946
Name: Taylor Gold
Commodities/purpose: Gold, silver, copper
Location: West Normanby Goldfield
Status: Granted
Date of application: 29/03/82 **Date granted:** 19/01/84
Major mines/prospects: Taylor Gold
Mining activity: No recent mining activity.

Tenure: ML 2949
Name: Palmer River 2
Commodities/purpose: Gold, diamonds, sapphires
Location: Palmer River (Byerstown area)
Status: Granted
Date of application: 03/06/82 **Date granted:** 05/07/84
Major mines/prospects: Palmer River
Mining activity: Awaiting rehabilitation of lease before surrender will be accepted.

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Tenure: ML 2950
Name: Palmer River 3
Commodities/purpose: Gold, diamonds, sapphires
Location: Palmer River (Byerstown area)
Status: Granted
Date of application: 03/06/82 **Date granted:** 24/04/85
Major mines/prospects: Palmer River
Mining activity: Awaiting rehabilitation of ML 2949 before surrender of lease will be accepted.

Tenure: ML 2952
Name: Blackfellow Creek
Commodities/purpose: Gold, diamonds, sapphires
Location: Blackfellow Creek
Status: Granted
Date of application: 03/06/82 **Date granted:** 24/04/85
Major mines/prospects: Blackfellow Creek
Mining activity: Operating mine; largely worked out.

Tenure: ML 2953
Name: Blackfellow Creek 2
Commodities/purpose: Gold, diamonds, sapphires, zircon
Location: Blackfellow Creek
Status: Granted
Date of application: 03/06/82 **Date granted:** 28/06/84
Major mines/prospects: Blackfellow Creek
Mining activity: Operating mine; plant and camp site.

Tenure: ML 2957
Name: Julie Anne
Commodities/purpose: Gold, silver
Location: Alice River Goldfield
Status: Granted
Date of application: 08/12/82 **Date granted:** 07/03/85
Major mines/prospects: Julie Anne
Mining activity: Not operating; some exploration.

Tenure: ML 2958
Name: Alice
Commodities/purpose: Gold, silver
Location: Alice River Goldfield
Status: Granted
Date of application: 08/12/82 **Date granted:** 01/05/86
Major mines/prospects: Taylors Reef
Mining activity: Not operating; some exploration.

Tenure: ML 2959
Name: Oaky No. 1
Commodities/purpose: Gold
Location: Oaky Creek (south of Maytown)
Status: Granted
Date of application: 03/05/83 **Date granted:** 28/03/85
Major mines/prospects: Oaky Creek
Mining activity: Not operating

Tenure: ML 2961
Name: Lower Haymust
Commodities/purpose: Gold, tin
Location: South Palmer River
Status: Granted
Date of application: 22/06/83 **Date granted:** 20/11/86
Major mines/prospects: South Palmer River
Mining activity: Operating mine; very small operation.

Tenure: ML 2965
Name: Stanton Lease
Commodities/purpose: Silica, monazite, rutile, zircon, loading facilities, stockpile ore/overburden, transport/conveyor/vehicular
Location: Cape Flattery
Status: Granted
Date of application: 18/04/84 **Date granted:** 14/02/85
Major mines/prospects: Cape Flattery Silica Sand
Mining activity: Operating mine

Tenure: ML 2966
Name: DI(1)
Commodities/purpose: Gold
Location: Southwest of Laura
Status: Granted
Date of application: 08/05/84 **Date granted:** 17/09/87
Major mines/prospects: Mosman River
Mining activity: Not operating

Tenure: ML 2967
Name: DI(2)
Commodities/purpose: Gold
Location: Southwest of Laura
Status: Granted
Date of application: 08/05/84 **Date granted:** 17/09/87
Major mines/prospects: Mosman River
Mining activity: Not operating

Tenure: ML 2968
Name: Luck
Commodities/purpose: Gold, silver, tin
Location: Rocky River
Status: Granted
Date of application: 17/05/84 **Date granted:** 18/02/88
Major mines/prospects: Rocky River
Mining activity: No recent mining activity

Tenure: ML 2978
Name: Great Northern
Commodities/purpose: Gold, silver
Location: Coen Goldfield
Status: Granted
Date of application: 22/10/84 **Date granted:** 17/04/86
Major mines/prospects: Great Northern
Mining activity: Not operating; site to be rehabilitated.

Tenure: ML 3002
Name: Debbie No. 1
Commodities/purpose: Gold
Location: Oaky Creek (south of Maytown)
Status: Granted
Date of application: 09/10/85 **Date granted:** 07/06/90
Major mines/prospects: Oaky Creek
Mining activity: Not operating

Tenure: ML 3003
Name: Bridget No. 2
Commodities/purpose: Gold
Location: Sandy Creek (south of Maytown)
Status: Granted
Date of application: 09/10/85 **Date granted:** 22/06/89
Major mines/prospects: Sandy Creek
Mining activity: No recent mining activity

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Tenure: ML 3004
Name: Bridget No. 1
Commodities/purpose: Gold
Location: Sandy Creek (south of Maytown)
Status: Granted
Date of application: 09/10/85 **Date granted:** 07/06/90
Major mines/prospects: Sandy Creek
Mining activity: No recent mining activity

Tenure: ML 3007
Name: Top Sandy No. 1
Commodities/purpose: Gold
Location: Sandy Creek (south of Maytown)
Status: Granted
Date of application: 16/12/85 **Date granted:** 07/06/90
Major mines/prospects: Sandy Creek
Mining activity: No recent mining activity

Tenure: ML 3008
Name: Top Sandy No. 3
Commodities/purpose: Gold
Location: Sandy Creek (south of Maytown)
Status: Granted
Date of application: 16/12/85 **Date granted:** 07/06/90
Major mines/prospects: Sandy Creek
Mining activity: No recent mining activity

Tenure: ML 3009
Name: Top Sandy No. 2
Commodities/purpose: Gold
Location: Sandy Creek (south of Maytown)
Status: Granted
Date of application: 16/12/85 **Date granted:** 07/06/90
Major mines/prospects: Sandy Creek
Mining activity: No recent mining activity

Tenure: ML 3010
Name: One Mile
Commodities/purpose: Gold
Location: Alice River Goldfield
Status: Granted
Date of application: 30/12/85 **Date granted:** 25/01/90
Major mines/prospects: One Mile, Alice Queen
Mining activity: Operating mine; mainly exploration.

Tenure: ML 3011
Name: Airstrip Block
Commodities/purpose: Living quarters/camp, workshop/machinery/store
Location: Alice River Goldfield
Status: Granted
Date of application: 30/12/85 **Date granted:** 01/10/87
Major mines/prospects: Airstrip Block
Mining activity: Operating mine; mainly exploration.

Tenure: ML 3021
Name: Progression
Commodities/purpose: Gold
Location: Doughboy Creek
Status: Granted
Date of application: 22/04/86 **Date granted:** 24/08/89
Major mines/prospects: Doughboy Creek
Mining activity: Operating mine; largely worked out.

Tenure: ML 3036
Name: Blackfellow Wing
Commodities/purpose: Gold, gemstones, platinum, tin
Location: Blackfellow Creek
Status: Granted
Date of application: 30/07/86 **Date granted:** 28/04/88
Major mines/prospects: Blackfellow Creek
Mining activity: Operating mine; largely worked out.

Tenure: ML 3042
Name: Red Prospect
Commodities/purpose: Gold, platinum, tin
Location: Palmer River - Campbell Creek
Status: Granted
Date of application: 08/10/86 **Date granted:** 18/06/87
Major mines/prospects: Palmer River, Campbell Creek
Mining activity: No recent mining activity

Tenure: ML 3053
Name: Stony Creek
Commodities/purpose: Tin, gold, monazite, rutile, tungsten
Location: Granite Creek (north of Coen)
Status: Granted
Date of application: 29/12/86 **Date granted:** 02/03/89
Major mines/prospects: Wolverton Tin Prospect
Mining activity: Not operating

Tenure: ML 3054
Name: Jessops
Commodities/purpose: Gold, tin
Location: North Palmer River area
Status: Granted
Date of application: 31/12/86 **Date granted:** 13/04/89
Major mines/prospects: Jessop Creek
Mining activity: Part of a current mining project

Tenure: ML 3055
Name: Battery No. 1
Commodities/purpose: Gold, silver, lead, tin
Location: Southwest of the Archer River Roadhouse
Status: Granted
Date of application: 08/01/97 **Date granted:** 28/09/89
Major mines/prospects: Battery Lease
Mining activity: Exploration in 1993; old shaft opened up; may commence underground mining in 1994.

Tenure: ML 3058
Name: Sue
Commodities/purpose: Gold, silver
Location: South-east of Maytown
Status: Granted
Date of application: 16/01/87 **Date granted:** 31/10/91
Major mines/prospects:
Mining activity: Mined area being rehabilitated

Tenure: ML 3062
Name: Machale No. 2
Commodities/purpose: Gold
Location: Palmer River
Status: Granted
Date of application: 11/03/87 **Date granted:** 13/02/92
Major mines/prospects: Palmer River
Mining activity: Operating mine; mobile plant.

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Tenure: ML 3068
Name: Collingwood Face
Commodities/purpose: Tin, gold, silver, copper
Location: Collingwood
Status: Granted
Date of application: 24/04/87 **Date granted:** 23/11/89
Major mines/prospects: Collingwood Tin Prospect
Mining activity: Not operating; care and maintenance.

Tenure: ML 3069
Name: Millsite
Commodities/purpose: Tin, gold, silver, copper, living quarters/camp, stockpile ore/overburden, treatment plant/mill site
Location: Collingwood
Status: Granted
Date of application: 14/04/87 **Date granted:** 30/11/89
Major mines/prospects: Collingwood Tin Prospect
Mining activity: Not operating; care and maintenance.

Tenure: ML 3070
Name: Campsite
Commodities/purpose: Tin, gold, silver, copper, living quarters/camp, tailings/settling dam
Location: Collingwood
Status: Granted
Date of application: 14/04/87 **Date granted:** 23/11/89
Major mines/prospects: Collingwood Tin Prospect
Mining activity: Not operating; care and maintenance.

Tenure: ML 3071
Name: Sam's Reef No. 2
Commodities/purpose: Tin, tungsten, gold
Location: Normanby River South Branch
Status: Granted
Date of application: 30/04/87 **Date granted:** 29/03/90
Major mines/prospects:
Mining activity: Not known if being worked - unlikely.

Tenure: ML 3075
Name: Revolver
Commodities/purpose: Gold, silver
Location: North Palmer River
Status: Application
Date of application: 27/05/87 **Date granted:**
Major mines/prospects: North Palmer River
Mining activity: May be worked in 1994 if granted

Tenure: ML 3076
Name: Revolver Extended
Commodities/purpose: Gold, silver
Location: North Palmer River
Status: Application
Date of application: 27/05/87 **Date granted:**
Major mines/prospects: North Palmer River
Mining activity: May be worked in 1994 if granted

Tenure: ML 3077
Name: Arcuate
Commodities/purpose: Gold, silver
Location: North Palmer River
Status: Application
Date of application: 27/05/87 **Date granted:**
Major mines/prospects: North Palmer River
Mining activity: May be worked in 1994 if granted

Tenure: ML 3083
Name: Catherine Mary
Commodities/purpose: Gold, silver
Location: Palmer River - Dog Leg Creek
Status: Granted
Date of application: 09/07/87 **Date granted:** 28/02/91
Major mines/prospects: Palmer River
Mining activity: No recent mining activity

Tenure: ML 3085
Name: Ten Mile 1
Commodities/purpose: Gold, tin, garnet
Location: Ten Mile Creek (South Palmer River area)
Status: Granted
Date of application: 03/08/87 **Date granted:** 19/01/89
Major mines/prospects: Ten Mile Creek
Mining activity: Not operating

Tenure: ML 3086
Name: Pure Gold
Commodities/purpose: Gold, silver
Location: Ebagoola Goldfield
Status: Granted
Date of application: 10/08/87 **Date granted:** 30/03/89
Major mines/prospects: Racecourse Creek
Mining activity: Operating mine; small-scale.

Tenure: ML 3091
Name: South Sandy Creek No. 4
Commodities/purpose: Gold, silver, copper, lead, platinum, tin, tungsten, zinc
Location: near Sandy Creek (south of Maytown)
Status: Granted
Date of application: 14/09/87 **Date granted:** 11/02/93
Major mines/prospects: Sandy Creek
Mining activity: Operating mine

Tenure: ML 3096
Name: Red Gold
Commodities/purpose: Gold, silver, living quarters/camp, tailings/settling dam, treatment plant
Location: Ebagoola Goldfield
Status: Granted
Date of application: 14/12/87 **Date granted:** 25/05/89
Major mines/prospects: Good Luck, Last Hit, Red Gold
Mining activity: Operating mine; small-scale.

Tenure: ML 3097
Name: Spear Creek No. 3
Commodities/purpose: Gold, silver
Location: Spear Creek
Status: Granted
Date of application: 24/12/87 **Date granted:** 06/08/92
Major mines/prospects: Spear Creek
Mining activity: Operating mine; plant to be moved to ML 40074.

Tenure: ML 3114
Name: Dambuster No. 1
Commodities/purpose: Gold, silver, arsenic, copper, molybdenum, lead, antimony, tin, tungsten, zinc
Location: Greasy Bill Creek
Status: Granted
Date of application: 19/04/88 **Date granted:** 28/09/89
Major mines/prospects:
Mining activity: Not operating

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Tenure: ML 3116
Name: Jessops Minesite
Commodities/purpose: Living quarters/camp, stockpile ore/overburden, tailings/settling dam, treatment plant
Location: North Palmer River area
Status: Granted
Date of application: 11/05/88 **Date granted:** 25/05/89
Major mines/prospects: Jessop Creek
Mining activity: Part of a current mining project

Tenure: ML 3118
Name: Rhys Demon
Commodities/purpose: Gold, silver, living quarters/camp, treatment plant
Location: Ebagoola Goldfield
Status: Granted
Date of application: 01/06/88 **Date granted:** 17/08/89
Major mines/prospects: Rhys Demon
Mining activity: Operating mine; small-scale.

Tenure: ML 3121
Name: Lower Gregory
Commodities/purpose: Gold, silver
Location: South-east of Maytown
Status: Granted
Date of application: 20/06/88 **Date granted:** 22/08/91
Major mines/prospects:
Mining activity: Mined area being rehabilitated

Tenure: ML 3123
Name: Oscar Creek
Commodities/purpose: Gold, silver
Location: Coen Goldfield
Status: Granted
Date of application: 06/07/88 **Date granted:** 11/07/91
Major mines/prospects: Oscar Creek
Mining activity: Recently mined; largely worked out along main creek; dam being considered for possible Coen town water supply

Tenure: ML 3125
Name: Blakes Gully
Commodities/purpose: Gold, tin
Location: North Palmer River area
Status: Granted
Date of application: 13/07/88 **Date granted:** 01/08/91
Major mines/prospects:
Mining activity: Not operating

Tenure: ML 3130
Name: Mannies Gully
Commodities/purpose: Gold, tin
Location: North Palmer River area
Status: Granted
Date of application: 16/08/88 **Date granted:** 01/08/91
Major mines/prospects:
Mining activity: Not operating

Tenure: ML 3133
Name: King Junction 1
Commodities/purpose: Gold, silver, ilmenite/leucoxene, monazite, platinum, tin, titanium, zircon
Location: Palmer River - King Junction
Status: Application
Date of application: 25/08/88 **Date granted:**
Major mines/prospects: Palmer River
Mining activity:

Tenure: ML 3134
Name: Mannies Gully No. 2
Commodities/purpose: Gold, tin
Location: North Palmer River area
Status: Granted
Date of application: 29/08/88 **Date granted:** 01/08/91
Major mines/prospects:
Mining activity: Not operating

Tenure: ML 3135
Name: Mannies Gully No. 3
Commodities/purpose: Gold, tin
Location: North Palmer River area
Status: Granted
Date of application: 29/08/88 **Date granted:** 01/08/91
Major mines/prospects:
Mining activity: Not operating

Tenure: ML 3137
Name: Mannies Gully No. 4
Commodities/purpose: Gold, tin
Location: North Palmer River area
Status: Granted
Date of application: 30/08/88 **Date granted:** 01/08/91
Major mines/prospects:
Mining activity: Not operating

Tenure: ML 3141
Name: Africa
Commodities/purpose: Gold, silver, platinum, living quarters/camp, treatment plant
Location: Ebagoola Goldfield
Status: Granted
Date of application: 14/09/88 **Date granted:** 17/08/89
Major mines/prospects: Trafalgar
Mining activity: Operating mine; small-scale.

Tenure: ML 3142
Name: Gold Mount
Commodities/purpose: Gold, silver, platinum, living quarters/camp, treatment plant
Location: Ebagoola Goldfield
Status: Granted
Date of application: 14/09/88 **Date granted:** 08/02/90
Major mines/prospects: Gold Mount
Mining activity: Operating mine; small-scale.

Tenure: ML 3143
Name: Hit or Miss
Commodities/purpose: Gold, silver, platinum, living quarters/camp, treatment plant
Location: Ebagoola Goldfield
Status: Granted
Date of application: 14/09/88 **Date granted:** 31/08/89
Major mines/prospects: Hit or Miss
Mining activity: Operating mine; small-scale.

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Tenure: ML 3145

Name: Never Mine
Commodities/purpose: Gold, silver, platinum, living quarters/camp, treatment plant
Location: Ebagoola Goldfield
Status: Granted
Date of application: 14/09/88 **Date granted:** 31/08/89
Major mines/prospects: Never Mine
Mining activity: Operating mine; small-scale.

Tenure: ML 3147

Name: May Queen
Commodities/purpose: Gold, silver, platinum, living quarters/camp, treatment plant
Location: Ebagoola Goldfield
Status: Granted
Date of application: 14/09/88 **Date granted:** 03/08/89
Major mines/prospects: May Queen
Mining activity: Operating mine; small-scale.

Tenure: ML 3151

Name: Black Gold
Commodities/purpose: Gold, silver
Location: Ebagoola Goldfield
Status: Granted
Date of application: 03/10/88 **Date granted:** 28/09/89
Major mines/prospects:
Mining activity: Operating mine; small-scale.

Tenure: ML 3152

Name: Chili 1
Commodities/purpose: Gold, monazite, rare earths, tantalum, titanium, zircon
Location: Palmer River - Strathleven area
Status: Granted
Date of application: 06/10/88 **Date granted:** 16/11/89
Major mines/prospects: Palmer River
Mining activity: Not operating

Tenure: ML 3153

Name: Chili 2
Commodities/purpose: Gold, monazite, rare earths, tantalum, titanium, zircon
Location: Palmer River - Strathleven area
Status: Granted
Date of application: 06/10/88 **Date granted:** 16/11/89
Major mines/prospects: Palmer River
Mining activity: Not operating

Tenure: ML 3159

Name: Dam Site
Commodities/purpose: Living quarters/camp, stockpile ore/overburden, tailings/settling dam, treatment plant, water supply
Location: North Palmer River area
Status: Granted
Date of application: 17/11/88 **Date granted:** 01/08/91
Major mines/prospects:
Mining activity: Not operating

Tenure: ML 5940
Name: Tagsando
Commodities/purpose: Silica sand
Location: Shelburne Bay
Status: Granted/renewal
Date of application: 26/04/67 **Date granted:** 20/02/75
Major mines/prospects: Shelburne Bay Silica Sand
Mining activity: Not operating

Tenure: ML 5941
Name: Tagsand No. 2
Commodities/purpose: Silica
Location: Shelburne Bay
Status: Granted/renewal
Date of application: 08/12/67 **Date granted:** 20/02/75
Major mines/prospects: Shelburne Bay Silica Sand
Mining activity: Not operating

Tenure: ML 5942
Name: White Point
Commodities/purpose: Silica, bauxite, chromite, iron, ilmenite/leucoxene, magnetite, rutile, tin, zircon
Location: Shelburne Bay
Status: Granted/renewal
Date of application: 09/12/70 **Date granted:** 05/02/76
Major mines/prospects: Shelburne Bay Silica Sand
Mining activity: Not operating

Tenure: ML 5943
Name: Round Point
Commodities/purpose: Silica, aluminium, chromite, iron, ilmenite/leucoxene, magnesium, rutile, tin, titanium, zircon
Location: Shelburne Bay
Status: Granted/renewal
Date of application: 15/01/71 **Date granted:** 05/02/76
Major mines/prospects: Shelburne Bay Silica Sand
Mining activity: Not operating

Tenure: ML 5944
Name: Tobais
Commodities/purpose: Silica, rutile, zircon
Location: Shelburne Bay
Status: Application
Date of application: 19/09/84 **Date granted:**
Major mines/prospects: Shelburne Bay Silica Sand
Mining activity: Not operating

Tenure: ML 5945
Name: Shelburne Silica JV
Commodities/purpose: Silica, living quarters/camp
Location: Shelburne Bay
Status: Granted
Date of application: 19/12/84 **Date granted:** 14/08/86
Major mines/prospects: Shelburne Bay Silica Sand
Mining activity: Not operating

Tenure: ML 5946
Name: White Point Extended
Commodities/purpose: Silica
Location: Shelburne Bay
Status: Application
Date of application: 18/12/85 **Date granted:**
Major mines/prospects: Shelburne Bay Silica Sand
Mining activity: Not operating

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Tenure: ML 6023
Name:
Commodities/purpose: Ilmenite/leucoxene, monazite, rutile, zircon
Location: Urquhart Point
Status: Granted
Date of application: 08/07/60 **Date granted:** 25/03/82
Major mines/prospects: Urquhart Point Heavy Minerals Deposit
Mining activity: Not operating

Tenure: ML 6024
Name:
Commodities/purpose: Construction of bridge
Location: Weipa
Status: Granted
Date of application: 10/01/79 **Date granted:** 25/07/85
Major mines/prospects:
Mining activity:

Tenure: ML 6025
Name: Skardon River L
Commodities/purpose: Kaolin, clay
Location: Skardon River
Status: Application
Date of application: 21/07/88 **Date granted:**
Major mines/prospects: Skardon River Kaolin
Mining activity: Not operating; mining planned to commence soon.

Tenure: ML 6054
Name: West Gregory
Commodities/purpose: Gold, silver
Location: South-east of Maytown
Status: Granted
Date of application: 05/06/87 **Date granted:** 08/08/91
Major mines/prospects:
Mining activity: Mined area being rehabilitated

Tenure: ML 6534
Name: Monte Christo
Commodities/purpose: Gold, silver, platinum, copper
Location: West Normanby Goldfield
Status: Granted
Date of application: 29/05/89 **Date granted:** 31/10/91
Major mines/prospects: Monte Christo, Norton, Zigzag, Endeavour
Mining activity: No recent mining activity

Tenure: ML 6713
Name: Shady Glen
Commodities/purpose: Gold, silver, copper, platinum, tin
Location: West Normanby Goldfield
Status: Granted
Date of application: 05/06/89 **Date granted:** 08/02/90
Major mines/prospects: Poverty
Mining activity: Operating mine

Tenure: ML 6714
Name: Chaos
Commodities/purpose: Gold, silver
Location: North Palmer River
Status: Granted
Date of application: 21/06/89 **Date granted:** 02/07/92
Major mines/prospects: North Palmer River
Mining activity: Not operating

Tenure: ML 6719
Name: Middle Revolver
Commodities/purpose: Gold, silver
Location: North Palmer River
Status: Application
Date of application: 25/05/89 **Date granted:**
Major mines/prospects: North Palmer River
Mining activity: May be worked in 1994 if granted

Tenure: ML 6763
Name: Isabella
Commodities/purpose: Gold, silver, copper, tin
Location: West Normanby Goldfield
Status: Granted
Date of application: 05/06/89 **Date granted:** 24/10/91
Major mines/prospects: Isabella
Mining activity: Decline excavated in 1993

Tenure: ML 6787
Name: Blakes Gully 2
Commodities/purpose: Gold, silver, tin
Location: North Palmer River area
Status: Application
Date of application: 23/08/89 **Date granted:**
Major mines/prospects:
Mining activity:

Tenure: ML 6788
Name: Blakes Gully 3
Commodities/purpose: Gold, silver, tin
Location: North Palmer River area
Status: Application
Date of application: 24/08/89 **Date granted:**
Major mines/prospects:
Mining activity:

Tenure: ML 6790
Name: Poverty
Commodities/purpose: Gold, silver, platinum, copper, tin
Location: West Normanby Goldfield
Status: Granted
Date of application: 05/06/89 **Date granted:** 24/10/91/
Major mines/prospects: Emily
Mining activity: Preliminary work carried out in 1993; more extensive working expected in 1994.

Tenure: ML 6945
Name: Tina No. 1
Commodities/purpose: Gold, silver
Location: Doughboy Creek
Status: Granted
Date of application: 02/10/89 **Date granted:** 20/08/92
Major mines/prospects: Doughboy Creek
Mining activity: Not operating; mining planned to commence soon.

Tenure: ML 7024
Name: Weipa
Commodities/purpose: Bauxite
Location: Aurukun - Weipa - Andoom - Skardon River
Status: Granted
Date of application: 01/01/58 **Date granted:** 01/01/58
Major mines/prospects: Bauxite - SBML 1
Mining activity: Operating mine; bauxite and kaolin being mined at Weipa and Andoom.

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Tenure: ML 7031
Name: Alcan Weipa
Commodities/purpose: Bauxite
Location: North of Weipa
Status: Granted
Date of application: 01/01/64 **Date granted:** 01/01/64
Major mines/prospects: Bauxite - SBML 8
Mining activity: Bauxite resources proved; not being worked.

Tenure: ML 7032
Name: Pechiney
Commodities/purpose: Bauxite
Location: East of Aurukun
Status: Granted
Date of application: 22/12/75 **Date granted:** 22/12/75
Major mines/prospects: Bauxite - SBML 9
Mining activity: Not operating

Tenure: ML 7069
Name: Spalenka
Commodities/purpose: Silica, ilmenite/leucoxene, monazite, rutile, zircon, stockpile ore/overburden
Location: Cape Flattery
Status: Granted
Date of application: 27/02/90 **Date granted:** 24/06/93
Major mines/prospects: Cape Flattery Silica Sand
Mining activity: Mining reserves

Tenure: ML 7103
Name: Zooz
Commodities/purpose: Gold
Location: South-east of Maytown
Status: Granted
Date of application: 27/04/90 **Date granted:** 20/08/92
Major mines/prospects:
Mining activity: Small-scale hard rock operation in 1993; one small shaft excavated.

Tenure: ML 7149
Name: That's It
Commodities/purpose: Tin, gold, garnet, ilmenite/leucoxene, monazite, rutile, zircon
Location: Wet Creek
Status: Granted
Date of application: 06/07/90 **Date granted:** 26/03/92
Major mines/prospects: Wolverton Tin Prospect
Mining activity: Not operating; mining may commence this financial year.

Tenure: ML 7195
Name: JL Sheppard
Commodities/purpose: Tin, gold, garnet, ilmenite/leucoxene, monazite, rutile, zircon
Location: Granite Creek (north of Coen)
Status: Granted
Date of application: 08/08/90 **Date granted:** 28/01/93
Major mines/prospects: Wolverton Tin Prospect
Mining activity: Not operating

Tenure: ML 7199
Name: Rocky Road
Commodities/purpose: Gold
Location: West Normanby Goldfield
Status: Granted
Date of application: 10/08/90 **Date granted:** 09/04/92
Major mines/prospects: Edna
Mining activity: Mining expected to commence in 1994; lode workings.

Tenure: ML 7219
Name: Chili 3
Commodities/purpose: Gold, silver, garnet, ilmenite/leucoxene, monazite, tin, tantalum, yttrium/xenotime
Location: Palmer River - Strathleven area
Status: Granted
Date of application: 14/06/90 **Date granted:** 09/07/92
Major mines/prospects: Palmer River
Mining activity: Not operating

Tenure: ML 7220
Name: Chili 4
Commodities/purpose: Gold, silver, garnet, ilmenite/leucoxene, monazite, tin, tantalum, yttrium/xenotime
Location: Palmer River - Strathleven area
Status: Granted
Date of application: 14/06/90 **Date granted:** 18/02/93
Major mines/prospects: Palmer River
Mining activity: Not operating

Tenure: ML 7392
Name: River Bend
Commodities/purpose: Gold, workshop/machinery/store
Location: Coen Goldfield
Status: Granted
Date of application: 08/11/90 **Date granted:** 17/12/92
Major mines/prospects: Bend
Mining activity: Not operating

Tenure: ML 7408
Name: The Start
Commodities/purpose: Gold, silver, bismuth, platinum, antimony
Location: Starcke No. 2 Goldfield
Status: Granted
Date of application: 28/11/90 **Date granted:** 15/10/92
Major mines/prospects:
Mining activity: Little current mining activity

Tenure: ML 40003
Name: MB Rogina
Commodities/purpose: Slate
Location: South Palmer River
Status: Granted
Date of application: 06/12/90 **Date granted:** 11/06/92
Major mines/prospects:
Mining activity: No recent mining

Tenure: ML 40004
Name: MB Rogina 2
Commodities/purpose: Slate
Location: White Creek (near Maitland Downs)
Status: Granted
Date of application: 06/12/90 **Date granted:** 28/11/91
Major mines/prospects:
Mining activity: Worked intermittently for slate; small operation.

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Tenure: ML 40005
Name: Maddens Plant Lease
Commodities/purpose: Gold
Location: West Normanby Goldfield
Status: Granted
Date of application: 06/12/90 **Date granted:** 14/05/92
Major mines/prospects:
Mining activity: Plant and camp site

Tenure: ML 40006
Name: Chili 5
Commodities/purpose: Gold, silver, garnet, ilmenite/leucoxene, monazite, platinum, tantalum, yttrium/xenotime
Location: Palmer River - Strathleven area
Status: Granted
Date of application: 10/12/90 **Date granted:** 09/07/92
Major mines/prospects: Palmer River
Mining activity: Not operating

Tenure: ML 40010
Name: Plant Lease
Commodities/purpose: Treatment plant/mill site
Location: Coen Goldfield
Status: Granted
Date of application: 06/02/91 **Date granted:** 19/03/92
Major mines/prospects:
Mining activity: Not operating; recently mined.

Tenure: ML 40012
Name: Granite One
Commodities/purpose: Gold, tin
Location: Granite Creek (south of Mount Bennett)
Status: Granted
Date of application: 18/04/91 **Date granted:** 19/09/91
Major mines/prospects: Granite Creek
Mining activity: Not operating

Tenure: ML 40013
Name: King Junction 2
Commodities/purpose: Gold, silver, monazite, platinum, tin, titanium, xenon, zircon
Location: Palmer River - King Junction
Status: Application
Date of application: 22/04/91 **Date granted:**
Major mines/prospects: Palmer River
Mining activity: Dredging-type operation being considered.

Tenure: ML 40014
Name: Stewart
Commodities/purpose: Gold, silver, monazite, platinum, tin, titanium, xenon, zircon
Location: Palmer River - King Junction
Status: Application
Date of application: 22/04/91 **Date granted:**
Major mines/prospects: Palmer River
Mining activity: Dredging-type operation being considered

Tenure: ML 40017
Name: Could Bee
Commodities/purpose: Tin, gold, garnet, ilmenite/leucoxene, monazite, rutile, zircon
Location: Wet Creek
Status: Granted
Date of application: 21/05/91 **Date granted:** 20/02/92
Major mines/prospects: Wolverton Tin Prospect
Mining activity: Not operating; mining may commence this financial year.

Tenure: ML 40018
Name: Rocky Road 2
Commodities/purpose: Gold, silver, copper, platinum, zinc
Location: West Normanby Goldfield
Status: Granted
Date of application: 23/05/91 **Date granted:** 11/06/92
Major mines/prospects: Mint
Mining activity: Operating mine

Tenure: ML 40019
Name: Eldorado 2
Commodities/purpose: Gold, silver
Location: Near Stewart River, south of Coen
Status: Granted
Date of application: 30/05/91 **Date granted:** 14/05/92
Major mines/prospects: Eldorado 2
Mining activity: Operating mine

Tenure: ML 40020
Name: Bennett One
Commodities/purpose: Gold, copper
Location: Palmer River
Status: Granted
Date of application: 17/06/91 **Date granted:** 14/05/92
Major mines/prospects: Palmer River
Mining activity: Not operating

Tenure: ML 40022
Name: Christmas Creek
Commodities/purpose: Gold, silver
Location: North Palmer River area
Status: Application
Date of application: 24/07/91 **Date granted:**
Major mines/prospects:
Mining activity: Not operating; mining may commence soon if granted.

Tenure: ML 40023
Name: East Jessops
Commodities/purpose: Gold, silver
Location: North Palmer River area
Status: Application
Date of application: 24/07/91 **Date granted:**
Major mines/prospects: Jessop Creek
Mining activity: Not operating; mining may commence soon if granted.

Tenure: ML 40024
Name: West Jessops
Commodities/purpose: Gold, silver
Location: North Palmer River area
Status: Application
Date of application: 24/07/91 **Date granted:**
Major mines/prospects: Jessop Creek
Mining activity: Not operating; mining may commence soon if granted.

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Tenure: ML 40025
Name: South Jessops
Commodities/purpose: Gold, silver
Location: North Palmer River area
Status: Application
Date of application: 24/07/91 **Date granted:**
Major mines/prospects:
Mining activity: Not operating; mining may commence soon if granted.

Tenure: ML 40026
Name: Pinnacle No. 1
Commodities/purpose: Gold, silver, tungsten
Location: Pinnacle Creek (south-east of Mount Bennett)
Status: Granted
Date of application: 02/08/91 **Date granted:** 19/12/91
Major mines/prospects: Pinnacle Creek
Mining activity: Operating mine

Tenure: ML 40027
Name: Granite Two
Commodities/purpose: Gold, tin
Location: Granite Creek (junction with Palmer River)
Status: Granted
Date of application: 12/08/91 **Date granted:** 16/04/92
Major mines/prospects: Granite Creek
Mining activity: Not operating

Tenure: ML 40028
Name: Daintree 1
Commodities/purpose: Gold, rare earths
Location: Palmer River - Mount Daintree area
Status: Granted
Date of application: 12/08/91 **Date granted:** 14/05/92
Major mines/prospects: Palmer River
Mining activity: Not operating

Tenure: ML 40029
Name: Daintree No. 2
Commodities/purpose: Gold, rare earths
Location: Palmer River - Mount Daintree area
Status: Granted
Date of application: 12/08/91 **Date granted:** 16/04/92
Major mines/prospects: Palmer River
Mining activity: Not operating; area has been rehabilitated.

Tenure: ML 40030
Name: George
Commodities/purpose: Gold
Location: Palmer River (south of Maytown)
Status: Granted
Date of application: 01/10/91 **Date granted:** 11/06/92
Major mines/prospects: Palmer River
Mining activity: Mining camp

Tenure: ML 40031
Name: Eagle Nest
Commodities/purpose: Gold, tin
Location: South Palmer River
Status: Granted
Date of application: 24/09/91 **Date granted:** 22/10/92
Major mines/prospects: South Palmer River
Mining activity: Mined area has been rehabilitated

Tenure: ML 40032
Name: Eagle Path
Commodities/purpose: Gold, tin
Location: South Palmer River
Status: Granted
Date of application: 24/09/91 Date granted: 17/12/92
Major mines/prospects: South Palmer River
Mining activity: Mined area has been rehabilitated

Tenure: ML 40033
Name: Queenslander
Commodities/purpose: Gold, silver
Location: Ebagoola Goldfield
Status: Granted
Date of application: 11/10/91 **Date granted:** 09/07/92
Major mines/prospects: Queenslander, Queenslander East, True Blue
Mining activity: Operating mine; small-scale.

Tenure: ML 40034
Name: Hopeful
Commodities/purpose: Gold
Location: North Palmer River
Status: Granted
Date of application: 20/09/91 **Date granted:** 01/02/94
Major mines/prospects: North Palmer River
Mining activity: Mining commenced recently

Tenure: ML 40035
Name: Amor Gold
Commodities/purpose: Gold
Location: Blackfellow Creek
Status: Granted
Date of application: 23/10/91 **Date granted:** 26/03/92
Major mines/prospects: Blackfellow Creek
Mining activity: Not operating; worked out; to be rehabilitated.

Tenure: ML 40037
Name: Lucky
Commodities/purpose: Gold, living quarters/camp, tailings/settling dam, treatment plant
Location: Palmer River (south-east of Maytown)
Status: Granted
Date of application: 19/11/91 **Date granted:** 06/08/92
Major mines/prospects: Palmer River
Mining activity: Largely mined out; area has been rehabilitated.

Tenure: ML 40039
Name: Blackfellow Junction
Commodities/purpose: Gold, silver, living quarters/camp, treatment plant
Location: Palmer River (Byerstown area)
Status: Granted
Date of application: 20/12/91 **Date granted:** 20/05/93
Major mines/prospects: Palmer River
Mining activity: This lease adjoins several others which are currently being worked and covers an old plant site.

Tenure: ML 40041
Name: Come By Chance
Commodities/purpose: Gold, silver, tin, treatment plant
Location: South Palmer River
Status: Granted
Date of application: 06/01/92 **Date granted:** 15/10/92
Major mines/prospects: South Palmer River
Mining activity: Operating mine; small-scale operation.

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Tenure: ML 40044

Name: Clyde Reef

Commodities/purpose: Gold, silver, platinum, copper, zircon, living quarters/camp, treatment plant

Location: West Normanby Goldfield

Status: Granted

Date of application: 23/03/92 **Date granted:** 11/02/93

Major mines/prospects: Tatlow Reef

Mining activity: Lease to be assigned to holder of Madden Mine.

Tenure: ML 40045

Name: White Horse

Commodities/purpose: Gold

Location: White Horse Creek (south of Maytown)

Status: Granted

Date of application: 28/05/92 **Date granted:** 28/01/93

Major mines/prospects: White Horse Creek

Mining activity: Not operating

Tenure: ML 40046

Name: McLennan's Lode

Commodities/purpose: Gold, silver

Location: Wenlock River - Larsens Creek

Status: Granted

Date of application: 29/05/92 **Date granted:** 15/10/92

Major mines/prospects: McLennan's Lode

Mining activity: Operating mine; costeaning in 1993 to trace quartz reefs; to be worked in 1994 with a better plant.

Tenure: ML 40049

Name: Rocky Creek

Commodities/purpose: Gold, living quarters/camp

Location: Rocky creek (Uhrstown area)

Status: Granted

Date of application: 21/07/92 **Date granted:** 20/05/93

Major mines/prospects: Rocky Creek

Mining activity: Small-scale mining operation

Tenure: ML 40050

Name: Jessops

Commodities/purpose: Gold, silver, treatment plant

Location: North Palmer River area

Status: Granted

Date of application: 17/08/92 **Date granted:** 27/05/93

Major mines/prospects: Jessop Creek

Mining activity: Part of a current mining project

Tenure: ML 40052

Name: Purple Patch

Commodities/purpose: Gold, corundum, chromite, tin, titanium, zircon, living quarters/camp, settling/tailings dam, transport/conveyor/vehicular, workshop/machinery/store

Location: Little Palmer River

Status: Granted

Date of application: 28/08/92 **Date granted:** 25/03/93

Major mines/prospects: Little Palmer River

Mining activity: Operating mine

Tenure: ML 40054
Name: Sheppard
Commodities/purpose: Treatment plant
Location: Granite Creek (north of Coen)
Status: Granted
Date of application: 24/11/92 **Date granted:** 22/07/93
Major mines/prospects: Wolverton Tin Prospect
Mining activity: Not operating

Tenure: ML 40055
Name: Eureka
Commodities/purpose: Gold, gemstones, ilmenite/leucoxene, antimony, tin, tantalum, tungsten, tourist mine/purposes
Location: Palmer River (Byerstown area)
Status: Application
Date of application: 30/11/92 **Date granted:**
Major mines/prospects: Palmer River
Mining activity: Tourist mine planned.

Tenure: ML 40056
Name: Woofy
Commodities/purpose: Gold
Location: South-east of Maytown
Status: Granted
Date of application: 02/12/92 **Date granted:** 01/11/93
Major mines/prospects:
Mining activity: Mined area being rehabilitated

Tenure: ML 40057
Name: Bourkey
Commodities/purpose: Gold, living quarters/camp, tailings/settling dam, treatment plant
Location: North Palmer River
Status: Application
Date of application: 02/12/92 **Date granted:**
Major mines/prospects: North Palmer River
Mining activity: May be worked in 1994 if granted

Tenure: ML 40058
Name: South Palmer
Commodities/purpose: Gold, living quarters/camp, tailings/settling dam, treatment plant
Location: South Palmer River
Status: Granted
Date of application: 16/12/92 **Date granted:** 26/08/93
Major mines/prospects: South Palmer River
Mining activity: Operating mine; little done in last 6 months.

Tenure: ML 40060
Name: You Can Tell Us
Commodities/purpose: Gold
Location: West Normanby Goldfield
Status: Granted
Date of application: 21/12/92 **Date granted:** 13/05/93
Major mines/prospects:
Mining activity: Operating mine

Tenure: ML 40061
Name: Mill Site
Commodities/purpose: Gold
Location: West Normanby Goldfield
Status: Granted
Date of application: 21/12/92 **Date granted:** 15/07/93
Major mines/prospects:
Mining activity: Not operating

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Tenure: ML 40062 **Name:** Jennings
Commodities/purpose: Gold
Location: Spear Creek
Status: Granted
Date of application: 03/02/93 **Date granted:** 20/05/93
Major mines/prospects: Spear Creek
Mining activity: Operating mine

Tenure: ML 40063 **Name:** Bandicoot
Commodities/purpose: Gold, antimony, living quarters/camp, tailings/settling dam, treatment plant/mill site
Location: Starcke No. 1 Goldfield
Status: Application
Date of application: 05/03/93 **Date granted:**
Major mines/prospects: Cocoa Creek
Mining activity: Operating mine; small-scale

Tenure: ML 40065 **Name:** Tailings Lease
Commodities/purpose: Gold, tailings/settling dam
Location: West Normanby Goldfield
Status: Application
Date of application: 13/04/93 **Date granted:**
Major mines/prospects:
Mining activity: Mining to commence in early 1994; planning to treat the tailings from the Maddens Flat mines.

Tenure: ML 40066 **Name:** Normanby 1
Commodities/purpose: Gold, silver, platinum, corundum, zircon, living quarters/camp, tailings/settling dam, treatment plant
Location: West Normanby Goldfield
Status: Granted
Date of application: 22/04/93 **Date granted:** 01/04/94
Major mines/prospects: West Normanby River
Mining activity: Not operating

Tenure: ML 40068 **Name:** Camp Site
Commodities/purpose: Living quarters/camp, workshop, machinery/store
Location: Palmer River
Status: Granted
Date of application: 21/05/93 **Date granted:** 16/09/93
Major mines/prospects:
Mining activity: Mining camp

Tenure: ML 40069 **Name:** Skardon Pipeline
Commodities/purpose: Kaolin, clay, silica, loading facilities, pipeline, workshop/machinery/store
Location: Skardon River
Status: Application
Date of application: 25/05/93 **Date granted:**
Major mines/prospects: Skardon River Kaolin
Mining activity: Mine not yet operational

Tenure: ML 40070

Name: Kings Plains
Commodities/purpose: Tin, gold,ilmenite/leucoxene, monazite, rutile, tantalum, topaz, zircon, living quarters/camp, treatment plant
Location: Kings Plains
Status: Application
Date of application: 30/06/93 **Date granted:**
Major mines/prospects: Kings Plains Tin Prospect
Mining activity:

Tenure: ML 40071

Name: Blackfellow Junction
Commodities/purpose: Gold, silver
Location: Palmer River (Byerstown area)
Status: Granted
Date of application: 02/06/93 **Date granted:** 01/04/94
Major mines/prospects: Palmer River
Mining activity: This lease adjoins several others which are currently being worked.

Tenure: ML 40072

Name: Campbell Creek
Commodities/purpose: Gold, tin, living quarters/camp, treatment plant
Location: Campbell Creek
Status: Granted
Date of application: 16/08/93 **Date granted:** 01/03/94
Major mines/prospects: Campbell Creek
Mining activity:

Tenure: ML 40073

Name: Poverty Extended
Commodities/purpose: Gold, silver, platinum, living quarters/camp, stockpile ore/overburden, tailings/settling dam, treatment plant, workshop/machinery/store
Location: West Normanby Goldfield
Status: Granted
Date of application: 17/08/93 **Date granted:** 01/04/94
Major mines/prospects:
Mining activity: Not operating

Tenure: ML 40074

Name: Spear Extended
Commodities/purpose: Gold, silver, living quarters/camp, tailings/settling dam, treatment plant
Location: Spear Creek
Status: Application
Date of application: 08/09/93 **Date granted:**
Major mines/prospects: Spear Creek
Mining activity: New plant site for operating mine on ML 3097

Tenure: ML 40075

Name: Shady Glen
Commodities/purpose: Gold, silver, copper, platinum, tin, living quarters/camp, tailings/settling dam, treatment plant
Location: West Normanby Goldfield
Status: Granted
Date of application: 17/09/93 **Date granted:** 01/02/94
Major mines/prospects: Gilbert
Mining activity: Camp site

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Tenure: ML 40076

Name: Jodie

Commodities/purpose: Gold, stockpile ore/overburden, tailings/settling dam, treatment plant

Location: Palmer River

Status: Application

Date of application: 20/09/93 **Date granted:**

Major mines/prospects: Palmer River

Mining activity: Plant site for current mining operation

Tenure: ML 40077

Name: Jade 1

Commodities/purpose: Andalusite/sillimanite, gold, ilmenite/leucoxene, monazite, rutile, tin, tungsten, zircon

Location: Captains Bend, Palmer River

Status: Granted

Date of application: 12/10/93 **Date granted:** 01/04/94

Major mines/prospects: Palmer River

Mining activity: Not operating yet

Tenure: ML 40078

Name: Pink Patch

Commodities/purpose: Gold, corundum, chromite, living quarters/camp, tin, tailings/settling dam, treatment plant/mill site, zircon

Location: East of Mammoth Bend, Palmer River

Status: Granted

Date of application: 15/10/93 **Date granted:** 01/04/94

Major mines/prospects: Palmer River

Mining activity:

Tenure: ML 40079

Name: Timmy Boy

Commodities/purpose: Living quarters/camp, tailings/settling dam, treatment plant/mill site

Location: North Palmer River

Status: Granted

Date of application: 21/10/93 **Date granted:** 01/04/94

Major mines/prospects: North Palmer River

Mining activity:

APPENDIX 2

EXPLANATORY NOTES FOR THE MINERAL RESOURCE ASSESSMENT MAPS AND GIS

The potential for undiscovered mineral deposits in the CYPLUS area has been assessed in terms of mineral deposit types and their geological setting, based on available geological, geochemical, geophysical, mineral occurrence and exploration data. This mineral resource assessment is concerned with the probability of mineral occurrence, particularly mineral occurrences of sufficient size and grade to constitute economic (mineable) resources. Qualitative assessment methods developed by the United States Geological Survey have been used. The following sections describe the database fields used to define areas with mineral resource potential on the resource assessment maps (Maps 1 to 4) and in the CYPLUS GIS.

MAP AREA

A two-part alphabetical identifier (for example, AuA) is used on the maps and in the GIS to represent each deposit type. The first part of the identifier refers to the main commodity present; the second part refers to the mineral deposit model. A third identifier, a numeric code, is an area identifier assigned to specific areas with mineral resource potential. Each alphanumeric combination indicates a geographic area with a defined resource potential and level of certainty for a particular commodity in a particular deposit type.

Symbols used to represent commodities are as follows:

Au	Gold
Bm	Base metals (copper, lead, zinc)
Bx	Bauxite
C	Coal
Fe	Iron
Gs	Gemstones (diamonds, sapphires, zircons)
Hm	Heavy minerals (ilmenite, rutile, leucoxene, zircon, monazite, xenotime)
Ko	Kaolin
Ls	Limestone
Sb	Antimony
Si	Silica
Sn	Tin
W	Tungsten

A mineral deposit model is a description of the essential attributes or properties of a group or class of mineral deposits. Models are based on the geological characteristics of known and inferred deposits within or close to the study area. The models used in this report are based primarily on those of the United States Geological Survey (Cox & Singer, 1986), supplemented by models from other sources and modified to reflect the characteristics of known mineralisation in the study area. Table 2.1 lists the mineral deposit models used on the resource assessment maps and in the GIS.

RESOURCE POTENTIAL

The mineral resource potential of an area is a measure of the likelihood of occurrence of mineral deposits that may be economic within the foreseeable future, that is, within the next twenty years or so. Mineral resource potential is ranked using the qualitative terms **high**, **moderate**, **low**, **nil** and **unknown**.

High mineral resource potential is assigned to areas where geological, geochemical and geophysical characteristics indicate a geological environment favourable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral deposit models indicating presence of resources, and where evidence indicates

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TABLE 2.1: Mineral deposit models

Commodity/ model code	Mineral deposit model
AuA	Iron-formation-hosted gold
AuB	Mesothermal Au-quartz veins (Coen type)
AuC	Chert-hosted gold deposits
AuD	Syntectonic Au-quartz and Au-Sb-quartz veins (Palmer type)
AuE	Carbonate-hosted gold
AuF	Porphyry intrusion-hosted Au-base metal sulphides-quartz veins and stockworks
AuG	Au skarn deposits
AuH	Porphyry dyke-related Au-quartz veins and stockworks
AuI	Porphyry-related Au-breccia deposits
AuJ	Epithermal gold deposits
AuK	Alluvial placer gold
BmA	Porphyry copper
BmB	Cu and Zn-Pb skarn deposits
BmC	Basaltic copper
BmD	Volcanogenic massive sulphide deposits
BmE	Sediment-hosted Zn-Pb
BmF	Precambrian Cu-Zn volcanogenic massive sulphide deposits
BxA	Laterite type bauxite
FeA	Enriched iron formation
GsA	ES-diamond model
HmA	Shoreline placer heavy minerals
HmB	Alluvial placer heavy minerals
KoA	Laterite type kaolin
LsA	High-calcium limestone
SbA	Syntectonic Sb-Au deposits
SiA	Silica sand dunes
SnA	Tin veins
SnB	Tin greisen deposits
SnC	Porphyry tin
SnD	Tin skarn deposits
SnE	Alluvial placer tin
SnF	Shoreline placer tin
WA	Tungsten veins
WB	Tungsten skarn deposits

that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area (Toth & others, 1993).

Moderate mineral resource potential is assigned to areas where geological, geochemical and geophysical characteristics indicate a geological environment favourable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and/or where an application of mineral deposit models indicates favourable ground for the specified type(s) of deposits.

Low mineral resource potential is assigned to areas where geological, geochemical and geophysical characteristics define a geological environment in which the existence of mineralisation is possible but any deposits are unlikely to be economic. This broad category covers areas with dispersed but insignificantly mineralised rock as well as areas with few or no indications of having been mineralised.

Nil mineral resource potential is a category reserved for a specific type of resource in a well-defined area. This category has not been assigned to any areas in this study because of the broad, regional scale used for the assessment.

Unknown mineral resource potential is assigned to areas where information is inadequate to assign low, moderate or high levels of resource potential. All areas without a high, moderate or low resource potential can be considered to have an unknown potential.

LEVEL OF CERTAINTY

Levels of certainty are applied to mineral resource assessment categories in accordance with the definitions of Toth and others (1993):

A. Available information is not adequate for determination of the level of mineral resource potential.

B. Available information suggests the level of mineral resource potential.

C. Available information gives a good indication of the level of mineral resource potential.

D. Available information clearly defines the level of mineral resource potential.

COMMODITIES

This field lists the main commodities likely to occur in each area which has been assigned a mineral resource potential. Chemical symbols used represent the following metallic elements:

Ag	Silver	Pb	Lead
Au	Gold	Sb	Antimony
Cu	Copper	Sn	Tin
Fe	Iron	W	Tungsten
Mn	Manganese	Zn	Zinc

SIZE

The size classification used for the maps and GIS is given in Table 2.2 and is based on cutoff classes used by Parkinson (1988) in the Atlas of Australian Resources, and by the Canadian Geological Survey and the Northern Territory Geological Survey, with adjustments to the cutoffs for gold to adequately relate the sizes of Australian gold deposits (Dash, 1991). Cutoffs for kaolin have been included, taking into consideration the size of Queensland kaolin deposits. Sizes have been adjusted for lead and zinc to allow distinction of medium and large deposits in the Mount Isa area.

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TABLE 2.2: Size classification of deposits

Commodity	Size of deposit (tonnes)		
	Small	Medium	Large
Aluminium	<100 000 000	100 000 000 - 200 000 000	>200 000 000
Antimony	<5 000	5 000 - 50 000	>50 000
Arsenic	<5 000	5 000 - 50 000	>50 000
Asbestos	<100 000	100 000 - 10 000 000	>10 000 000
Barite	<50 000	50 000 - 5 000 000	>5 000 000
Beryllium	<10	10 - 1 000	>1 000
Bismuth	<5 000	5 000 - 50 000	>50 000
Cadmium	<5 000	5 000 - 50 000	>50 000
Chromium	<10 000	10 000 - 1 000 000	>1 000 000
Cobalt	<1 000	1 000 - 20 000	>20 000
Copper	<50 000	50 000 - 1 000 000	>1 000 000
Dolomite	<2 000 000	2 000 000 - 10 000 000	>10 000 000
Fluorite	<50 000	50 000 - 5 000 000	>5 000 000
Gold	<5	5 - 50	>50
Gypsum	<5 000 000	5 000 000 - 100 000 000	>100 000 000
Ilmenite	<5 000 000	5 000 000 - 10 000 000	>10 000 000
Iron	<5 000 000	5 000 000 - 100 000 000	>100 000 000
Kaolin	<200 000	200 000 - 20 000 000	>20 000 000
Lead	<100 000	100 000 - 2 500 000	>2 500 000
Limestone	<2 000 000	2 000 000 - 10 000 000	>10 000 000
Lithium	<10 000	10 000 - 100 000	>100 000
Magnesite	<2 000 000	2 000 000 - 10 000 000	>10 000 000
Magnesium	<100 000	100 000 - 10 000 000	>10 000 000
Manganese	<100 000	100 000 - 10 000 000	>10 000 000
Mercury	<10 000 (flasks)	10 000 - 500 000 (flasks)	>500 000 (flasks)
Molybdenum	<5 000	5 000 - 200 000	>200 000
Monazite	<20 000	20 000 - 50 000	>50 000
Nickel	<25 000	25 000 - 500 000	>500 000
Phosphate rock	<200 000	200 000 - 200 000 000	>200 000 000
Platinum, palladium	<5	5 - 50	>50
Precious gemstones	<1	1 - 10	>10
Rare earths	<1 000	1 000 - 1 000 000	>1 000 000
Rutile	<200 000	200 000 - 500 000	>500 000
Semi-precious gemstones	<10	10 - 100	>100
Silica	<1 000 000	1 000 000 - 2 500 000	>2 500 000
Silver	<500	500 - 10 000	>10 000
Talc	<1 000 000	1 000 000 - 10 000 000	>10 000 000
Tantalum	<1 000	1 000 - 100 000	>100 000
Tin	<5 000	5 000 - 100 000	>100 000
Titanium	<10 000	100 000 - 10 000 000	>10 000 000
Tungsten	<500	500 - 10 000	>10 000
Uranium	<10 000	10 000 - 40 000	>40 000
Vanadium	<500	500 - 10 000	>10 000
Zircon	<500 000	500 000 - 1 000 000	>1 000 000
Zinc	<200 000	200 000 - 5 000 000	>5 000 000

TYPE OF DEPOSIT

This field provides a simple description of the type of mineral deposit, for example, gold-quartz veins.

BIBLIOGRAPHY

COX, D.P. & SINGER, D.A. (Editors), 1986: Mineral deposit models. *United States Geological Survey, Bulletin,* **1693**.

DASH, P.H., 1991: A review of mineral occurrence data collection for metallogenic studies. Unpublished thesis submitted for progression to Senior Geologist. Queensland Department of Minerals and Energy, Brisbane.

PARKINSON, G. (Editor), 1988: *Atlas of Australian Resources. Third Series. Volume 5. Geology and Minerals.* Australian Surveying and Land Information Group, Department of Administrative Services, Canberra.

TOTH, M.I., WILSON, A.B., COOKRO, T.M., BANKEY, V., LEE, G.K. & CASE, J.E., 1993: Mineral resource potential and geology of the White River National Forest and the Dillon Ranger District of the Arapaho National Forest, Colorado. *United States Geological Survey, Bulletin,* **2035**.

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