Department of **Employment, Economic Development and Innovation**
Geological Survey of Queensland

Queensland Geological Record 2011/10

A review of Queensland's non-energy mineral deposits and resources

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Queensland Government

EXECUTIVE SUMMARY

This report was prepared to document Queensland's known mineral occurrences, deposits and resources for a variety of non-energy commodities.

Metals and ores of major importance produced in Queensland include aluminium (bauxite), copper, zinc, lead, gold and silver; the state also hosts significant resources of antimony, cobalt, indium, iron ore, molybdenum, nickel, rhenium, scandium, tin, tungsten, uranium and vanadium. A range of gemstones and industrial minerals is also produced, including chrysoprase, opal, sapphire, bentonite, kaolin and ceramic clays, calcined bauxite, diatomite, dimension stone, earthy lime, dolomite, feldspar, gypsum, limestone, magnesite, magnetite, mineral sands (rutile, ilmenite and zircon), perlite, phosphate rock, salt, silica sand and zeolite.

Given the wide range of geological terrains present in the state, Queensland remains highly prospective and offers excellent opportunities for the mineral exploration and mining sectors.

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SUMMARY

Queensland produces a broad range of metallic minerals (Figure 1). Given the wide range of geological terrains present in the state, Queensland remains highly prospective and offers excellent opportunities for the mineral exploration and mining sectors.

Metals and ores of major importance produced in Queensland include aluminium (bauxite), copper, zinc, lead, gold and silver; the state also hosts significant resources of antimony, cobalt, indium, iron ore, molybdenum, nickel, rhenium, scandium, tin, tungsten, uranium and vanadium. A range of gemstones and industrial minerals is also produced, including chrysoprase, opal, sapphire, bentonite, kaolin and ceramic clays, calcined bauxite, diatomite, dimension stone, earthy lime, dolomite, feldspar, gypsum, limestone, magnesite, magnetite, mineral sands (rutile, ilmenite and zircon), perlite, phosphate rock, salt, silica sand and zeolite.

Keywords. Mineral deposits; mineral resources; agate; aluminium; andalusite; antimony; apatite; aquamarine; arsenic; barite; bauxite; bentinite; beryl; beryllium; bismuth; brine; cadmium; chalcedony; chromium; clay; cobalt; copper; cordierite; corundum; diamond; diatomite; dimension stone; dolomite; earthy lime; extractive materials; feldspar; fluorite; gallium; garnet; gemstones; germanium; gold; graphite; halite; ilmenite; indium; iron; kaolin; kyanite; lead; leucoxene; limestone; lithium; magnesite; magnetite; manganese; mercury; mica; molybdenum; monazite; nickel; niobium; opal; peat; peridot; perlite; petrified wood; phosphate; platinum group metals; potash; quartz; rare earth elements; rhenium; rhodonite; rutile, sapphire; scandium; selenium; silica; sillimanite; silver; sodium bicarbonate; staurolite; structural clay; sulphur; talc; tantalum; tellurium; thorium; tin; topaz; tungsten; uranium; vanadium; vermiculite; wollastonite; yttrium; zeolite; zinc; zircon; Queensland.

INTRODUCTION

Queensland leads Australia in copper, lead, silver and zinc production and is Australia's second largest bauxite producer. Most of Queensland's base metal production is from the North West Queensland Mineral Province, which is one of the world's leading base metal provinces. Queensland is also Australia's third largest gold producer and has potential to become a significant producer of nickel, molybdenum, rhenium, scandium, tin and tungsten (Department of Employment, Economic Development and Innovation, 2009b).

This record was prepared to document Queensland's known mineral occurrences, deposits and resources for a variety of non-energy commodities. It provides baseline data for research under the Geological Survey of Queensland's Greenfields 2020 program. A condensed version will be included in the new "Queensland Geology"

book to be published in 2012 for the 34th International Geological Congress in Brisbane.

Not all resources quoted in this report are compliant with the Australasian Joint Ore Reserves Committee (JORC) Code for Reporting of Mineral Resources and Ore Reserves (The Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australalian Institute of Geoscientists and Minerals Council of Australia, 2004). In some cases, the figures quoted, particularly those published prior to adoption of the JORC Code in 1989, should be considered as geological estimates only. In all cases, the original reference is provided for the reader to assess the standard of the resource figures.

Resource data have been compiled up to 30 June 2011. The websites of individual companies or the Australian Securities Exchange (www.asx.com.au) should be checked for more recent data.

EXTRACTIVE MATERIALS

Extractive resources, or construction aggregates, are the primary source of materials used for building roads, ports, airports, bridges, railways, factories, hospitals, schools and houses. The quarries that exploit these resources to produce sand, gravel, crushed aggregates, armour stone, soil, loam and fill are vital for society in constructing the built environment (O'Flynn, 1992; Department of Employment, Economic Development and Innovation, 2009a).

While the existence and suitability of potential extractive resources is governed by geology, the availability of those resources is strongly dependant on economic, social and environmental constraints. Because extractive materials are high-volume and low-cost commodities, a major economic component of supplying material is the cost of transport. As a result, only those resources that are located close to the communities that use them are likely to be economically viable.

Social and environmental constraints have imposed limits on resource extraction to protect the community and the environment from adverse impacts. These constraints relate to noise, dust and visual amenity impacts as well as factors compromising environmental values such as biodiversity, remnant vegetation and threatened species. Those resources that can satisfy these constraint criteria can be developed as quarries and worked for aggregates. The maintenance of existing infrastructure and construction of new housing and community infrastructure create ongoing demand for aggregates and drives the need for resources to be located and developed.

Extractive resources used in construction are second only to coal in Queensland in total volume mined. Total production for 2009–10 was 43Mt, a decrease of 12% from the previous financial year, with 25Mt sourced from the South-East Queensland region. About 301 operating sites, including most large (>200 000 tonnes per annum) to medium (50 000 to 200 000 tonnes per annum) operations, reported production (Figure 2).

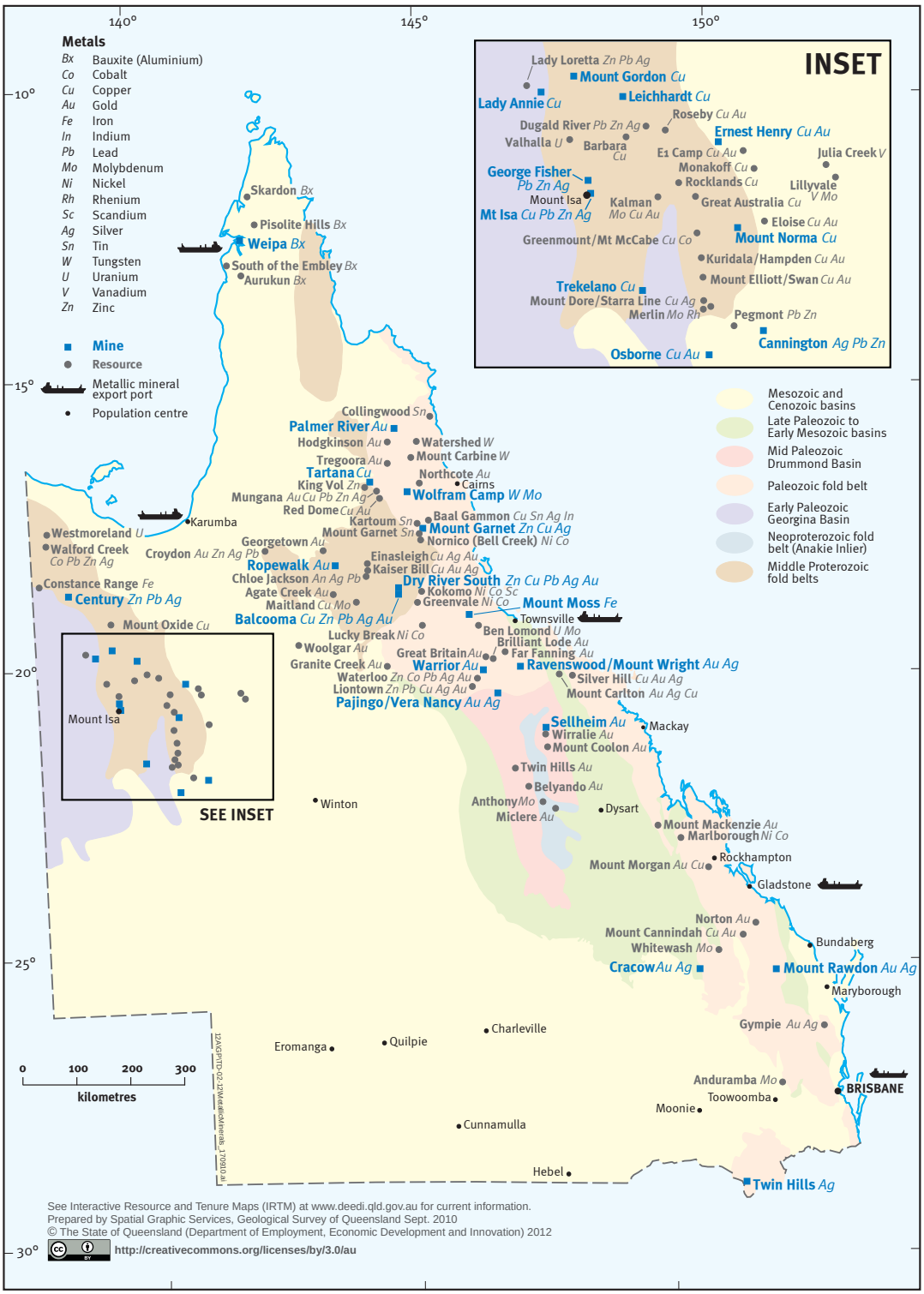

Figure 1: Distribution of major Queensland mineral mines and resources, September 2010

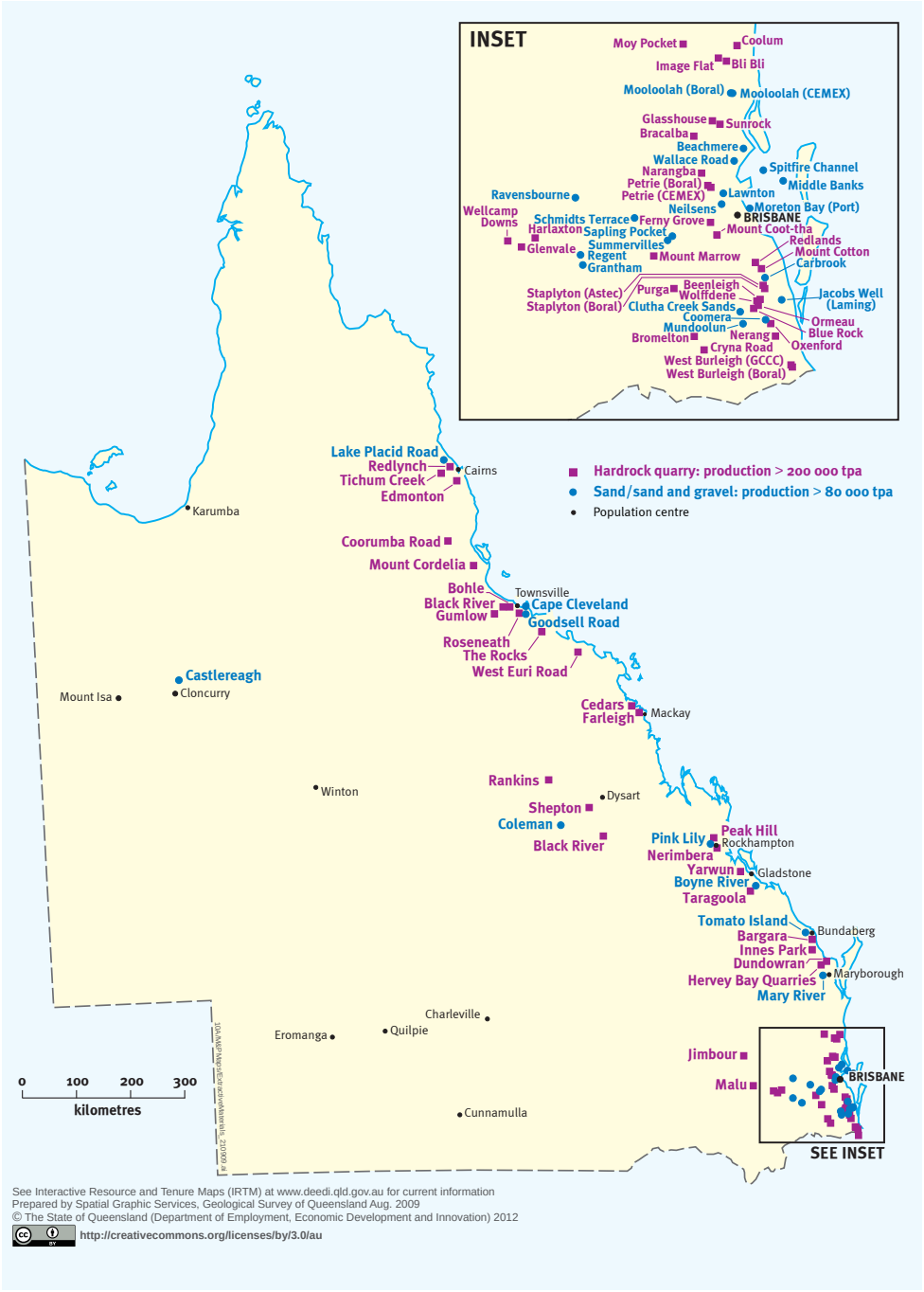

Figure 2: Queensland's major extractive materials sites

HARD-ROCK QUARRIES

Crushed aggregates are produced from a variety of rock types in Queensland. These include igneous rocks such as granite, trachyte, rhyolite and basalt, and a variety of metamorphic rocks, including greywacke, greenstone, hornfels and quartzite. The main rock types utilised are greywacke and basalt, which make up about 45 per cent of rock won from Queensland's hard-rock quarries.

SAND AND GRAVEL

Natural aggregates of sand and gravel are extracted mainly from off-stream alluvial deposits, coastal sand-dune systems, beach ridges and submerged tidal deltas in major estuaries, such as Moreton Bay. Increasingly, fine aggregate is being made by crushing quarry rock to produce manufactured sand.

GEMSTONES

Queensland's known gem deposits are quite diversified (Figure 3). Opals, sapphires and other gemstones are mined commercially for international markets. Gemstone production by value in 2009–10 totalled A$999 045 and was mainly from opal (66%) and sapphire (31%). The remaining gemstone production comes from small quantities of agate, chrysoprase, topaz, zircon, garnet and aquamarine (von Gnielinski, 2010).

Sapphires have been mined commercially for more than a hundred years on the Anakie field located west of Emerald in central Queensland. The state's opal fields lie within a 300 kilometre-wide belt extending from the New South Wales border, west of Cunnamulla, north through Quilpie, Longreach and Winton, to Kynuna. Most of the opal mined in Queensland is boulder opal, a form of precious opal unique to the state. Other gemstones of lesser importance are found throughout the state and are mined on a small scale or in conjunction with other minerals, to supply local tourist and lapidary markets. These include agate, thunder eggs, aquamarine, topaz, zircon and garnet. Queensland's gemfields support a 'cottage' industry where local stone is cut and polished for the domestic jewellery trade and tourist market.

Tourist and recreational fossicking are welcomed in Queensland and many visitors come to the gemfields, where specific areas have been established to exclude larger machinery mining and allow smaller tourist fossicking activities. Official fossicking areas occur in the Agate Creek (agate), Anakie (sapphire, zircon), Chinchilla (petrified wood), Cloncurry (amethyst, gold, maltese crosses), Emerald (gold), Gympie (gold), Mount Gibson (topaz), O'Brien's Creek (topaz, aquamarine, quartz), Opalton (opal), Quilpie (opal), Stanthorpe (topaz, smoky quartz), The Lynd (moonstone), Warwick (gold) and Yowah (opal) areas. In addition, a small number of private mining leases allow fossickers to collect material for a fee.

AGATE, CHALCEDONY, THUNDER EGGS

Chalcedony is the cryptocrystalline or microcrystalline variety of quartz (silica). It displays faint to well developed banding and the colour of true chalcedony is usually grey, cream or milky, often with pale tints of brown, green, blue, yellowish pink or reddish. If the colouring of individual layers is distinct, it is referred to as agate (Myatt, 1972). Agates occur as nodules (solid agate), or as geodes (an outer casing of agate with a central cavity lined or filled with clear crystalline quartz, amethyst, smoky quartz or calcite), roughly ellipsoidal or rounded in shape in various sizes

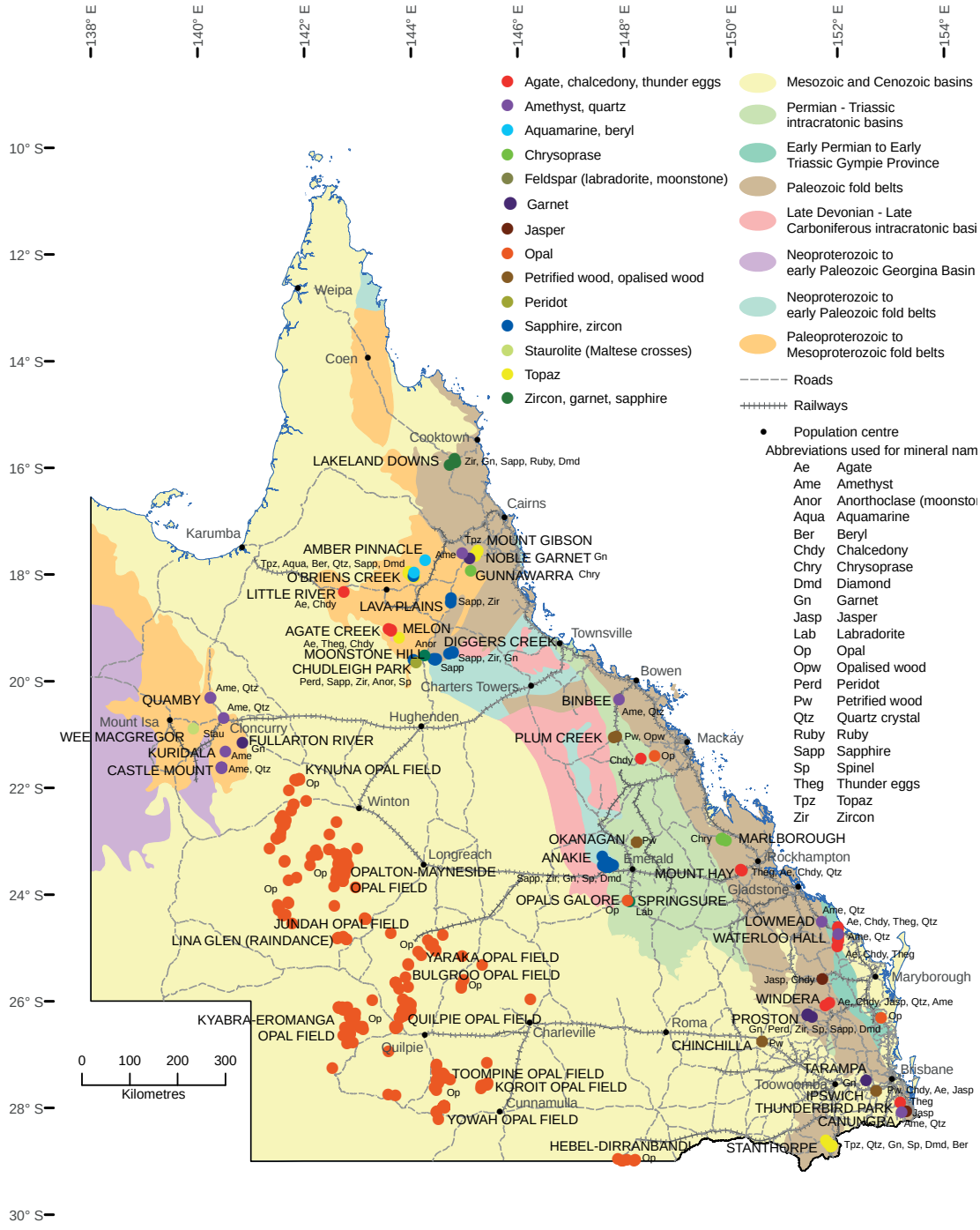

Figure 3: Gemstone occurrences and deposits

but averaging about 50mm. Agate is often multi-coloured and usually banded in straight, curved or irregular patterns. Thunder eggs are spherulites in rhyolite that may contain infillings of agate, chalcedony or jasper. Chalcedony and agate are important ornamental stones; they may also be cut into cabochons and beads or tumbled and polished. Thunder eggs are usually sawn in half and polished for use as ornamental stone or may be slabbed for use as book ends and clock faces.

Chalcedony, agate and thunder eggs occur widely in Queensland in association with volcanic rocks. Sources of material include decomposed and weathered rock and alluvial and eluvial deposits.

Agate Creek, south of Forsayth in north Queensland, is world renowned for agates of superb colours and patterns and is a Declared Fossicking Area. Agate occurs in amygdales (filled gas bubbles) and veins in the upper parts of basaltic andesite lava flows of the Black Soil Andesite (early Permian Agate Creek Volcanic Group). Thunder eggs occur in spherulitic lavas of the Thunder Egg Rhyolite. The agates are recovered from decomposed lavas, colluvial deposits and alluvium (Ridgway, 1945a; Hutchinson, 1965; Buchester, 1971; Withnall, 1981; Howard, 1996; Rees & Genn, 1999).

Agate from the Little River area, south-south-west of Gilbert River Homestead, was collected for exhibition purposes in 1903 (Dunstan, 1905a). The agate occurs as nodules in the Permian McFarlanes Andesite and is inferior in quality compared with material from Agate Creek (Denaro & Morwood, 1997). The deposits are on private property.

Agate, chalcedony, jasper and amethyst occur in alluvial and eluvial deposits derived from Triassic volcanic rocks on private property at Windera, west of Murgon in south-east Queensland (Murphy & others, 1976).

At Mount Hay, west of Rockhampton, thunder eggs, agate, chalcedony, agatised rhyolite, quartz crystal, amethyst and smoky quartz occur in spherulitic, rhyolite flows within a complex of acid volcanic plugs, flows and pyroclastics (Late Cretaceous Mount Salmon Volcanics) (Kay, 1981; Morwood, 2002b). Thunder eggs are produced commercially by Aradon Australia Pty Ltd and tourists can fossick at the Mount Hay Gemstone Tourist Park.

Tourists can also fossick for thunder eggs at Thunderbird Park at Mount Tamborine in south-east Queensland. The thunder eggs occur in spherulitic rhyolite of the Triassic Chillingham Volcanics.

AQUAMARINE AND BERYL

Pure beryl (beryllium aluminium silicate) is colourless but a wide range of impurities cause a diverse range of colours in greens, blues, pinks, purples and reds. Only transparent beryl is suitable for use as gemstone. Aquamarine is a blue to blue-green variety of beryl. Aquamarine and beryl are faceted for use in jewellery.

Gem quality beryl and aquamarine occur mostly in quartz-pegmatite dykes, veins and segregations within the Carboniferous Elizabeth Creek Granite in the O'Brien's Creek Gemfield and within unnamed Carboniferous granite at Amber Pinnacle, north-west and north of Mount Surprise in north Queensland (Brown, 1985; Lam & others, 1989; Barker & others, 1997). Rare aquamarine, along with crystalline quartz varieties and topaz, also occurs in alluvial gravels and colluvial hill wash at O'Briens Creek. Small, green, semi-transparent beryl crystals have been reported from stanniferous gravels and pegmatite dykes in the Stanthorpe area (Robertson, 1974; Denaro & Burrows, 1992). Queensland produced aquamarine worth A$4485 in 2007–08; no production was reported in 2008–09.

CHRYSOPRASE

Chrysoprase is a translucent green chalcedony that owes its colour to traces of nickel oxide compounds. Gem quality chrysoprase can be pale green, yellowish green, apple green, to deep green. It is usually translucent, but may become opaque in poorer quality material. The highest quality material is a rich apple green of even colour, without flaws, fractures, inclusions, cavities or other imperfections. Chrysoprase is rare and is the most valuable of the chalcedony group. Being an important ornamental gemstone, it is fashioned principally into cabochons, beads and bangles or is carved to produce jewellery and other objects. It is easily worked and takes a fine polish.

Australia is the world's principal producer of chrysoprase, and the major Australian deposits are in the Marlborough Block, about 90km north-west of Rockhampton. Chrysoprase is associated with nickeliferous laterite that has formed from the weathering of serpentinites and ultrabasic rocks of the Neoproterozoic to early Palaeozoic Princhester Serpentinite and occurs as veins and nodules in the magnesite-rich saprolite zone, underlying an iron-rich silica cap. During weathering, the silicate minerals decompose to iron oxides, releasing silica and nickel that migrate down through the developing laterite profile to precipitate as veins and nodules (Brooks, 1964a; Digby Matheson, 1967; Geological Survey of Queensland, 1978; Krosch, 1990b; Wilson, 1995; Garrad & Withnall, 2004; Downing, 2007). Marlborough chrysoprase is the best quality stone produced in the world. Queensland produced chrysoprase worth A$169,300 in 2007–08; no production was reported in 2008–09.

Gumigil Pty Ltd, a Hong Kong-based company, owns the Marlborough chrysoprase deposits. The Gumigil and Currawong mines have been producing chrysoprase for more than 30 years and currently export high quality chrysoprase to China. Three other chrysoprase leases occur adjacent to the Gumigil operations and are owned by Candala Pty Ltd, which produces ~15t per annum. Only 4.5% of this is "Grade A" material and only 0.05% of total production is absolute gem quality (Osmond & Baker, 2009).

Minor low quality chrysoprase is known to occur associated with nickeliferous laterites developed on serpentinised ultramafic rocks in the Kilkivan-Widgee area west of Gympie and in the Greenvale-Mount Garnet area of north Queensland but no production is recorded (Krosch, 1990b).

DIAMOND

Diamond is the hardest known natural substance and the most highly valued of all precious gemstones. It is the high pressure form of pure carbon. Only 20 % of mined diamonds are used in jewellery, as most are unsuitable. The other 80 % are use as abrasives and thermal insulators and in optics and electronics.

Although Queensland has no known commercial diamond deposits, diamonds have been recovered from time to time as a by-product of alluvial tin, gold and sapphire mining (Dunstan, 1913) and from heavy mineral sampling during mineral exploration.

Diamonds and microdiamonds have been found in the Stanthorpe (Skertchly, 1898; Ball, 1904a; Denaro & Burrows, 1992), Proston (Robertson & Robertson, 1994), Anakie (Robertson & Sutherland, 1992), Mount Isa, Gilberton, O'Briens Creek (Barker & others, 1997), Herberton and Lakeland Downs areas. All Queensland diamonds are very small (between four and eight to the carat) and may be regarded as isolated occurrences (Buchester, 1971).

There appears to be a regional difference in diamond occurrences in Queensland, with kimberlite and lamproite models favoured for the northwestern regions of the State and the subduction eclogite or S-type model (Barron & others, 1996; Sutherland, 1996) favoured for the eastern coastal and sub-coastal zones, linked to Cenozoic alkalic basalt volcanism. Sapphire is commonly associated with diamonds in eastern Queensland (Cranfield & Diprose, 2008).

Palaeozoic diamondiferous kimberlite pipes (for example, Merlin) intrude Proterozoic rocks of the North Australian Craton in the Northern Territory and studies in New South Wales indicate that diamonds also occur in economic quantities in Cenozoic alkali basaltic intrusions. Therefore, further exploration in Queensland is warranted based on geology and diamond indicator minerals and their composition (Cranfield & Diprose, 2008).

FELDSPAR

Labradorite is a plagioclase feldspar (sodium calcium aluminium silicate). It displays an iridescent play of colours (labradorescence) due to the interference of light on twinned lamellae and can be faceted or cut into cabochons and beads. Facetable, transparent, colourless to yellowish labradorite occurs in crystalline masses in a basalt lava flow near Springsure. Iridescent labradorite is also reported to occur near the head of the Dugald River in north-west Queensland (Jack, 1885).

Moonstone is a general term used to describe gem feldspar varieties that display adularescence, a milky, bluish lustre or glow ('schiller') caused by the interplay of light with stacked, alternating layers of different feldspar species. Anorthoclase, some of which is of gem quality, occurs in a scoria vent of the Cenozoic Chudleigh Basalt Province at Moonstone Hill, between Hughenden and Mount Garnet in north Queensland. The material has weathered out of the host rock and can be found on the ground surface and in soil around the lower flanks of the vent (Brown, 1986). Some specimens show a silvery white to bluish adularescence (presumably because of separation into albite and anorthoclase crypto-perthitic layers) and can be classified as moonstone. Moonstone Hill is within a General Permission Fossicking Area. Moonstone of poorer quality can also be found at the nearby Chudleigh Park peridot diggings.

GARNET

Garnet is a popular gemstone that is faceted for use in jewellery due to its hardness and durability. The common gem varieties include pyrope (blood-red to nearly black

and rose-red to violet), almandine (deep red to reddish brown to black), grossular (colourless to pink to red and green) and andradite (green, yellow, orange, reddish brown, brown and black).

Garnet is a common mineral associated with skarns, metamorphic rocks and alkali basalts and volcaniclastics in Queensland. However, stones of gem quality are very restricted in distribution.

The best known Queensland garnet locality is at Brigooda, near Proston in south-east Queensland, where garnet occurs with sapphire, peridot, spinel and rare diamond in soils and alluvium derived from Cenozoic alkali basalts and pyroclastic vent deposits (Hollis & others, 1983; Robertson & Robertson, 1994; Robertson & others, 1985). This was once a popular fossicking locality. The current Leurajoy mining lease produced stones commercially from 1996 to 2002.

Dark green grossular garnet of poor gem quality has been produced from quartz veins and weathered hornfelsed metasediments of the Hodgkinson Formation at the Noble Garnet lease, 2km south-west of Mount Garnet in north Queensland (Bruvel & others, 1991). A commercial mine has been operating since 1996.

Blood-red, brown, and brown-red pyrope garnet occurs in black volcanic soil and a basalt dyke at Tarampa, near Lowood in south-east Queensland. This occurrence is on private property.

Red garnets with a mulberry tinge occur in schist of the Proterozoic Soldiers Cap Group at the Fullarton River Gem Site on Maronan Station in north-west Queensland (Donchak & others, 1983; Denaro & others, 2003). Most have a black carbon speck in the centre but large stones can be cut in half to provide faceting material. Pyrope garnet has also been reported from the Dinosaur Rock area, west of Cloncurry.

Gem quality garnet occurs with sapphire and zircon in gravel wash at Diggers Creek in the Broken River area in north Queensland (Lam, 1995).

Garnets have also been found in alluvial tin wash in the Stanthorpe area, with sapphire and zircon in alluvium and volcaniclastic rocks in the Anakie area and in volcaniclastic rocks near Lakeland Downs.

OPAL

Precious opal (hydrated cryptocrystalline silica) is Australia’s national gemstone. Australia produces 95% of the world’s precious opal and probably has almost all of the world’s opal reserves (Horton, 2002) but the value to the Australian economy is unknown owing to the opal industry’s fragmented nature and inadequate official records. Production figures of between $100 million and $200 million per annum for uncut gems are generally quoted. Estimates from the various State governments support the more conservative figure. Australia exports most of its opals to Germany,

Holland, Japan, the USA and China. Queensland produced opal with a rough value of A$659,444 in 2009–10.

Australia has three main types of natural precious opal, with varieties defined by both body tone and transparency. Varieties include black opal from Lightning Ridge in New South Wales, white opal from South Australia, and Queensland boulder or matrix opal. Common opal (opalite) does not exhibit a play-of-colour. When common opal is found in association with precious opal, it is known as potch.

The term ‘boulder opal’ describes precious opal that occurs in deposits within weathered sedimentary rocks of Cretaceous age in western Queensland. Boulder opal is unique to Queensland. The boulder or matrix opal occurs as an infilling of pores and cavities or between grains of ironstone host rock. The ironstone host rock is generally elongated or ellipsoidal in shape, forming concretions or boulders that range in size from less than a few centimetres to >20cm. Boulders may be confined to one or more layers, known as the boulder layer, or may be randomly distributed throughout the weathered sandstone. Smaller ironstone concretions up to 5cm across are known as ‘nuts’ and may host a kernel of solid opal or contain a network of thin veins of opal throughout the ironstone. Similar to other precious opal types, there are many varieties of boulder opals as defined by body tone, play-of-colour and transparency, including black boulder opal and dark or light boulder opal.

Australian precious opal is a product of a unique set of geological events that occurred over a 100 million year period (Horton, 2002):

- Between about 122 and 91 million years ago, central Australia was covered by a vast shallow epicontinental sea. The sedimentary rocks that were deposited in this sea were derived from volcanic rocks and were organic-rich. These formed the principal host rocks for opal deposits in central Australia.
- Following surface exposure through lowering of the sea level, these host rocks were subjected to a prolonged sub-tropical weathering regime until about 40 million years ago. During this time, the water table was close to the surface and was acidic, releasing silica and iron from weathering of the host rocks.
- The climate became more arid from about 40Ma, water table levels gradually lowered, and the groundwater became alkaline. Mild tectonism at 24Ma gave rise to subtle extremely long wavelength surface folds that facilitated both lateral and vertical migration under arid conditions of the earlier-released silica. Opal was preserved in the weathered profiles beneath the crests of the developing surface folds, where water tables were lowered more rapidly due to tectonic uplift. Siliceous cap rocks discouraged erosion.
- Over the last 10 million years, dissection and scarp erosion exposed the weathering profiles containing the opal.

Queensland’s opal fields lie within a 300km wide belt of deeply weathered Cretaceous sedimentary rocks known as the Winton Formation in the Eromanga Basin (Jackson, 1902a; Jackson, 1902b; Jackson, 1903; Cribb, 1948; Connah, 1966; Brooks, 1967; Ingram, 1968; Connah, 1971; Krosch, 1983; Krosch, 1985a; Cooper & Krosch, 1993;

Department of Mines and Energy, 2000). This belt extends in a north-north-westerly direction from Hungerford on the New South Wales border to Kynuna in north-west Queensland, a distance of ~1000km, and west of the townships of Cunnamulla, Quilpie, Longreach and Winton. They include:

- Yowah field (the southernmost field centred on the small town of Yowah — includes Black Gate)
- Koroit field (north-east of Yowah)
- Toompine or Paroo field (east and south-east of Toompine — includes Lushingtons, Coparella, Fiery Cross, Duck Creek, Sheep Station Creek and Emu Creek)
- Quilpie field (west and north-north-west of Quilpie — includes some of the more productive mines in recent times: Pinkilla, Bull Creek, Harlequin and, probably the most famous of all, Hayricks
- Kyabra-Eromanga field (west and north-west of Eromanga) — includes Kyabra, Erounghoola and Quart Pot)
- Bulgroo field (north of Quilpie field in the Cheviot Range — includes the Bulgroo [or Germans] and Budgerigar to the north)
- Yaraka field — includes the mines in the Macedon Range, such as Mount Tighe
- Jundah field (west of Jundah over the Thompson River — includes Jundah and Opalville mines)
- Opalton-Mayneside field (centred on the old abandoned township of Opalton, and to the south in the Horse Creek-Mount Vergemont area)
- Kynuna field — the most northerly field, south of the township of Kynuna.

On average, individual opal fields cover areas of 0.05–5km^2, with opal mineralisation occurring in flat-lying layers at depths of up to 30m below the surface. Commonly, two or more levels of opal mineralisation may be present in any given field. Gem quality opals are seldom distributed evenly throughout a field. Distribution is sporadic and is usually related to structure or rock type, with rare rich pockets of opal. Opal mining is predominantly by open cut operations that involve overburden stripping to expose the ironstone boulders. Underground mining methods are applied with success in localised areas.

Exploration is continuing over potential opal-bearing country and an increasing interest from small exploration companies applying modern exploration techniques should lead to further discoveries. In addition to traditional opal fields, exploration for opal is also being carried out in the Hebel–Dirranbandi area near the Queensland–New South Wales border, where there is a 70km northern extension of the Cretaceous Griman Creek Formation, host to the Lightning Ridge opal field. Detailed exploration in the Hebel–Dirranbandi area has revealed gem quality black opal and prospective geological conditions.

Opal Horizon Ltd recently uncovered spectacular “pipe” opal deposits at its Lina Glen project near Jundah in western Queensland and commenced mining on its Raindance lease.

Small amounts of precious and common opal of volcanic origin also occur in basaltic and rhyolitic lavas and pyroclastics at a number of localities in eastern Queensland, for example, the operating Opals Galore mine near Springsure, which is hosted by Cenozoic basalt and tuff (Saint-Smith, 1922). Sandstone and ironstone hosted occurrences are also known in eastern Queensland.

A number of areas in western Queensland have been set aside for opal fossickers. These include the Yowah Fossicking Area and Opalton, Duck Creek and Sheep Station Creek Designated Fossicking Lands.

PERIDOT

Olivine, a silicate of magnesium and iron, is a common constituent of mafic and ultramafic rocks. Peridot is the transparent, pale to dark olive green gem variety of olivine and is faceted for use in jewellery.

Olivine, some of which is gem quality peridot, is common in Cenozoic basalts in eastern Queensland and is obtained from decomposed rock, soils and alluvial wash. Known localities include Tamborine Mountain, the Toowoomba area (Cameron, 1911; King, 2009), Gatton, Proston, the Atherton Tableland, the Russell Goldfield and Cooktown (Dunstan, 1913).

At the Chudleigh Park diggings, between Hughenden and Mount Garnet in north Queensland, gem quality peridot occurs with minor sapphire, zircon, moonstone and spinel in decomposed basalt, soil and wash on the slopes of a Cenozoic basalt cone known locally as Mount Batchelor (Levingston, 1979; Lam, 1994a). The diggings are popular with fossickers.

PETRIFIED WOOD

Petrified wood, also referred to as silicified or fossilised wood, is material formed by the replacement of wood by silica. The original form and structure of the wood is preserved in the process. Generally, the silica is in the form of opal or chalcedony (jasper, agate) and colours are often variegated in shades of grey, brown, cream, yellow, red and pink. Petrified wood is a popular ornamental material used mainly for decorative pieces (bookends, clock faces, ashtrays, etcetera) and for lapidary purposes as polished specimens, slabs, cabochons, tumbled stones and spheres.

Petrified wood occurs mainly in volcaniclastic and sedimentary rocks in Queensland’s Palaeozoic, Mesozoic and Cenozoic sedimentary basins and in their derived alluvium. The best known occurrence is in the Chinchilla area in southern Queensland where petrified wood is found in unconsolidated gravels capping low ridges of the Mesozoic Kumbarilla beds. It is sought after by lapidary enthusiasts for its quality and colours

and three General Permission Fossicking Areas have been set aside for fossickers. Similar deposits occur nearby at Brigalow, Warra, Miles and Wandoan (Myatt, 1972).

Other known locations include the Ipswich, Beaudesert, Redcliffe, Gatton, Warwick, Roma and Murgon areas and the central Queensland coalfields of the Bowen Basin (Sahni, 1920; Buchester, 1971; Myatt, 1972). In most localities, the petrified wood is accompanied by chalcedony, agate and jasper of varying quality.

Opalised wood is common throughout the opal fields of western Queensland.

QUARTZ

Quartz (silicon dioxide) is the second most common mineral in the earth's crust and is the most common gangue mineral associated with many orebodies. Because of its durability it is a common detrital mineral in alluvial deposits. Transparent gem quality crystalline quartz is a faceting stone and varieties include rock crystal (colourless), amethyst (pale mauve to deep purple), cairngorm or smoky quartz (deep golden to smoky brown to almost black) and citrine (pale yellow to yellowish brown). However, the coloured varieties of transparent quartz are rather rare and most quartz is translucent to opaque. Coloured material with good crystal structure (particularly amethyst and quartz geodes) is popular as an ornamental stone (Buchester, 1971; Myatt, 1972).

Quartz crystals, some of good specimen value, are common in veins and alluvial deposits in Queensland's gold, tin and tungsten fields. O'Briens Creek and the Stanthorpe district are well known for producing quality stones. Varieties found in Queensland include rock crystal, amethyst, cairngorm, citrine and rare rose quartz. The most popular variety with fossickers is amethyst.

Minor, poor quality 'zig-zag' zoned phantom amethyst and quartz crystals occur in cockade banded veins in the Naraku Granite north of Quamby in north-west Queensland. The fossicking site is covered by a Restricted Area but has been well worked over. The material is suitable for slabbing for ornamental purposes. A small deposit of low quality amethyst also occurs on private property as part of a milky quartz vein on two prominent quartz ridges associated with the Naraku Granite and Mitakoodi Quartzite 3km north-west of Cloncurry (Denaro & others, 2004a).

Amethyst occurs as singly- and doubly-terminated crystals in veins cutting pegmatite and muscovite schist of the Kuridala Formation at the Kuridala Gem Site, 65km south of Cloncurry. Amethyst also occurs with quartz in banded, laminated and comb-textured veins in the Gin Creek Granite at the Castle Mount (Amethyst Castle) Gem Site, 100km south of Cloncurry. These localities are covered by Restricted Areas but have been worked by fossickers for many years and good quality stones are increasingly difficult to find (Donchak & others, 1983; Denaro & others, 2003).

Good quality amethyst, including some well formed crystals, occurs in vughs in a quartz blow on the contact of a rhyolitic ash flow of the Claret Creek Volcanics and the Emuford Granite north-west of Mount Garnet (Lam & others, 1988).

Zoned amethyst and quartz crystals occur within vughs in weathered Thunderbolt Granite at Binbee between Bowen and Collinsville (Horton, 1976; Denaro & others, 2009). Many of the crystals are fractured or contain inclusions that make them valueless. The site is covered by a Restricted Area but has not yet been designated a fossicking area.

Amethyst and quartz crystals occur in vughs, pockets and layers in soil and decomposed granodiorite of the North Gwynne Granite near Lowmead. Colour zoning is common and deep violet purple gem quality crystals are rare (Ellis & Whitaker, 1976; Robertson, 1978). This site was once popular with fossickers but little good quality material remains.

Small, well formed quartz crystals, some with amethystine tops, occur in small quantities in weathered granite south-east of the Waterloo Hall near Bundaberg.

Amethyst and quartz crystals occur with chalcedony and common opal in veins in the Chillingham Volcanics at Back Creek south-east of Canungra in south-east Queensland (Brooks, 1965a). This locality is within the Canungra military training ground.

RHODONITE

Rhodonite is a pink to rose-red manganese silicate, generally with black streaks and bands of manganese oxides, that generally occurs associated with manganese ore deposits. It is popular as an ornamental stone and is cut into cabochons for jewellery.

Queensland does not have any significant occurrences of high quality rhodonite. However, minor, poor quality rhodonite is associated with many of the numerous, small manganese oxide orebodies in the Warwick, Kilcoy, Kenilworth, Gympie, Kilkivan, Gayndah, Gin Gin and Bajool areas (Dunstan, 1913).

RHYOLITE AND OTHER ORNAMENTAL SILICEOUS VOLCANIC ROCKS

Green and blue, banded, cherty dacitic tuff, locally termed ‘Gympieite’, occurs in the Rammutt Formation near Gympie. It has been mined and promoted as a semiprecious gemstone (Barker & others, 1993) but the site is now closed to collectors.

Flow-banded rhyolite that takes a good polish occurs at Wappa Dam near Nambour (Myatt, 1972). The stone is banded in reds, greens, browns, greys and whites and has been popular with lapidarists in the past.

Spherulitic rhyolites from thunder egg localities such as Mount Hay and Thunderbird Park have also proved popular as ornamental stone.

SAPPHIRE AND ZIRCON

Sapphire is a gem variety of the mineral corundum (aluminium oxide) and one of Queensland's most important gemstones. Sapphire occurs widely on Queensland, but the only deposits of commercial significance are the Anakie field in central Queensland and the Lava Plains field in north Queensland (Jack, 1892; Dunstan, 1902a; Dunstan, 1902b; Ball, 1905a; Ball, 1913; Cribb, 1953; Geological Survey of Queensland, 1978; Krosch & Cooper, 1990; Neville & von Gnielinski, 1999). Most of Queensland's sapphire production comes from the Anakie field, west of Emerald, where commercial mining has occurred for more than 100 years. Gem quality zircon (zirconium silicate) is a common accessory mineral in sapphire-bearing alluvial deposits. Queensland produced gem sapphire and zircon worth A$307,881 and A$9017, respectively, in 2009–10.

Sapphire and zircon deposits in Queensland are mainly associated with Cenozoic alluvial deposits derived from the weathering and erosion of Tertiary alkali-volcanic rocks (basaltic lavas, pyroclastics and volcaniclastics) of the Eastern Australian Cenozoic Igneous Province (Robertson & Sutherland, 1992; Oakes & others, 1996; Sutherland, 1996). Varieties of sapphire recovered from mining include dark blue, multi-coloured (parti-colours) and fancy stones in green and yellow. A large proportion of sapphires mined commercially are medium to dark blue due to their high iron content. Most sapphires are 'heat treated' to improve clarity and colour. Only the blue stone is sold in volume to the world market. Production is made up of a significant quantity of smaller commercial size stone suitable for cutting into 2–3mm calibrated stones for the mass jewellery market. The bulk of commercial sapphires produced in Queensland are exported to Thailand as rough stone with very little value adding done in Australia.

Mining varies from simple hand mining methods (suitable for working shallow surface wash deposits) to large-scale open cut operations employed on the deeper ground. Techniques for processing the wash to concentrate sapphires and heavy minerals range from rudimentary hand sieving and washing to mechanised plants. Gem-quality zircons (clear, pink to red, and yellow) and rare diamonds are recovered with the sapphires.

Tertiary-age sapphire-bearing palaeodrainage systems in the Anakie field have been reworked by modern drainage systems to form the main sapphire-bearing alluvium. Remnants of older alluvium occur in many areas as primary, high-level gravels (known as wash by the miners) on elevated ridges between or adjacent to the present drainage. Sapphire-bearing alluvium may be exposed at the surface or covered by up to 20m of barren overburden. Sapphires and associated heavy minerals (zircon, spinel, corundum, garnet, topaz) are commonly concentrated in 'runs' along particular drainage channels. The character and size of sapphire grains, associated heavy mineral assemblages and detritus varies considerably. The most intense mining has

taken place in the Rubyvale-Sapphire area, where large-scale machinery mining has exploited wash at depths of up to 20m below the surface (Krosch & Cooper, 1990). The probable original source of the sapphires is the Hoy Basalt, represented by a group of at least 70 eroded volcanic vent plugs that intrude the pre-Devonian age Retreat Granite. The Hoy Basalt is characterised by porphyritic olivine and contains inclusions of basic plutonic rocks, especially peridotite (Robertson, 1983).

The Anakie field is popular with recreational fossickers and there are Declared Fossicking Areas at Big Bessie, Glenalva, Graves Hill, Middle Ridge and Tomahawk Creek and Designated Fossicking Lands at Divide, Reward, Rubyvale, Sapphire, Scrub Lead and Willows.

The smaller Lava Plains field, between Greenvale and Mount Garnet in north Queensland, differs markedly from the Anakie field because the basalt hosting the sapphires crops out at the surface. Sapphires in the Lava Plains field occur in modern eluvium, colluvium and alluvium derived from eruptive Cenozoic volcanics of the McBride Basalt Province in the vicinity of a limited number of vents. The sapphires are hosted by brown and black clayey soils containing vesicular basalt rock fragments, basalt cobbles and boulders. Associated minerals in the wash include zircon, ilmenite, olivine, hematite and feldspar. The main mining areas are centred on Wyandotte Creek and Mines Hill (Krosch & Cooper, 1990; Barker & others, 1997). Two Restricted Areas have been designated to facilitate the grant of a future fossicking area.

Sapphires and zircons of variable quality have also been found associated with alluvial tin wash in the Stanthorpe, Elizabeth Creek – O'Briens Creek, Herberton, Mount Garnet, Cooktown and Kangaroo Hills areas. Other known occurrences include Dalrymple Creek east of Warwick, Googa Googa Creek near Blackbutt, Burrandoan Station south-west of Kingaroy, Kingar Creek west of Gayndah, Brigooda near Proston, Seven Mile Diggings near Nanango, Don River south-east of Dululu, Jordan and Henrietta Creeks west-south-west of Innisfail, Russell Goldfield near Innisfail, Etheridge Goldfield, Campbell and Spear Creeks south of Laura, Lakeland Downs and Chudleigh Park areas (Dunstan, 1913; Krosch & Cooper, 1990), and Diggers Creek in the Broken River area (Lam, 1995).

The commercial production of sapphires in Queensland has been in decline since the late 1970s, and only intermittent improvements to prices and markets have occurred since. The downturn in sapphire production has been partially the result of increased production from low-cost sources such as Madagascar, Nigeria and Tanzania.

STAUROLITE

Staurolite is abundant in pelitic schist of the White Blow Formation at the Wee MacGregor Creek Gem Site, south-west of Cloncurry in north-west Queensland. The staurolite occurs as twinned crystals (Maltese crosses) and the site is popular with fossickers (Denaro & others, 2004a).

TOPAZ

Topaz (aluminium fluorosilicate) is a very popular gemstone and Queensland produced gem quality material worth A$5265 in 2009–10. Clear topaz is the most common but blues and pale yellows are also found.

Topaz crystals showing good form and clarity are found in the Mount Gibson Fossicking Area, near Innot Hot Springs in north Queensland. The topaz is usually colourless but rare golden and blue colours have been found. The topaz is recovered from scree and from vughs in cassiterite-bearing quartz veins and quartz-greisen rock derived from a pendant of hornfelsed Hodgkinson Formation metasediments in the roof zone of a Permo-Carboniferous granitic batholith with late-stage topaz-bearing intrusions of the Mount Gibson Microgranite (Bruvel & others, 1991; Johnston & Chappell, 1992).

The O'Briens Creek Gemfield, a Declared Fossicking Area near Mount Surprise in north Queensland is well known for gem quality topaz and attracts visitors from all over Australia and overseas. Topaz, along with crystalline quartz varieties and rare aquamarine, is found in alluvial gravels and colluvial hill wash. The gems are derived from cassiterite-bearing veins and alteration zones, quartz-pegmatite dykes and segregations within the Carboniferous Elizabeth Creek Granite (Lam & others, 1989; Barker & others, 1997).

Gem quality topaz can be recovered from alluvium and tailings from old tin mining operations in the Stanthorpe area in south-east Queensland (Denaro & Burrows 1992). The topaz is commonly colourless but pale blue stones have been found. Stones are generally waterworn but crystals are not uncommon. Other gems associated with the topaz include clear and smoky quartz and rare garnet and zircon. The gems are derived from cassiterite-bearing veins and greisen zones in the Triassic Stanthorpe and Ruby Creek Granites. A General Permission Fossicking Area has been set aside at Swiper's Gully in the Passchendaele State Forest.

Minor topaz has been produced from alluvium at the Melon deposit near Mount Hogan in north Queensland.

INDUSTRIAL MINERALS AND ROCKS

Queensland is a significant producer of industrial minerals, including bentonite, kaolin and ceramic clays, diatomite, dimension stone, dolomite, gypsum, limestone, magnesite, magnetite, mineral sands (rutile, ilmenite and zircon), peat, perlite, phosphate rock, salt, silica sand and zeolite. The State also hosts occurrences and deposits of other industrial minerals, some with potential for future production.

ALUMINOSILICATES (ANDALUSITE, CORDIERITE, KYANITE, SILLIMANITE AND STAUROLITE)

The aluminosilicates andalusite, cordierite, kyanite and staurolite are common regional metamorphic minerals. Andalusite and cordierite is also common in hornfels produced by contact metamorphism of pelitic rocks.

Andalusite and sillimanite are used in refractory products, mainly for the iron and steel industries, and also in the aluminium, cement, foundry, insulation and petrochemical industries. Cordierite is used in the manufacture of ceramics for catalytic converters. Kyanite is used in refractory, glass and ceramic products, electronics, electrical insulators and abrasives. Staurolite is used as an abrasive, particularly in sandblasting, as foundry sand, as a filler in paint primers and as a source of alumina for cement production. Queensland does not currently produce any aluminosilicate minerals but a number of occurrences are known (Figure 4).

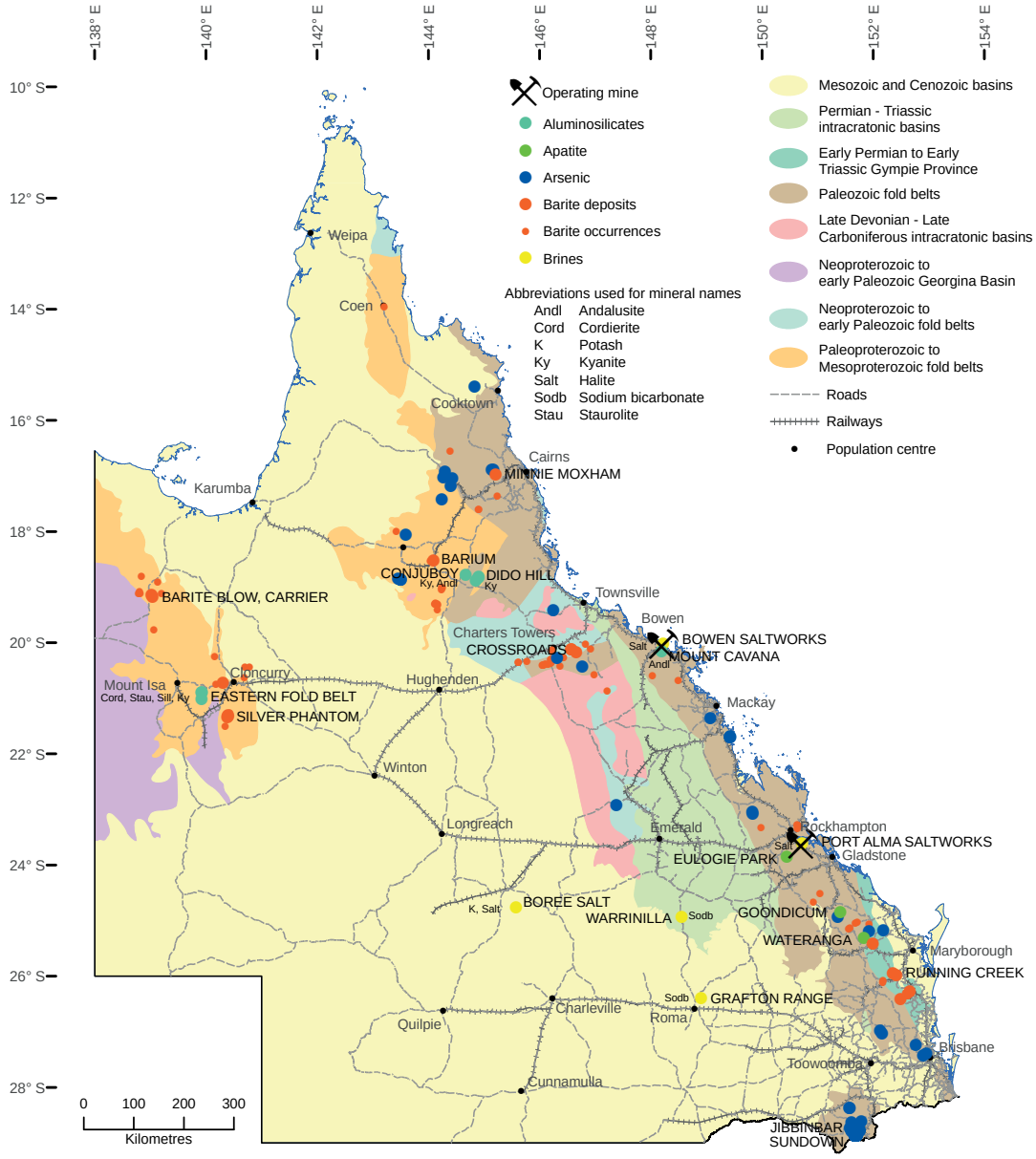

Figure 4: Aluminosilicate, apatite, arsenic, barite and brine occurrences and deposits

Andalusite-bearing quartzite crops out at Mount Cavana, 15.5km south of Bowen. The quartzite comprises very fine grained quartz, muscovite, andalusite and almandine garnet with fine-grained pyrite and is possibly a contact metamorphosed roof pendant in an area of Carboniferous to Permian intrusives. The deposit has been estimated to contain ~9.7Mt of quartzite grading 12–15% Al_2O_3 (average 13.2%) (Clayton & Bichard, 1988; Denaro & others, 2009).

Timmins (1990) described a quartzite ridge in the early Palaeozoic Balcooma Metavolcanic Group (Thalanga Province) in an area south-south-west of Conjuboy Homestead in north Queensland. The quartzite contains widespread kyanite and andalusite, with lesser corundum, diaspore, muscovite, topaz, apatite and aluminium phosphates. Withnall & Grimes (1991) highlighted the potential of these aluminosilicate rocks as a source of material for refractory products.

A quartzite unit of the early Palaeozoic Lugano Metamorphics (Thalanga Province) at Dido Hill, south-east of Conjuboy Homestead, has been reported as a potential source of kyanite for the manufacture of refractory products (Withnall & Grimes, 1991; Barker & others, 1997). The quartzite contains up to 25% kyanite (Withnall, 1989) but is replaced by phyllosilicates in places.

Aluminosilicate-bearing rocks occur throughout the Eastern Fold Belt Province of the Mount Isa Inlier in north-west Queensland. Staurolite is abundant in pelitic schist of the White Blow Formation near the Wee Macgregor mine. Andalusite-bearing schists occur in the Cloncurry, Duchess and Snake Creek areas. Cordierite-anthophyllite rock has been reported from the Snake Creek, Rosebud mine and Little Sunset mine areas; large tonnages of rock at the Little Sunset probably contain >30% cordierite. Sillimanite-bearing schists occur in the Dugald River area and kyanite has been reported from the Kajabbi area. Cordierite occurs with chlorite in a lens in calc-silicate granofels of the Corella Formation north of Duchess (Carter & others, 1961; Reinhardt, 1987; Denaro & others, 2003; Denaro & others, 2004a).

Minor occurrences in Queensland include andalusite at Cape Upstart, Rookwood and Mount Samford, kyanite near Kilkivan, sillimanite at Ebagoola, and staurolite at Chillagoe (Dunstan, 1913) and andalusite in altered andesite at Mount Perry (Denaro, 1986; Duggan & others, 1990).

APATITE

Apatite (calcium fluoro-chloro-hydroxyl phosphate) is the most common phosphate mineral and apatite-rich rocks are a source of phosphorous for fertiliser manufacture. Apatite is also used in the chemical, water treatment and pharmaceutical industries and can be used as an ore mineral for rare earth metals.

Queensland's significant apatite resources are all within Late Permian to Late Cretaceous layered gabbro complexes in central and south-east Queensland and their derived eluvium and alluvium (Figure 4). Monto Minerals NL produced 6896t apatite from eluvial material at Goondicum between 2004 and 2009. The project had proved

reserves of 110 000t apatite and measured, indicated and inferred resources of 0.65Mt apatite (Moore, 2003; Monto Minerals NL, 2005). Apatite also occurs associated with the Wateranga Gabbro, where Queensland Industrial Minerals Ltd has delineated measured, indicated and inferred unconsolidated ores with ~1.17Mt apatite and inferred hard rock resources with 26.5Mt apatite (sourced from Queensland Industrial Minerals Ltd website, April 2009). The Eulogie Park Gabbro contains cumulate bands with ilmenite, titanomagnetite, feldspar, vanadium oxide and minor apatite (Wilson & Mathison, 1968; Brooks, 1970); alluvial, eluvial and flood plain mineral sands are widespread.

ARSENIC

Arsenic was mined in the Sundown and Jibbinbar areas in the Stanthorpe district to produce arsenic oxide for poisoning the then prickly pear infestation that was threatening to decimate agriculture and grazing in south-east and central Queensland. Arsenic was also used in cattle dips and for hardening lead for bullets. White arsenic oxide was produced by roasting arsenopyrite-rich ores and condensing the fumes at treatment plants at Jibbinbar, Sundown and Wallangarra. The State Arsenic Mine at Jibbinbar was run by the Queensland Government to provide subsidised arsenic oxide to farmers. Total recorded production from 1917 to 1927 was 2290.5t of arsenic oxide and 2150.3t of arsenic concentrates (Denaro & Burrows, 1992).

At Sundown and Jibbinbar (Figure 4), arsenopyrite is associated with cassiterite and copper in quartz greisen lodes and sheeted vein systems in hornfelsed Texas beds and the intruding Ruby Creek Granite (Dunstan, 1917a; Jensen, 1918a; Jensen, 1918b).

Arsenopyrite is known to occur in tin, gold and base metals lodes in many other parts of the State (Dunstan, 1917a; Jensen, 1918b; Ball, 1919; Taylor, 1919; Dunstan, 1921c; Dunstan, 1922; Dunstan, 1926) but no production of arsenic compounds has occurred.

BARITE

Barite (barium sulphate) is a fairly common accessory mineral, along with quartz and calcite, in the gangue of Cu, Pb, Zn, Au and Ag ores. It also occurs as bedded sedimentary deposits and as lenses associated with volcanogenic and exhalative deposits. Barite is used as a commercial source of barium and many of its compounds. Ground barite is used as a filler in the manufacturing of linoleum, oilcloth, paper, textiles, rubber, plastics, pottery, pharmaceuticals and cosmetics. Finely ground barite is used to make a thixotropic drilling mud. Prime white, a bleached barite, is used as a pigment in white paint. Barite's high density makes it opaque to x-rays and it is given to patients before imaging the shape of internal organs by x-ray.

Queensland does not produce barite and known deposits are small in size (Figure 4). Barite occurs in vein deposits in the Palaeozoic rocks of eastern Queensland (for example, Minnie Moxham, Crossroads, Running Creek) and Proterozoic rocks of the Etheridge Province (for example, Barium) and Mount Isa Inlier (for example, Barite

Blow, Carrier, Silver Phantom). Barite Blow, 165km north-north-west of Mount Isa, has an estimated geological resource of 101 600t at 20% barite (Carpentaria Exploration Company Pty Ltd, 1971). Barite is a common gangue mineral in volcanogenic base metal deposits in the Rockhampton and Charters Towers areas and Cannington and Mount Isa style Ag-Pb-Zn deposits in the Mount Isa-Cloncurry region.

BRINES

Halite

As well as its use in food manufacturing and preparation, halite (sodium chloride) is used in textile manufacturing, metal recycling, rubber manufacturing, soap making, hide and skin processing and tanning, water conditioning and softening, livestock food supplements, and the chemical and pharmaceutical industries.

The east coast of Queensland has the necessary conditions for the manufacture of sea salt (halite), including:

- extensive areas of flat coastal land, covered only by high tides, and having a surface of clay impervious to water (for example, Moreton Bay, Keppel Bay and Port Curtis)
- suitable climatic conditions (Dunstan, 1913).

Historically, saltworks were established in Queensland at Burketown, Mine Island, Bowen, Mackay, Port Alma near Rockhampton, Port Curtis near Gladstone and Redland Bay near Brisbane. Only the Bowen and Port Alma saltworks are still operating (Figure 4).

Cheetham Salt Limited, a wholly-owned subsidiary of the Ridley Corporation Limited, is Australia's largest producer and refiner of salt and operates the Port Alma saltworks 40km south-east of Rockhampton, and the Bowen saltworks near Bowen. The salt is recovered from evaporative salt pans (Geological Survey of Queensland, 1978; Department of Employment, Economic Development and Innovation, 2009a) and shipped to Botany Bay in New South Wales for the manufacture of caustic soda and chlorine and is also supplied to Orica Australia Pty Ltd in Gladstone for the chlorine production. Queensland produced 92 158t of salt in 2009–10.

Queensland also possesses some ephemeral salt lakes such as Lakes Buchanan, Galilee, Wyara, Barcoorah and Mueller. These occur in areas with closed, internal drainage systems.

Potash

Potash is a general name for any mineral that contains potassium, most usually potassium chloride or potassium carbonate. Potassium is an essential element in fertilisers for food and forage crops. Other uses include the production of livestock

feed supplements, glass, ceramics, soaps, chemical dyes, drugs, synthetic rubber, de-icing agents, water softeners and explosives.

In Queensland, potash occurs as sylvite (potassium chloride) in the Boree Salt Member of the Etonvale Formation, which occurs along the western edge of the Adavale Basin south of Blackall (Figure 4). The Boree Salt Member, an evaporite sequence of halite, sylvite, mudstones and anhydrite is estimated to be of the order of several tens of cubic kilometres in volume and is up to 500m thick at depths of between 2000 and 2500m below ground surface (Bluck & others, 1982; Campbell & King, 2009). Bromine contents of the salts are of the order of 200–300ppm for halite and 2000–20 000ppm for sylvite. AusPotash Corporation (Queensland Potash Pty Ltd), Boree Potash Pty Ltd, Holocene Pty Ltd and Innovative Energy Consulting Pty Ltd are carrying out studies into the feasibility of mining the salt by an injected solution mining process. Innovative Energy Consulting Pty Ltd is also investigating the potential of the Boree Salt Member for underground cavern development for temporary storage of petroleum products and permanent storage of carbon dioxide, nuclear waste and other solid wastes.

Sodium bicarbonate

Sodium bicarbonate (baking soda) is used widely in food manufacture, pharmaceuticals, mineral processing and other industries. Major derivative products such as sodium carbonate (soda ash) and caustic soda are used in a number of industries including chemicals, glass manufacture, pulp and paper industries, the manufacture of detergents and water treatment.

Sodium bicarbonate occurs in high salinity brines in the Precipice Sandstone, which is 800 to 1000m below ground surface in the Surat Basin at Grafton Range, north-east of Roma (Figure 4). Resources have been estimated at 2.2Mt of sodium bicarbonate in brines with 14mg/litre sodium bicarbonate (Laing, 2003; Queensland Department of Mines and Energy, 2006). The sodium bicarbonate originates from the underlying Aldebaran Sandstone, which contains up to 25 000mg/litre of sodium bicarbonate at Warrinilla, 160km to the north. Pacific Enviromin Ltd is investigating the feasibility of production from the Grafton Range brines by solar evaporation and reverse osmosis (Pacific Enviromin Limited, 2008).

CALCINED BAUXITE

Bauxite is mainly used in the production of aluminium metal, but small amounts are processed into calcined bauxite, which is used in high alumina refractory bricks and shapes, plastics, castables, mortars, abrasives and grinding and polishing agents. Queensland's largest bauxite deposits, near Weipa on Cape York Peninsula, produced 58 905t of calcined bauxite in 2008–09 (von Gnielinski, 2010).

CLAYS

Queensland is well endowed with deposits of a range of clay types (Figure 5).

Bentonite

Bentonite is a complex absorbent clay mineral of the montmorillonite group that has unique swelling properties and multiple industrial uses, based on the chemical activity provided by the mineral's cation exchange characteristics. Bentonites are used in drilling muds, foundry sands, animal feed, pet litter, waterproofing sealants, absorbents, catalysts, ceramics, pesticides, paints and filtration and clarification of animal, vegetable and mineral oils.

Bentonite deposits form *in situ* by the alteration of minute glass particles in volcanic ash or tuff beds that were deposited in sedimentary sequences characterised by low energy depositional environments and temperate climatic conditions. Bentonite deposits are hosted by and associated with argillite, mudstone, siltstone, sandstone, tuff, agglomerate, ignimbrite, marl, shale, zeolite beds and coal. World-wide, most

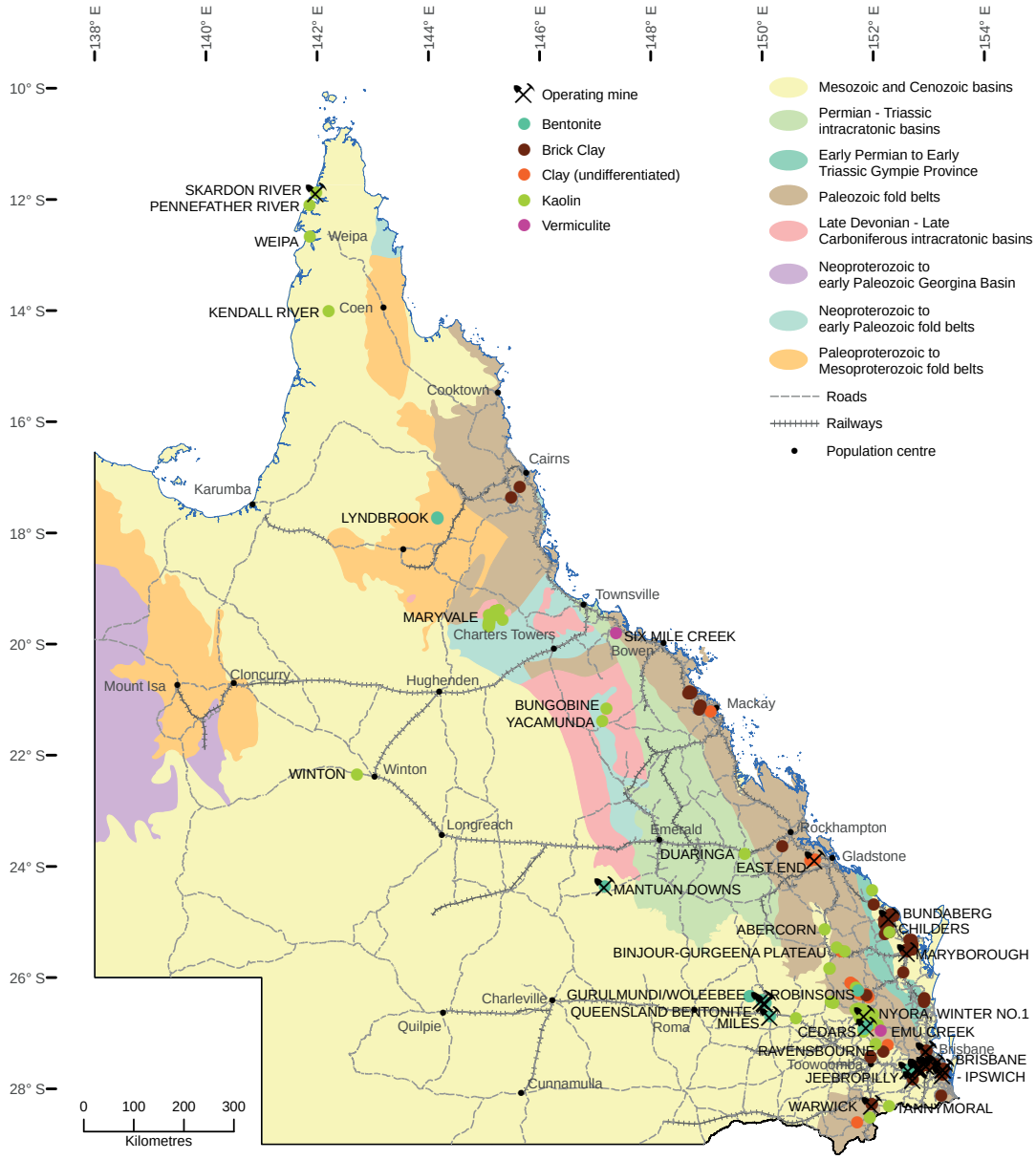

Figure 5: Clay occurrences and deposits

economic bentonite deposits are of Cretaceous age or younger. However, Queensland occurrences are mainly Jurassic in age and some are Palaeozoic.

The most common and commercially significant natural bentonites are sodium (generally swelling), calcium (generally non-swelling) and calcium-magnesium varieties. Activated bentonites are natural bentonites treated to produce a wider range of applications; calcium bentonite can be converted to sodium bentonite by the addition of soda ash. Most of Queensland's major bentonite deposits are principally sodium bentonite. Premium grade sodium bentonite has exceptional water absorbency and cation exchange capacity. The value (grade) of the product depends on the type of impurities, colour, size of clay particles, cation exchange capability, rheological properties and structure of the clay.

Queensland is the major bentonite producing state in Australia, with production from large, shallow open cut deposits in the State's south-east. Bentonite production in Queensland was 103 055t in 2009–10. Known resources and reserves contain ~44.4Mt of bentonite (Table 1).

The largest bentonite resources in Queensland are in the Miles–Gurulmundi region of the Darling Downs, 300km west of Brisbane, where Sibelco Australia Ltd mines the Woleebee, Gurulmundi and Gurulmundi North deposits. Bentonite occurs as lenticular, bedded deposits near the top of the Late Jurassic Orallo Formation, just below its contact with the Cretaceous Mooga Sandstone (Sawers & Cooper, 1985).

Non-swelling calcium bentonite at Mantuan Downs in central Queensland occurs in the Late Permian Black Alley Shale of the Bowen Basin (Thompson & Duff, 1965; Houston, 1967a; Geological Survey of Queensland, 1978).

Bentonite deposits derived from *in situ* decomposition of altered acidic volcaniclastic sediments of the Tertiary Main Range Volcanics at Yarraman, south-east of Kingaroy, have been worked intermittently since 1937 (Cribb, 1943; Fisher, 1946; Croft & Zeissink, 1967; Houston, 1967a; Sawers & Cooper, 1985); modest production currently comes from PCP Douglass Pty Ltd's Cedars mine. A similar deposit at Robinsons, near Wondai, produced 165t of bentonite in 2005–2006.

Seams of bentonite occur in the Middle Jurrassic Walloon Coal Measures in the Ipswich area. Clay Resources Company, a subsidiary of Ebenezer Mining Company Pty Ltd, produced sodium bentonite as a by-product of coal mining at the Ebenezer mine. Jeebropilly Collieries Pty Ltd produces minor quantities of Ca–Mg bentonite from stockpiles at the Jeebropilly open cut coal mine.

Minor small bentonite exposures occur in weathered tuffaceous rocks of the Carboniferous Skardons Volcanic Group and in the Tertiary McBride Basalt Group 30km west-north-west of Lyndbrook in north Queensland (Lam & others, 1989).

The outlook for Queensland bentonite production is mixed, with sales growth dependent on further penetration of domestic and export markets and the development of new applications for bentonite products.

Table 1: Significant bentonite deposits of Queensland

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Cedars Mine	10km SW of Yarraman	Operating mine	71 036t (1937–1942, 1996–2008)	0.2Mt (von Gnielinski, 2010)	Main Range Volcanics/ Main Range Volcanic Subprovince	Operated by PCP Douglass Pty Ltd. Used as a stock feed, in air filter in septic systems and sewage pumping plants, and as an odour absorbent in chicken manures, pellet binder and in refractories, 17 years mine life. No recent production.
Ebenezer (sodium bentonite)	10km SE of Ipswich	Abandoned mine, active prospect	133 537t (1996–2004)	1.9Mt (estimated in 1999; von Gnielinski, 2010)	Walloon Subgroup/ Clarence-Moreton Basin	Abandoned mine was operated by Clay Resources Company, a subsidiary of Ebenezer Mining Company Pty Ltd - by-product of coal mining. Used in stockfeed, pet litter, civil engineering, dam sealing and wine making
Gurulmundi and Gurulmundi North (sodium bentonite)	30km N of Miles	Operating mine	989 488t (1996–2009)	12Mt (von Gnielinski, 2010)	Orallo Formation/ Surat Basin	Operated by Sibelco Australia Ltd - Australia's largest producer, with a 120 000 tpa capacity processing plant. Bentonite used for drilling mud, civil engineering applications, pet litter and as a binder for foundry sands and stock feed
Jeebropilly (calcium-magnesium bentonite)	7km SW of Ipswich	Operating mine	66 595t (1998–2008)	Not reported	Walloon Subgroup/ Clarence-Moreton Basin	Stockpile of Ca–Mg bentonite held by Jeebropilly Collieries Pty Ltd.
Mantuan Downs (calcium bentonite)	135km SW of Emerald	Operating mine	2000t (2008–2009)	15Mt (Pacific Enviromin Ltd, 2009)	Black Alley Shale/ Bowen Basin	Mining by Pacific Enviromin Ltd commenced in April 2008. Bentonite products are being marketed for soil remediation and crop yield improvement, livestock nutrition and methane reduction, and composting.
Miles (sodium bentonite)	5km SW of Miles	Operating mine	127 691t (1995–2008)	3.3Mt (von Gnielinski, 2010)	Orallo Formation/ Surat Basin	Local and export industrial and feedstock markets. Operated by Bioclay Pty Ltd trading as Miles Bentonite.
Queensland Bentonite (high swelling sodium bentonite)	36km NW of Miles	Operating mine	79 761t (1996–2008)	12Mt (von Gnielinski, 2010)	Orallo Formation/ Surat Basin	Operated by AMCOL Australia Pty Ltd. Services a broad range of domestic and international markets including exploration drilling, construction/civil, foundry, cat litter, stockfeed, dam sealing and wine clarification.
Woleebee (sodium bentonite)	28.9km SW of Wandoan	Active prospect	171 797t (2004–2005)	Not reported	Orallo Formation/ Surat Basin	Held by Unimin Australia Ltd (Sibelco Australia Ltd). No recent production.

Kaolin

Kaolin is a soft, fine, non-swelling white clay consisting mainly of kaolinite ($Al_4Si_4O_{10}(OH)_8$). It has a wide range of uses and is important for manufacturing ceramics and refractories and putting a gloss coat on paper. It is also used as a filler and extender in plastics, rubber, paints, insecticides, fertilisers, cosmetics and textiles and as an ingredient in pharmaceutical products.

Differences in kaolin products are due to property variations such as degree of crystallinity, particle size, shape and distribution. Crystallinity impacts on the brightness, whiteness, opacity, gloss and viscosity properties of kaolin. Particle size, shape and distribution influence the smoothness, optical, deformation and flow properties of kaolin.

Primary kaolin deposits form from the alteration of feldspar- and mica-rich parent rocks through either weathering or hydrothermal alteration processes. Both processes leach most mobile elements from the parent rock, leaving the constituent clay elements of silicon, aluminium, oxygen and hydrogen. Secondary kaolin comprises sedimentary deposits formed from the alteration of pre-existing sediments or the direct deposition of kaolin from transported material. Kaolin usually contains some free quartz as well as subsidiary resistant minerals derived from the parent source.

Substantial kaolin resources occur along the western side of Cape York Peninsula, in the Kingaroy district (150km north-west of Brisbane) and at Duaringa in central Queensland. Queensland's known major kaolin resources total 2.96Bt (Table 2). Kaolin is mined at Skardon River on the western side of Cape York Peninsula and at Kingaroy in south-east Queensland. Production in 2009–10 totalled 3900t.

Queensland's largest kaolin deposits are associated with the Tertiary laterite profiles that formed the extensive bauxite deposits along the western side of Cape York Peninsula. They occur in the pallid zone of the laterite profile (Schaap, 1990; Hopwood & Fardon, 2003; Eggleton & others, 2008). Weipa, Skardon River, Kendall River and Pennefather River are the main kaolin deposits.

Kaolin deposits near Kingaroy, 200km north-west of Brisbane, comprise two distinct deposit types — massive kaolinised granites with 20–30% kaolin and kaolin-rich bedded sediments of the Tarong Basin with 60–80% kaolin. The bedded kaolin deposits formed in a lacustrine environment and could be primary weathering products of shales or secondary deposits of reworked kaolin clay (Smart, 1999a). Mining is currently carried out at Nyora. Numerous other kaolin mines have operated in the Kingaroy-Nanango-Yarraman district in the past (Connah, 1950b; Houston, 1967a; Sawers & Cooper, 1985). Kingaroy kaolin is used as coating clay for paper manufacture and in the paint and plastics industries.

The Duaringa kaolin deposit consists mainly of opaline silica and kaolinite and is a highly leached rock formed during lateritisation of Tertiary rhyolitic tuff beds in the Duaringa Basin (Smart, 1999a). The tuffs were probably derived from volcanic

activity in the Clermont – Peak Range – Minerva Hills area. Lateritisation has concentrated opaline silica and kaolinite. Mined material contained 30% kaolin cemented by secondary opaline silica and was a porous, lightweight material with a bulk density of <0.70 and an average absorbency of 50% when milled. The silica gives the kaolin high strength, producing hard, non-draining granules that do not turn to mud when wet.

At Ravensbourne, 34km north-east of Toowoomba, kaolin is associated with beds and lenses of sand beneath Tertiary basalt, soil or silcrete. The deposit is considered to be associated with the Jurassic Helidon Sandstone (Sawers & Cooper, 1985; Smart, 1999a).

Primary and secondary kaolin deposits occur in the Maryvale area in north Queensland. The primary deposits are derived from weathered basalts and occur in black soil environments throughout the Nulla Basalt Province but are considered to be subeconomic because of their small size. Subeconomic sedimentary kaolin deposits crop out near the base of the basalt sequence (Lam, 1994b).

A potentially large deposit of sedimentary kaolin (white mudstone of the Cretaceous Winton Formation) occurs 35km west of Winton; samples contain 70–80% kaolinite but no resources have been estimated (Saul & Steine, 1996).

Kaolin has been intersected in the subsurface in sub-basins of the Tertiary Suttor Formation at Bungobine and Yacamunda west of Mount Coolon. Kaolin formed as part of a cyclical sequence in a lacustrine system in which blue-grey kaolin alternates with oil shales (Denaro & others, 2004b); kaolin is also present as primary deposits derived from weathered granite. Austral Dutch Kaolin Pty Ltd has announced that preliminary analytical data from samples of raw material compare favourably with product specifications for premium Georgian (USA) products. The Bungobine project has potential for white clay production for ceramics, refractories, fillers, chemical products and the new “XAM” product being developed in Australia for water decontamination and filtration. Sizeable deposits have been identified but resources have not yet been quantified.

Kaolin occurs as part of the bauxitic laterite profile developed on Cainozoic basalt on the Binjour-Gurgeena Plateau, 21km north-east of Mundubbera (Australasian Exploration Company Incorporated, 1974).

Denmead (1929) and Houston (1967a, 1967b) listed numerous other clay deposits in south-east Queensland that are potentially suitable for pottery and whiteware manufacture, for example, Abercorn, Childers, Tannymorel.

Structural clay

Queensland is fortunate in having extensive deposits of clays suitable for brick, pipe, paver and tile manufacture close to major regional centres along the east coast (Houston, 1967a; Martin, 1975; Cooper & others, 1979; Siemon, 1980; Cooper,

Table 2: Significant kaolin production and resources in Queensland

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Duaringa Kaolin	5km SE of Duaringa, 155km WNW of Gladstone	Abandoned mine, active prospect	15 970t (1998–2002)	Estimated 1Mt (Leu, 1993)	Duaringa Formation/ Duaringa Basin	Held by Queensland Zeolite Pty Ltd.
Kendall River	105km W of Coen, 150km S of Weipa	Active prospect	Mining lease applied for; feasibility study in progress	Drilled *in situ* resource of 100Mt (Queensland Department of Natural Resources, Mines and Water, 2005)	Bulimba Formation/ Karumba Basin	Held by Kendall Resources Ltd. Gulf Minerals Ltd has carried out drilling and resource estimation. Product testing has indicated that a fine coating clay with strong market appeal can be produced. Gulf Minerals Ltd has applied for a mining lease and is carrying out a feasibility study.
Nyora	15km S of Kingaroy	Operating mine	73 250t (1996–2008)	Confidential	Tarong beds/ Tarong Basin	Operated by Sibelco Australia Ltd. Coating clay for paper manufacture and in the paint and plastics industries.
Pennefather River	N of Weipa	Abandoned prospect	No current exploration	Estimated 2.8Bt (Morgan, 1993)	Bulimba Formation/ Karumba Basin	Drill testing by Comalco. Currently held by Cape Alumina Pty Ltd.
Ravensbourne	Esk area, W of Brisbane	Care and maintenance	30 754t (2004–2006)	4.6Mt (Sawers & Cooper, 1985)	Woogaroo Subgroup/ Clarence-Moreton Basin	Mainly worked for brick clay but some kaolin has been produced. Now held by Hanson Construction Materials Pty Ltd.
Skardon River	85km N of Weipa	Operating mine	5766t (1998–1999, 2002–2008)	9.24Mt; includes proved reserve of 0.7Mt at 95% percent finer than 45 microns, probable reserve of 2.1Mt at 92% finer than 45 microns, indicated resource of 0.9Mt at 78% finer than 45 microns and an inferred resource of 10.4Mt at >65% finer than 45 microns (Minerals Corporation Limited, 2009)	Bulimba Formation/ Karumba Basin	Operated by Minerals Corporation Ltd through its subsidiary Skardon River Kaolin Pty Ltd. Production of bulk samples of “Kaocem”, a low-carbon kaolin-base cementitious product, commenced in June 2009; applications include mortar, render, grout and flooring compounds. Minerals Corporation Ltd was placed into voluntary administration in June 2010.
Weipa	5.7km WNW of Weipa airstrip	Kaolin production ceased	971 200t (1986 to 1996)	48Mt (von Gnielinski, 2010)	Bulimba Formation/ Karumba Basin	Production by Comalco Aluminium Ltd was discontinued in 1996.
Winter No 1	13km SW of Kingaroy	Active prospect	12 426t (1996–2002)	Not reported	Tertiary sediments/ Main Range-Lamington Basalt Province	Held by Unimin Australia Ltd (Sibelco Australia Ltd).

1983; Cooper & Carmichael, 1992). Most of these are sedimentary deposits within Mesozoic and Cainozoic basins. In 2009–10, Queensland produced 849 751t of brick and paver clays and shale and 262 213t of cement clay and shale.

Current brick clay mining operations in regional centres are carried out at Maryborough (Maryborough Brickworks Pty Ltd, Marcotta Tiles Pty Ltd), Bundaberg (QC Bricks Pty Ltd), and Warwick (Warwick Brick Works Pty Ltd) near Warwick.

In the Brisbane-Ipswich area, The Austral Brick Company Pty Ltd, Boral Bricks Pty Ltd, CSR Building Products Ltd (Monier/PGH Bricks and Pavers) and Claypave Pty Ltd operate brickworks with clay sourced from various locations, including Ipswich, Riverview, Dinmore, Darra, Oxley, Strathpine, Rochdale and Stapylton.

Clay is mined for use in cement manufacture at East End (Cement Australia Pty Ltd) near Gladstone.

Vermiculite

Vermiculite is the name given to a tri-octahedral smectite clay that is formed by the weathering or hydrothermal alteration of biotite, chlorite or phlogopite. On heating, vermiculite loses its compositional water and exfoliates, with a twisting worm-like form, to as much as 20 times its original volume. Vermiculite is used as a lightweight fire-proof insulator against heat and sound, both in bonded form in concrete and plaster and in bonded and loose form in walls and ceilings, refrigerators, kilns, furnaces and stoves. Vermiculite is also used as a packing material and as an alternative to asbestos in brake and clutch linings. Agricultural applications include potting soils and growing mixes, stockfeed, fertilisers, pesticides and soil conditioners. It is a common component of soils developed from the weathering of biotite-, phlogopite- and chlorite-bearing intrusive and metamorphic rocks in eastern Queensland but is seldom present in economically extractable concentrations.

Minor vermiculite occurs in lenticular bands up to 50m long and 2m wide in shear zones in altered Carboniferous biotite schist, gneiss and granite of the Kennedy Province at Six Mile Creek, 25km south of Ayr (Carruthers, 1954). The material contains too much quartz to be economically processed into a saleable product (Spectrum Resources NL, 1988).

Vermiculite has been reported from sheared zones in microgranite on the margins of a tonalite intrusion near the junction of Googa Googa and Emu Creeks, 8.5km south-south-east of Blackbutt (Connah, 1950a; Boots, 1997). The vein, which is 12 to 275mm wide, was mined to a small extent but no production is recorded (Murphy & others, 1976).

Dunstan (1913) reported that vermiculite occurs in decomposed granite in a railway cutting at Moonmera, 32km south-south-west of Rockhampton (Geological Survey of Queensland, 1978).

CORUNDUM

Because of its great hardness and high melting point, natural corundum (aluminium oxide) is used as an abrasive material, mainly for grinding and polishing optical components and for grinding and lapping fabricated metal products and as a refractory. Corundum is commonly used in the preparation of toothpastes. Granular corundum is known as emery and is used to manufacture emery boards, sandpapers and cutting, grinding and polishing wheels.

Sapphire mining operations in Queensland at Anakie and Lava Plains (Figure 6) produce small quantities of waste or by-product sub-gem quality corundum. Fine-grained sapphire and corundum are treated as waste and abandoned to tailings by these treatment plants. Although most of this material is discarded, it is believed that intermittent sales for abrasive use are made (Krosch & Cooper, 1990).

The Wateranga prospect, in south-east Queensland, comprises eluvial, alluvial and hard-rock deposits containing high-Al feldspar, apatite, ilmenite, mica (muscovite, phlogopite) and magnetite, with minor corundum, zircon and rutile. These deposits are associated with the Wateranga Gabbro (Brooks, 1970; Evans & others, 1993). Queensland Industrial Minerals Ltd (2004) has been carrying out feasibility studies and mine planning.

DIATOMITE

Diatoms are microscopic, unicellular aquatic plants related to algae and have siliceous cell walls. As diatoms die and sink through the water column, accumulations of siliceous sediments form on the sea or lake floor and are preserved in geological history. Consolidated deposits of these siliceous sediments are called diatomite and unconsolidated deposits are referred to as diatomaceous earth. Diatomite is chalk-like, soft, friable, very fine grained and earthy. Diatomite is usually light in colour, ranging from buff to grey, white when pure and very rarely black.

Diatomite has a wide variety of uses, including as a filtering medium, additive in paints and plastics, absorbent for cleaning up spills, soil additive, insulation, natural insecticide, roofing compounds, adhesives, sealants, oil drilling compounds, specialty concretes and in paper manufacture.

Commercial diatomite products come in a great variety of grades. Principal factors affecting diatomite grade are size, shape, arrangement, silica content and impurities, brightness and abrasive hardness. Diatomite may be calcined to remove organic material, increase pore size and enhance the filtration rate. Most filter grade diatomite is calcined.

Queensland diatomite production totalled 2433t in 2009-10, of which 1254t was for use as absorbents, and came from the Mount Sylvia and Maidenwell deposits; Queensland’s potential resources are many hundred million tonnes (Lam, 2008).

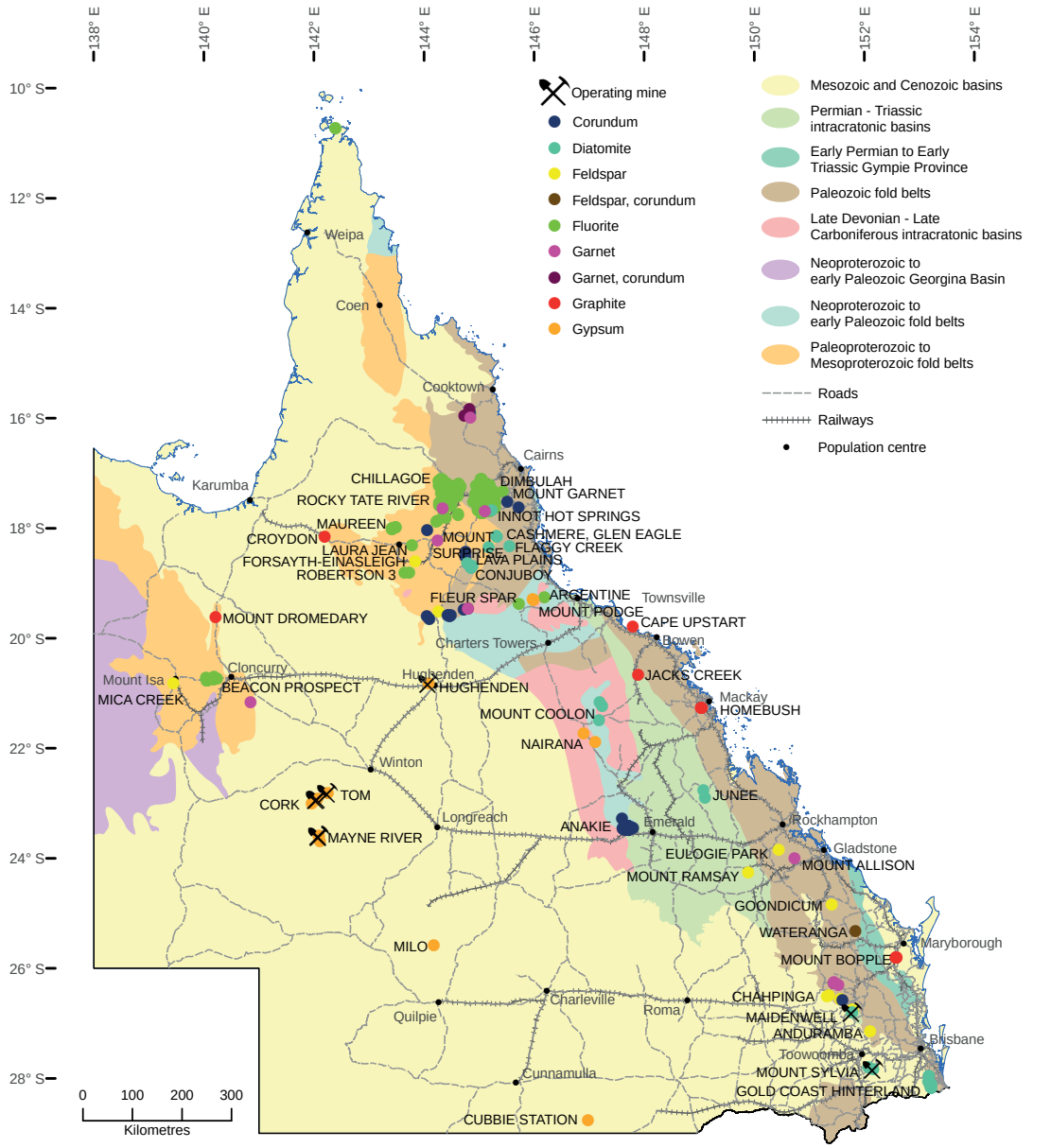

Figure 6: Corundum, diatomite, feldspar, fluorite, garnet, graphite and gypsum occurrences and deposits

Queensland diatomites formed in freshwater lakes associated with Cainozoic volcanic activity and are usually interbedded with basaltic flows (Sawers & Cooper, 1985).

Mount Sylvia (Figure 6), near Gatton 35km south-east of Toowoomba, is a lacustrine style deposit that occurs as thin lenses (averaging ~2m thick) formed when basalt lava flows of the late Oligocene to early Miocene Main Range Volcanics dammed local drainages (Ball, 1927; Bonner, 1951; Sawers & Cooper, 1985; Lam, 2008). It comprises small cylindrical Melosira plus some colloidal fines and occasional sponge spicules in a white, dense rock containing relatively little opaline material. Mount Sylvia Diatomite Pty Ltd produces various grades of diatomite for soil conditioning, pet litter, potting mix, oil and beverage clarifying, industrial and domestic spillage absorbents, fillers, abrasives, insecticides and stock feeds. Resources are estimated as >0.6Mt (source – www.mtsylviadiatomite.com.au). Diatomite also occurs at West

Haldon, ~10km to the west-north-west (Bonner, 1950; Bonner, 1953; Sawers & Cooper, 1985; Lam, 2008).

Diatomite has been mined in recent years from the Maidenwell deposit, 26km south-west of Nanango, by Maidenwell Diatomite Australia Pty Ltd (Lam, 2008). This lacustrine deposit formed within the Main Range Volcanics. Diatomite from this deposit is used largely as a soil conditioner in the local grape and nursery industries.

Conjuboy, north of Greenvale, is a lacustrine deposit consisting mainly of the cylindrical diatom Melosira in a poorly cemented horizon, interbedded with clay sand and conglomerate lenses, and is associated with the Cainozoic McBride Basalt Province (White & Crespin, 1959; Sawers & Cooper, 1985; Lam, 2008). Typically, diatomite at Conjuboy is 10–15m thick beneath 3–4m of sandy clay, diatomite and basalt rubble. It is exposed in the beds of creeks that cut the Quaternary basalt cover. Drilling has defined resources of >20Mm^3 of diatomite-bearing material within a small portion of the overall deposit; global resources exceed 200Mm^3 (Prentice, 2003). The Australian Diatomaceous Earth Joint Venture is investigating this deposit.

Diatomite also occurs to the north-east in the McBride and Wallaroo Basalt Provinces at Cashmere, Glen Eagle, Flaggy Creek (Princess Hills) and Walters Plains Lake (Lake Walters) (White & Crespin, 1959; Sawers & Cooper, 1985; Lam, 2008). The Glen Eagle deposit has a potential, but poorly defined geological resource of 22Mt of diatomaceous earth (Adams & West, 2003).

Diatomite also occurs in the early Tertiary Duaringa Formation at Junee (Reid, 1939; Geological Survey of Queensland, 1978; Sawers & Cooper, 1985; Lam, 2008), in the Tertiary Lamington Basalt Province at Tamborine Mountain, Mount Meershaum, Beechmont, Canungra, Numinbah Valley and Nixon Creek in the Gold Coast Hinterland (Dunstan, 1911; Sawers & Cooper, 1985; Lam, 2008), in the Tertiary Suttor Formation near Mount Coolon (Hutton & others, 1991; Lam, 2008), and in Tertiary sediments near Innot Hot Springs (Crespin, 1947; Sawers & Cooper, 1985; Lam, 2008).

DIMENSION STONE

Dimension stone is any naturally occurring rock that can be cut and trimmed for use in building applications such as solid walls and for decorative uses such as cladding, floor tiles and roofing. The main types of commercial dimension stone produced in Queensland are sandstone, marble and slate (Figure 7). Queensland resources of dimension stone are substantial in terms of quantities and diversity of qualities sought by the construction industry (Bruvel, 2001a). Queensland's building stone quarries and resources have been described by Wolff (1957a, 1957b) and Trezise (1990).

Queensland produced 48 395t of sandstone, 1298t of marble, 14t of slate and 3235t of unspecified dimension stone in 2009-10.

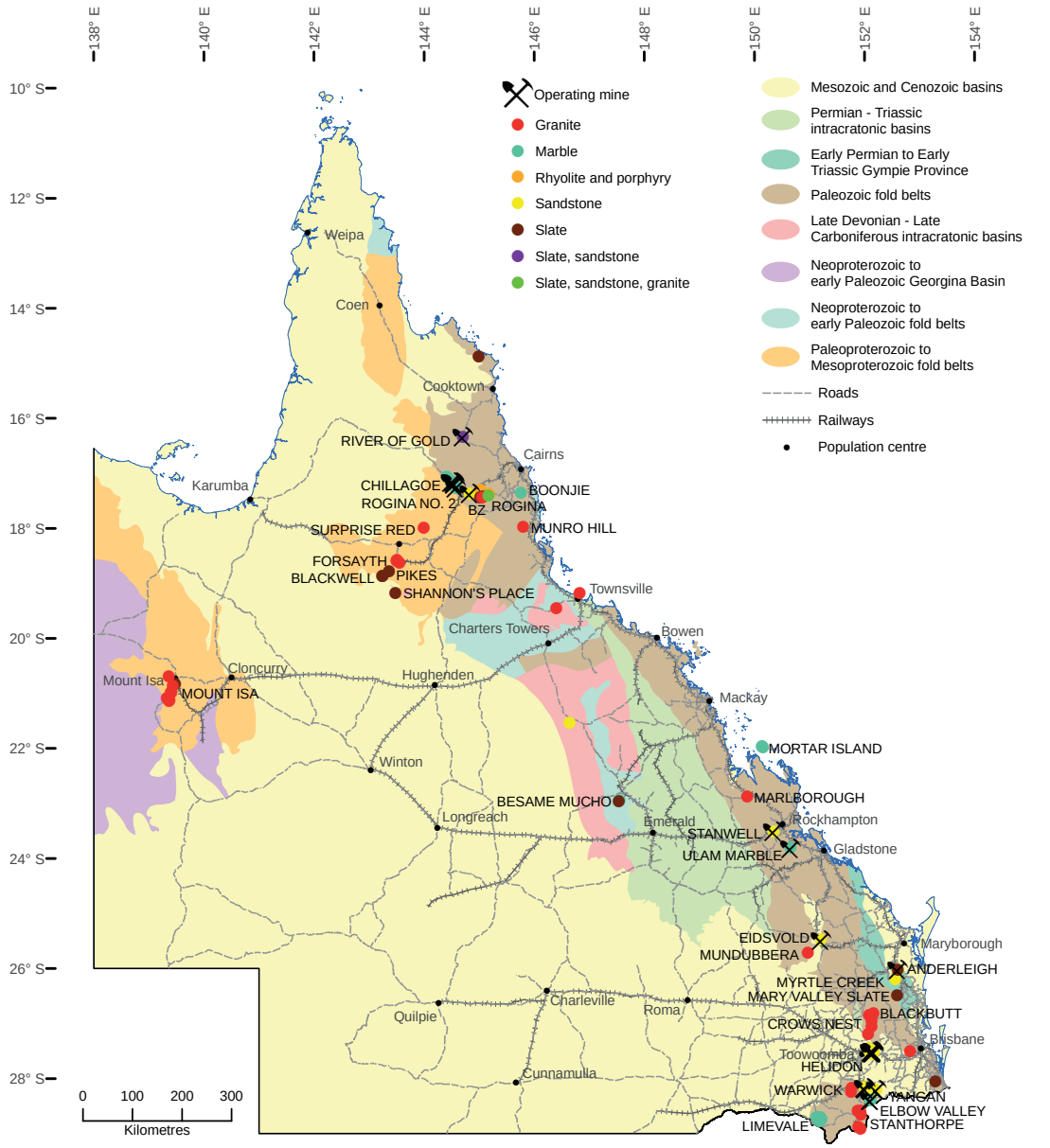

Figure 7: Dimension stone occurrences and deposits

Granite

As a building stone, the term granite is used in its wider context to cover all rocks of granitic texture, including granites, granodiorites and gabbros. Historically, granite was quarried at Enoggera (Enoggera Granite), Samford (Samford Granodiorite, Cedar Creek Granite), Mount Crosby (Kholo Granite), Blackbutt (Tarameo Igneous Complex), Gracemere (Boulder combe Complex), Magnetic Island (Magnetic Island Granite), Townsville (Townsville Granite), Cooktown (Cooktown Granite), Maroochydore (Maroochydore Granite), Crows Nest (Crows Nest Granite, Eskdale Granodiorite) and Warwick (Greymare Granodiorite) and stone from these sources was used in many historic buildings in Brisbane and regional Queensland towns and cities (Wolff 1957a, 1957b). Minor granite has also been produced from the BZ Mine, Rogina and Forsayth (Ropewalk Granite) in far north Queensland and Mundubbera (Delubra Quartz Gabbro, Hawkwood Gabbro) in south-east Queensland.

Australian Granites Ltd and Granite Resources Ltd produced granite tiles, slabs and building stone from the Sybella Granite on leases near Mount Isa in the late 1990s. Granite from these deposits was used to pave the Queen Street Mall in Brisbane (Denaro & others, 2001). Australian Granites still holds five leases, all of which have stockpiles of granite blocks, and supplies granites tiles and blocks to order.

Other known granite resources with potential for development as dimension stone include Munro Hill near Tully (Ingham Granite), Surprise Red north-west of Mount Surprise (Elizabeth Creek Granite), Mount Garnet (Herbert River Granite), Marlborough (Racecourse Creek Gabbro), Nanango (Boondooma Complex), and the Stanthorpe-Wallangarra area (Ruby Creek Granite, Stanthorpe Granite, Undercliffe Falls Granite, unnamed gabbro) (Bruvel, 2001a).

Marble

Cairns Marble Australia Pty Ltd, S & A Pty Ltd and Australian Fine Grain Marble Pty Ltd produce marble from a number of quarries in the Chillagoe district in far north Queensland to produce raw marble blocks, unpolished and polished slabs, marble tiles and monumental and furniture products for domestic and export markets. The marble has formed by intrusive contact metamorphism of limestones of the Silurian Chillagoe Formation.

Unimin Lime (NSW) Pty Ltd produces some marble dimension stone from its limestone quarries in the Rosenthal Creek Formation (Silverwood Province) in the Elbow Valley area south-east of Warwick.

Historically, marble has been produced from the Mount Holly beds on Mortar Island; resources are also known on nearby Hunter Island (Shepherd, 1955) and in the Mount Larcom areas. Marble was also quarried at Ulam in the Bajool area, but the mine currently produces limestone only (Geological Survey of Queensland, 1978). Quarries in the Limevale area, north of Texas, were worked intermittently from 1931 to 2003 to produce marble blocks, terrazzo chips and monumental stone from the Texas beds. Some high-grade, excellent quality ornamental marble was produced, some of which was used in the Suncorp Building in Brisbane (Denaro, 1989). A lease is still held by Unimin Lime (NSW) Pty Ltd over the main deposit and there are significant resources available in the area (Siemon, 1973).

Marble resources with potential for development are also known at Boonjie near Malanda (Hodgkinson Formation),

Rhyolite and porphyry

Historically, the “Brisbane Tuff” was used widely for road-making, kerbing, monuments, ornamental works, retaining walls and for building purposes in Brisbane and was quarried at Kangaroo Point, Spring Hill, Stafford and Windsor (Wolff, 1957a, 1957b)

Minor rhyolitic ignimbrite has been produced from the Featherbed Volcanic Group at the BZ Mine, near Emuford, for use as paving stone and retaining wall blocks.

Sandstone

Helidon in southern Queensland is the major source of sandstone suitable for the dimension stone industry locally and for export to destinations such as Hong Kong, Indonesia, Malaysia, Korea, China, Japan, Taiwan, Canada and USA (Neville & others, 2000).

Sandstone has been quarried from the Helidon Sandstone (Woogaroo Subgroup) of the Clarence-Moreton Basin for more than 100 years and was used in the construction of many historic buildings in Brisbane, Ipswich, Toowoomba and Warwick. The nearby Murphy's Creek Sandstone has also been used extensively in historic buildings.

Other historic sources of sandstone included Toowoomba (Highfields Sandstone), Goodna (Goodna Sandstone), Moggill (Moggill Sandstone), Logan and Tamborine ("Beaudesert-Logan Village Sandstone"), Pentland ("Pentland and Torrens Creek Sandstone"), Grandchester (Calvert Sandstone) and Albion (Breakfast Creek Sandstone) (Wolff, 1957a, 1957b).

Helidon sandstone is fine- to coarse-grained, hard and relatively strong as a building material. It is renowned for its banding, often as concentric rings, and unusual colourings. Scotbar Pty Ltd, Chongherr Investments Ltd, J H Wagner & Sons Pty Ltd, Helidon Sandstone Industries Pty Ltd, Albatio Pty Ltd, Gosford Quarries Pty Ltd, Comerford Sandstone Pty Ltd and Earth Commodities Pty Ltd produce sandstone for tiles, wall cladding, pavers, masonry blocks, architectural and decorative pieces, furniture, sculpture, monumental stone, retaining wall blocks and landscaping stone. Sandstone from Helidon has been used recently at Jupiters Casino, Arundel Hills Country Club and Bond University on the Gold Coast, Sheraton Mirage Resort in Port Douglas, Hayman Island Resort, Crown Casino in Melbourne, Quay West Hotel in Brisbane, and for various restoration projects in Brisbane, including the recent completion of St John's Cathedral (Dare, 2003).

Tanamerah Sandstone Pty Ltd, Dama Holdings (Australia) Pty Ltd and Freesport Pty Ltd produce sandstone from the Marburg Subgroup at their quarries near Warwick and Yangan. Coarse-grained sandstone is produced for landscaping and fine-grained sandstone is processed for tiles, sculpture and building stone.

Another significant source is at Stanwell, west of Rockhampton, where Capricorn Stone Products Pty Ltd produces landscape through to restoration grade sandstone in a variety of colours from the Early Jurassic Razorback beds (Precipice Sandstone).

Minor sandstone for pavers is produced from the Hodgkinson Formation at the River of Gold Slate Mine, Rogina and Rogina No.2 in far north Queensland.

Eidsvold Siltstone Pty Ltd produces wall tiles, paving bricks, construction blocks, monumental stone, sculpture blocks and tumbled landscaping sandstone from the Early Jurassic Evergreen Formation at Eidsvold.

Anderleigh Enterprises Pty Ltd produces sandstone boulders and retaining wall blocks from the Late Triassic to Early Jurassic Myrtle Creek Sandstone at Anderleigh in south-east Queensland. Myrtle Creek Sandstone has also been quarried near Gympie.

Fine-grained and variously coloured sandstone also occurs in the Coffin Hill Member in the Gilbert River district near Georgetown (Bruvel, 2001a).

Slate

The River of Gold Slate Mine and Rogina in far north Queensland produce small tonnages of slate pavers from the Devonian Hodgkinson Formation.

Anderleigh Enterprises Pty Ltd produces coloured slate and decorative stone from the Early to Middle Triassic Kin Kin beds at Anderleigh in south-east Queensland.

Minor slate has been mined historically from the Bernecker Creek and Corbett Formations (Etheridge Province) at Shannon's Place, Pikes Slate Quarry and Blackwell in the Forsayth area (Trezise, 1990), and from the Amamoor beds at Imbil (Mary Valley Slate). Other known deposits with potential include Besame Muco (Silver Hills Volcanics) near Clermont.

EARTHY LIME AND DOLOMITE

The term 'dolomite' is usually applied to rocks that consist of >50% carbonate minerals and in which magnesium exceeds calcium. Rocks with less magnesium content are termed dolomitic limestone. Commonly, dolomite is associated with limestone, and can represent diagenetic or metasomatic replacement of limestone (dolomitisation). Lacustrine dolomites formed in north Queensland as beds of magnesite and earthy lime sediments where valleys were dammed by Tertiary basalt flows. Earthy limes contain a mixture of calcium and magnesium carbonate and clays and commonly form from the weathering and surface enrichment of intermediate to basic volcanic rocks.

Numerous dolomite and earthy lime deposits occur scattered along the east coast of Queensland (Figure 8). These small deposits have been surface mined for low-grade calcium-magnesium material for agricultural purposes, primarily in the sugar cane industry. Production in 2009-10 totalled 53 095t of dolomite and 2876t of lime sand. Queensland's significant earthy lime/dolomite deposits are listed in Table 3. Large resources of dolomite also occur in Proterozoic sequences in north-west Queensland but their distance from agricultural markets precludes their development.

Table 3: Significant earthy lime/dolomite deposits of Queensland

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/Province	Comments
Alimb (Hillgrove)	74km NW of Charters Towers	Operating mine	85 535t agricultural dolomite (1996–2010)	Not reported	Allingham Formation/ Nulla Basalt Province	Tertiary lacustrine dolomite deposit mined by Alimb Pty Ltd for agricultural dolomitic lime.
Almaden	6km W of Almaden	Abandoned mine	167t agricultural dolomite (1963–1966)	Not reported	Chillagoe Formation/ Hodgkinson Province	
Blue Gums	19km NW of Wondai	Abandoned mine	4006.3t agricultural dolomite (1996–1997, 1999–2000)	Not reported	Main Range Volcanics/ Main Range Volcanic Subprovince	Tertiary lacustrine dolomite deposit.
Blue Moon	19km NW of Wondai	Operating mine	22 569.3t agricultural dolomite (1996–2009)	Not reported	Main Range Volcanics/ Main Range Volcanic Subprovince	Tertiary lacustrine dolomite deposit.
Blue Rocks	19km NW of Wondai	Abandoned mine	8764t agricultural dolomite (1996–1997, 1999–2004)	Not reported	Main Range Volcanics/ Main Range Volcanic Subprovince	Tertiary lacustrine dolomite deposit.
Buchanan	24.2km SSE of Home Hill	Operating mine	61 382.2t earthy lime (1972–1978, 1997–2010)	Not reported	/ Kennedy Province	Residual enriched earthy lime deposit developed by weathering of dolerite dykes in altered Carboniferous granite. Agricultural lime produced by Tama family.
Buckland	12.2km WNW of Mount Garnet	Abandoned mine	196 085t agricultural dolomite (1982–1993, 1996–2009)	Not reported	Undara Basalt/ McBride Basalt Province	Tertiary lacustrine limestone/dolomite deposit mined by Miriwinni Lime Company Ltd to produce dolomitic lime for agricultural purposes.
Delta	27km S of Home Hill	Operating mine, no recent production	41 089.6t earthy lime (1996–2008)	Not reported	/ Kennedy Province	Residual enriched lime deposit developed by weathering of dolerite dykes in altered Carboniferous granite. Agricultural lime produced by A.J. and L.W. Oats.
Didcot Earthy Lime	29km ENE of Gayndah	Abandoned mine	19 396.6t earthy lime (1951–1969, 1981, 1996–2001)	Not reported	Mount Marcella Volcanics/ South-East Queensland Volcanic and Plutonic Province	Residual enriched earthy lime deposit developed by weathering of Triassic andesite and basalt.
Emu Apple Creek	47km SW of Carmila	Operating mine	1643t earthy lime (2008–2010)	103 530t earthy lime (Stuart & King, 1996)	Mount Benmore Volcanics/ Connors Subprovince	Residual enriched earthy lime deposit developed by weathering of Early Permian andesite. Agricultural earthy lime produced by CQ Dolomite Pty Ltd.
Flinders	20km S of Ipswich	Operating mine	203 309t agricultural dolomite (1937–1973, 1999–2010)	Confidential	Flinders Dolomite/ Amberley Basin	Tertiary lacustrine dolomite deposit. Agricultural dolomite produced by Flinders Trading Pty Ltd.
Kennedy Creek	70km SW of Sarina	Operating mine	822t earthy lime (2008–2010)	Confidential	Lizzie Creek Volcanics/ Connors Subprovince	Residual enriched earthy lime deposit developed by weathering of Early Permian andesite. Agricultural earthy lime produced by CQ Dolomite Pty Ltd.

Table 3 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/Province	Comments
Magenta	11km SE of Clermont	Prospect	Not mined	50Mt earthy lime (from application documents for non-current MDL)	Unnamed basalt/ Clermont–Springsure Basalt Province	Residual enriched earthy lime deposit developed by weathering of Cainozoic basalt.
Mookarra	11.8km S of Bowen	Abandoned mine	914.4t earthy lime (1952-1953)	Not reported	/ Kennedy Province	Residual enriched earthy lime deposit developed by weathering of dolerite dykes in altered Carboniferous granite.
Moreton Dolomite	24.6km S of Ipswich		26 355t agricultural dolomite (1998-2010)	Not reported	Flinders Dolomite/ Amberley Basin	Tertiary lacustrine dolomite deposit. Agricultural dolomite produced by Moreton Dolomite Pty Ltd.
Pine Mountain	17km ESE of Nebo	Abandoned mine	17 820.1t earthy lime (1996-2008)	Not reported	/ Cainozoic Basalt Provinces	Residual enriched earthy lime deposit developed by weathering of Cainozoic basalt.
Plain Creek	46km W of Carmila	Prospect	Not mined	364 131t earthy lime (Stuart & King, 1996)	Mount Benmore Volcanics/ Connors Subprovince	Residual enriched earthy lime deposit developed by weathering of Early Permian andesitic lavas. Current lease held by CQ Dolomite Pty Ltd.
Plains Creek	180km S of Charters Towers	Prospect	Not mined	50 000t agricultural grade dolomite (English, 1997)	Quaternary lacustrine deposits/ Cainozoic sedimentary cover	Quaternary lacustrine dolomite deposit.
Parkers	33.3km S of Ayr	Abandoned mine	8075.7t earthy lime (1974-1978)	Not reported	/ Kennedy Province	Residual enriched earthy lime deposit developed by weathering of dolerite dykes in altered Carboniferous granite.
Robinsons	17km NW of Wondai	Abandoned mine	3539t agricultural dolomite (1997-2000, 2003-2006)	Not reported	Main Range Volcanics/ Main Range Volcanic Subprovince	Tertiary lacustrine dolomite deposit.
Sheepskin Creek	50km W of Saint Lawrence	Prospect	Not mined	Confidential	Lizzie Creek Volcanics/ Connors Subprovince	Residual enriched earthy lime deposit developed by weathering of Early Permian andesite. MDL application by Macegate Pty Ltd and CQ Dolomite Pty Ltd.
Terryglen	26.5km S of Home Hill	Abandoned mine, current lease	20 122.5t earthy lime (1996-2000, 2002-2003)	Not reported	/ Kennedy Province	Residual enriched earthy lime deposit developed by weathering of dolerite dykes in altered Carboniferous granite.
Whitebank	19km NW of Wondai	Abandoned mine	9308t agricultural dolomite (1997-1999, 2001-2003)	Not reported	Main Range Volcanics/ Main Range Volcanic Subprovince	Tertiary lacustrine dolomite deposit.
Whitehill	19km NW of Wondai	Abandoned mine	18 373.8t agricultural dolomite (1996-2008)	Not reported	Main Range Volcanics/ Main Range Volcanic Subprovince	Tertiary lacustrine dolomite deposit.
Zinaback	72km NW of Charters Towers	Operating mine	35 907t agricultural dolomite (1993, 1996-2001, 2008-2010)	450 000t agricultural grade dolomite (Saul, 1990)	Allingham Formation/ Nulla Basalt Province	Tertiary lacustrine dolomite deposit mined by Zinaback Pty Ltd for agricultural dolomitic lime.

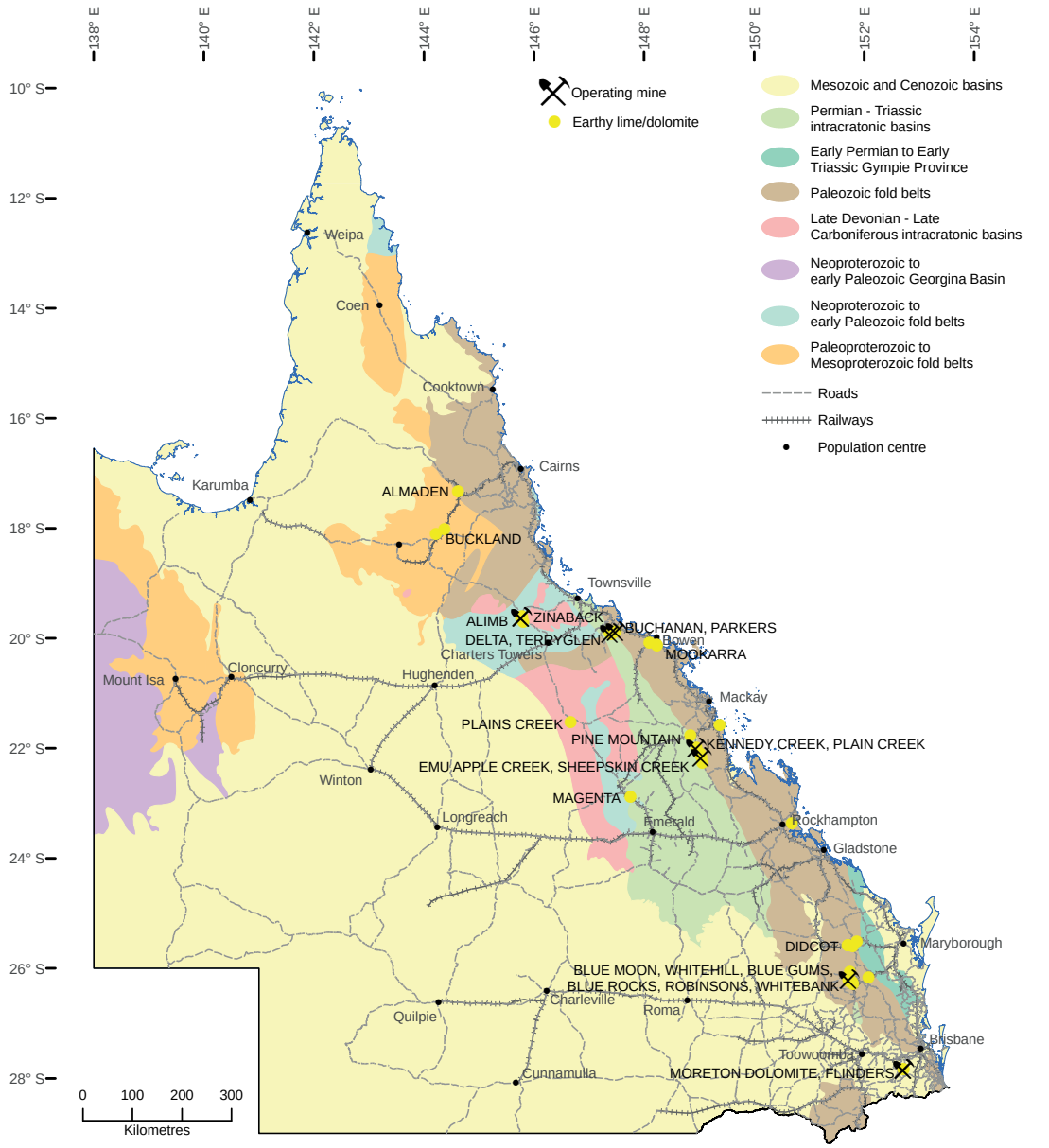

Figure 8: Earthy lime/dolomite occurrences and deposits

FELDSPAR

Feldspars form one of the most abundant groups of minerals and occur as major components in most igneous rocks. They are used primarily as a flux in the manufacture of glasses, ceramics and enamels, as well as fillers in plastics and extenders in paints (Sawers & Cooper, 1985). Queensland produced 2379t of sodium feldspar in 2008-09.

Feldspar resources have been delineated associated with alluvial and eluvial ilmenite resources derived from the weathering of ilmenite-bearing Late Permian to Late Cretaceous layered gabbro complexes in central and south-east Queensland (Figure 6).

The Eulogie Park Gabbro contains cumulate bands with ilmenite, titanomagnetite, feldspar, vanadium oxide and minor apatite (Wilson & Mathison, 1968; Brooks, 1970). Alluvial, eluvial and flood plain mineral sands, some with high ilmenite concentrations, are widespread.

At Goondicum, alluvial, eluvial and flood plain placer deposits derived from erosion of the Goondicum Gabbro contain high proportions of ilmenite, titanomagnetite, feldspar and apatite. In 2005, the project had proved reserves of 570 000t feldspar and probable reserves of 1.55Mt feldspar. The deposit also had measured, indicated and inferred resources of 4.57Mt feldspar (Monto Minerals NL, 2005). Monto Minerals commenced commercial operations in 2007 but the mine closed in 2008 due to problems with the treatment plant. The mine has been acquired by Belridge Enterprises Pty Ltd; production from 2004 to 2009 included 5713t feldspar.

The Wateranga project, in south-east Queensland, comprises eluvial, alluvial and hard-rock deposits containing high-Al feldspar, apatite, ilmenite, mica (muscovite, phlogopite) and magnetite, with minor corundum, zircon and rutile. These deposits are associated with the Wateranga Gabbro (Brooks, 1970; Evans & others, 1993). Queensland Industrial Minerals Ltd (2004) has been carrying out feasibility studies and mine planning. Measured, indicated and inferred unconsolidated ores contain 29Mt feldspar (sourced from Queensland Industrial Minerals Ltd website, April 2009).

Potential feldspar resources are associated with feldspar pegmatites and other granitic rocks in Queensland. Potash feldspar pegmatites are abundant in Queensland but few have been investigated in any detail (Brooks & others, 1976). In north Queensland, the more significant occurrences are related to granites in Proterozoic inliers, for example, Mica Creek near Mount Isa and the Forsayth-Einasleigh area.

The potential for discovery of economic deposits appears to be greatest in the granites of central and southeastern Queensland, where pegmatites essentially comprise feldspar-quartz intergrowths (Sawers & Cooper, 1985). Feldspar pegmatite dykes occur in granitic gneiss of the Chahpingah Meta-igneous Complex at the Chahpinga prospect west of Kingaroy and were worked in the 1960s and 1970s to provide feldspar for refractories (Siemon, 1996). The rock would require significant processing to remove quartz and other contaminants.

D’Aguilar Gold Ltd is investigating the feasibility of producing saleable industrial sand (including feldspar) from tailings at its proposed Anduramba molybdenite project near Crows Nest in south-east Queensland.

A Cretaceous to Tertiary nepheline microsyenite body forming Mount Ramsay, 11km south-east of Baralaba, has been investigated in some detail in the past. Valley Exploration Pty Ltd investigated the deposit in the 1970s with a view to producing caustic soda, potash chemicals, alumina and a calcium disilicate residue using a process of desilicifying the syenite by sintering with limestone (Irving, 1972).

Removal of iron-bearing minerals would be required before it would approach a commercial nepheline syenite (Sawers & Cooper, 1985).

FLUORITE

Fluorite (calcium fluoride) is the main source of the element fluorine and is used as a flux in steel smelting and in the ceramics, glass making and chemical industries. Fluorite is used instead of glass in some high performance telescopes and camera lens elements. Fluorite is a common accessory mineral in many replacement and intrusive-related deposits in Queensland but there is no current production. The major known fluorite resources are in north and north-west Queensland and total 606 571t (von Gnielinski, 2010)

In north-west Queensland, fluorite commonly occurs in small skarn deposits associated with the Tommy Creek Microgranite and Wonga and Burstall Granites. Fluorite occurs associated with copper skarn mineralisation in the Milo beds at the Beacon Prospect, 33.3km west of Cloncurry (Figure 6). Inferred resources are 1.3Mt at 40% fluorite (Scott, 1982). Fluorite is associated with copper and uranium mineralisation at Monakoff and Milo. Minor fluorite has been reported from the Apple Pie copper mine, north of Mary Kathleen, the Dugald River zinc-lead-silver deposit and the Mary Kathleen uranium deposit (Carter & others, 1961).

At Fleur Spar, near Mount Oweenee, fluorite-bearing Sn-Cu-Fe veins are associated with the Carboniferous Baumans Camp Granite. Fluorite veins also occur in the Paluma Rhyolite near Argentine (de Keyser & others, 1965).

Fluorite and quartz occur as breccia fill in Permo-Carboniferous rhyolite dykes at Robertson 3, south of Forsayth. Fluorite also occurs with uranium mineralisation along the contact of rhyolite dykes with arkosic sediments in the same area (Culpeper & others, 1997).

The Laura Jean U-Mo-F deposit near Georgetown contains an inferred resource of 1500t of fluorite (Andrews, 1980). Mineralisation comprises highly radioactive fluorite as breccia fill and replacements in a faulted and brecciated porphyritic dacite dyke zone. Similar mineralisation in late Palaeozoic dykes and pre-Carboniferous basement in the Fiery Creek area also contains fluorite (Culpeper & others, 1997). Minor fluorite occurs in fluviatile arkosic sediments of the Gilberton Formation in the Maureen group of stratabound, unconformity-related U-Mo-F prospects (Barker & others, 1996). Total estimated resources for the Maureen group are 1.49Mt at 15.93% CaF_2 (Allen, 1980).

Numerous quartz-fluorite veins occur in Proterozoic to Devonian metamorphic and metasedimentary rocks and Carboniferous granites in the Chillagoe and Mount Garnet areas in north Queensland (Ridgway, 1945b; de Keyser & Wolff, 1964; Levingston, 1970; Gregory & others, 1980; Sawers & Cooper, 1985). Fluorite is also associated with tin and tungsten lodes in the same area. Many veins were worked historically

to supply metallurgical or fluxing grade, enamelling or ceramic grade and acid grade fluorite for the Australian market.

Veins near the Rocky Tate River were worked in the 1940s and 1950s (Lam & others, 1989). Mount Victory contains an estimated 3000t of fluorite (Ridgway, 1945b). The Jacques deposit contains ~3000t of fluorite (Southland Mining Limited, 1974).

Quartz-fluorite veins in the Chillagoe area were worked from the 1910s to 1970s and supplied almost all of the 80 000t produced in Australia (Sawers & Cooper, 1985). About 0.5Mt of 40% ore probably remain (Gregory & others, 1980). The Mistake fluorite–tungsten lode in the Carboniferous Elizabeth Creek Granite near Petford contains ~50 800t at 25% fluorite (Saint-Smith, 1921; Smith, 1972).

Fluorite occurs in tin and magnetite veins and skarns in the Chillagoe and Hodgkinson Formations and Carboniferous granites in the Mount Garnet and Dimbulah areas (Blake, 1972; Dash & others, 1991; Bruvel & others, 1991). A fluorite–magnetite skarn at the Ironstone Leases, 9km south-west of Mount Garnet, contains estimated resources of 613 300t at 10.8% fluorite (Marshall, 1974). 'Wrigglite' tin skarns at the Pinnacles, 6km north-east of Mount Garnet, have inferred resources of 0.96Mt at 15.25% F (Consolidated Tin Mines Limited, 2010).

GARNET

Garnet is ground to a variety of sizes for use as an abrasive in sandpapers, sanding belts and discs, sand blasting, water jet cutting and abrasive powders. It is also used as a filtration medium. Garnet is a common mineral associated with skarns, metamorphic rocks and alkali basalts and volcaniclastics and their derived eluvium and alluvium in Queensland.

Garnet in schist and alluvium south-west of Mount Surprise (Figure 6) has been tested for potential use as an abrasive but the small volumes available and the presence of iron oxide coatings (potentially causing dust and contamination problems) downgraded the viability of this source (Barker & others, 1997).

The Mount Allison garnet-magnetite skarn, 50km west of Gladstone, has indicated and measured resources of 793 585t garnet (Barrett, 2000). The deposit is hosted by the Late Permian to Early Triassic Sawnee Gabbro. Leases are held by Economite Pty Ltd, a Brisbane abrasives company.

GRAPHITE

Graphite (elemental carbon) is valued for its good conductivity of heat and electricity and high refractoriness. Graphite is used in the manufacture of carbon electrodes, plates and brushes, crucibles, foundry facings and refractory bricks. Graphite has a low coefficient of friction and colloidal properties (remains in suspension in oil) and therefore is used in lubricants. Graphite is also used in the manufacture of paints and pencils and as a water repellent. Artificial graphite has replaced natural graphite in

many applications. Only minor low-quality graphite has been found in Queensland, mainly in contact metamorphosed coal measures (Dunstan, 1921a, 1926).

A zone of amorphous graphite occurs in schist of the Corella Formation at the Mount Dromedary Cu-Au prospect north of Cloncurry (Figure 6). The zone has a potential size of 4000m by 400m (Newbery, 1994).

In the Croydon area, graphite occurs, mostly as rounded or ellipsoidal pellets up to 10mm long, in the Croydon Volcanic Group and commonly forms about 1% of the minerals in the rocks. As well, some parts of the Esmeralda Granite, particularly close to contacts with the volcanics, are extremely rich in graphite and are packed with graphitic metasedimentary enclaves and masses of almost pure graphite in a matrix of intensely altered granite (Mackenzie, 1988; Denaro & Morwood, 1997). Estimated resources in the Gold Gate mine area, based on carbon grades alone, are 16.5Mt at 6.5% C. Metallurgical testing failed to provide the required grade and recovery relationships for economic development (Van Eck, 1990).

A small, low-grade graphite deposit in hornfelsed Devonian to Carboniferous coal measures of the Cape River Province intruded by Permian to Cretaceous granite, south-south-east of Cape Upstart, was worked early in the 1900s. (Dunstan, 1926; Denaro & others, 2009).

Graphite was mined intermittently at Jacks Creek, 13km south-south-east of Collinsville, from 1935 to 1963; total recorded production was 1880t. The graphite was sold on the domestic market as attempts to secure overseas markets proved unsuccessful due to inadequate grades. Although the graphite did not compare with some imported products, it was acceptable for certain uses. The graphite has formed by contact metamorphism of coaly sediments of the Blenheim Formation (Permian Back Creek Group of the Bowen Basin) by sills and dykes of Cretaceous granodiorite and diorite (Morton, 1934; Levingston, 1953; Geological Survey of Queensland, 1978; Denaro & others, 2004b).

Graphite occurs in contact metamorphosed carbonaceous shale of the Early Permian Carmila beds at Homebush, 20km south-west of Mackay; at least 20t of graphite was produced historically (Dunstan, 1902c; Geological Survey of Queensland, 1978).

Graphite deposits at Mount Bopple were worked between 1905 and 1908 for a total production of 150.4t of graphite. Thin semi-bituminous coal seams in the Tiaro Coal Measures have been variously altered to anthracite and graphite bands up to 1.2m thick by the intrusion of Jurassic andesite and the Late Jurassic to Early Cretaceous Mount Bauple Syenite (Rands, 1890; Dunstan, 1906a; Denaro & others, 2007).

GYPSUM

Gypsum (hydrated calcium sulphate) is used in cement, plaster and plasterboards, as a fertiliser and soil conditioner, as a filler in paints, as a chemical, food and polymer additive, in glass and ceramic manufacturing, and in thermoplastics, erosion and

dust control products and hydro seeding. Queensland produced 49 351t of gypsum in 2009-10.

The Burdekin Lime Company Pty Ltd produces gypsum from a series of gypsum-veined earthy lime deposits in a 10km long, narrow corridor of Cretaceous Toolebuc Formation at Hughenden (Figure 6). Screening of the material allows a higher grade gypsum product to be produced, which is used as a soil conditioner, mainly for sugar cane and peanuts. Almost 200 000t of gypsum has been produced since 1996; estimated resources were 0.4Mt in 1999 (Smart, 1999b).

Gypsum in the Tertiary Old Cork beds (Ball, 1944) is mined by R.P. Dooley and Zinaback Pty Ltd on the Tom, Cork and Cork No.4 leases, south-west of Winton. Total production from this area between 1996 and 2010 was 209 312.6t. Gypsum occurs as unconsolidated crystals in beds up to 2m thick. It is suitable for agricultural use. Resources on the Cork leases were estimated as 2Mt in 1999 (Smart, 1999b).

Gypsum is mined by Mayne River Gypsum Sales Pty Ltd from the Cretaceous Winton Formation and overlying alluvial deposits on the Bry and Mayne River leases in the Mayne River area, 170km south-west of Winton. Total production from 1996 to 2010 was 126 682t. The gypsum is sold for agricultural use.

Limestone quarries at Mount Podge, 80km west of Townsville, produced 32 147t of gypsum in 2001–03. These quarries in the Early to Middle Devonian Mount Podge Limestone have mainly been worked for limestone for cement manufacture and crushed aggregate.

A small resource of ~20 000t of gypsum occurs as a discontinuous 3m thick layer at the base of a black soil profile at Nairana in central Queensland. The nodular and laminated nature of the gypsum crystals is suggestive of *in situ* growth within the black soil (Doherty, 1999). Similar gypsum occurrences have been noted elsewhere in this district (Denaro & others, 2004b).

Gypsum nodules occur in clay near Milo Station, north of Quilpie. Drilling intersected gypsum-bearing clay over an area some 1200m in diameter (Connah, 1944).

Gypsum occurs in a Quaternary lake bed deposit on Cubbie Station in southern Queensland. From 2000 to 2007, some 117 734t of gypsum was produced for use on cotton plantations in northern New South Wales.

HEAVY MINERALS (RUTILE, ILMENITE, ZIRCON, MONAZITE, LEUCOXENE)

Rutile, ilmenite, zircon, monazite and leucoxene are heavy minerals that are major economic components of heavy mineral sands; hard rock, alluvial and eluvial deposits are also known. Rutile, ilmenite and leucoxene are titanium minerals and more than 95% of production is used to make titanium dioxide pigment, known as ‘titanium white’, a white pigment used in paint, rubber, plastics, paper, cosmetics and ceramics.

The remainder is used in the production of titanium metal; ilmenite is also used for sand blasting and furnace linings. Rutile and leucoxene are used as a flux material in welding electrodes. In the western world, more than 90% of zircon is used in foundry sands and ceramics; zircon is also widely used in television and computer screens and for welding purposes. Monazite is a source of thorium and rare-earth elements, particularly cerium, lanthanum and yttrium. Queensland's heavy mineral deposits have been described by Carlson (1944), Carlson (1948), Connah (1948), Carlson (1950), Bayly (1952), Brooks (1953), Gardner (1955), Dunn & Morgan (1955), Connah (1961), Cooper (1990a) and Wallis & Oakes (1990).

Heavy mineral sands occur in Pleistocene and Holocene coastal beach and dune systems that commonly fringe the Queensland coastline. These deposits consist almost entirely of quartz, with a heavy mineral content of 1–1.5%. The same dune systems are also a prime source of high purity silica sand for glass and foundry use.

Queensland's major accessible mineral sands resources are on North Stradbroke Island, where the state's only mineral sand mining operation is located. Consolidated Rutile Ltd runs two dredge mining operations at the Enterprise and Yarraman mines. Production in 2009-10 totalled 322 503t ilmenite, 78 003t rutile and 69 712t zircon.

Queensland's total resources and reserves are 8.06Mt rutile, 6.95Mt zircon and 45.75Mt ilmenite but the majority of these resources are now alienated (Figure 9; Table 4; von Gnielinski, 2010).

Heavy minerals also occur in alluvial deposits in streams in north, central and southern Queensland. Some alluvial and eluvial heavy mineral resources in central and south-east Queensland are derived from the weathering of Late Permian to Late Cretaceous layered gabbro complexes.

LIMESTONE

Limestone is a general term for sedimentary rocks consisting mainly of calcium carbonate. It is formed in marine and sometimes freshwater environments by the accumulation of coral, lime and shells to form layered beds. In other cases, direct precipitation is responsible for limestone formed as stalactites, stalagmites, oolitic limestones and travertine. Limestone is the most abundant of all commercially used sedimentary rocks. Calcite veins and marble are also mined as sources of lime. Many manufactured items require limestone or lime during some phase of their production. The main users of limestone are cement and glass manufacturers and the agriculture and alumina industries. Limestone is also used in acid neutralisation, water treatment, paper manufacturing, sugar milling, as a filler and reinforcing pigment in plastics, paint and rubber, as a metallurgical flux, and as stone dust in underground coal mines.

Major limestone deposits in Queensland are restricted to specific geological ages and formations. Large resources of high quality limestone occur along the eastern coastline and in the Mount Isa region, with major quarries in the Cairns–Chillagoe, Townsville–Broken River, Rockhampton–Gladstone, Maryborough–Gympie,

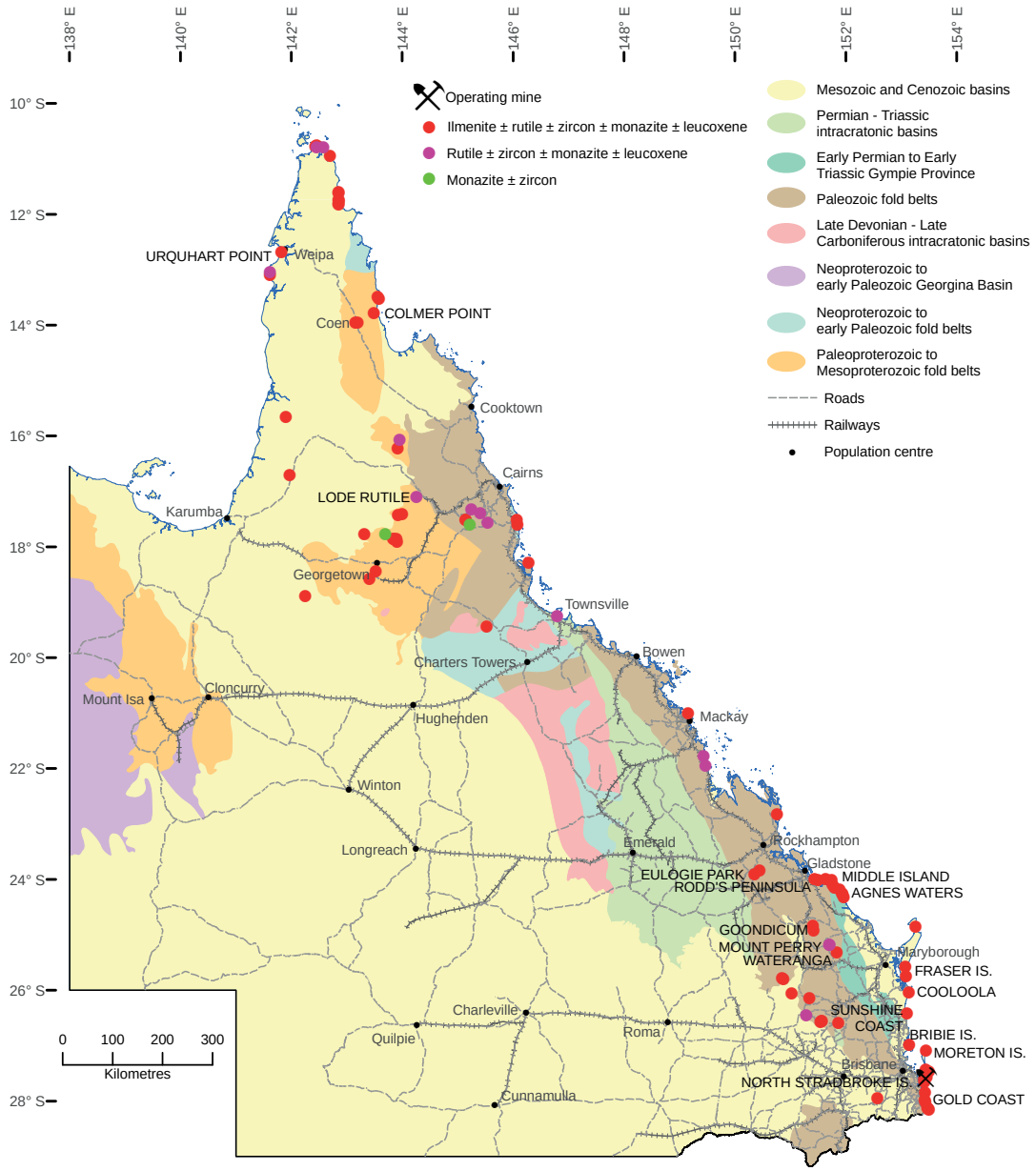

Figure 9: Heavy mineral occurrences and deposits

Warwick–Texas and Cloncurry areas (Figure 10; Ball, 1904b; Shepherd, 1955; Connah, 1958a; Connah, 1958b; Levingston, 1958; Simmonds, 1960; Sawers, 1968; Sawers, 1969; Siemon, 1973; Ishaq, 1977; Krosch & Martin, 1977; Geological Survey of Queensland, 1978; Willmott, 1979; Willmott, 1980; Krosch, 1979; Krosch, 1981a; Krosch, 1985b; Krosch, 1990a; Kay, 1991). Demand for limestone is related to economic growth and expansion in limestone mining is expected to parallel industrial growth in Queensland. Queensland limestone production in 2009-10 totalled 3.43Mt. Current resources and reserves are >1.09Bt (von Gnielinski, 2010).

In 2009–10, the major limestone mining operations were at East End (Mount Larcom), Taragoola, O'Dea Extended, Ulam, Murgon and Cement Mills. Limestone is also quarried at Greenwood, Christmas Creek, Coralime, Fairchance, Calcium, Marule, Ootann and Riverton (Table 5).

Table 4: Significant heavy mineral deposits in Queensland

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Agnes Waters	40km ENE of Miriamvale	Abandoned prospect	Not mined	Deep Water, Rocky Point and Round Hill Head – 717 300t ilmenite, 20 700t rutile, 37 000t zircon (Cooper 1990a); South Wreck Rock – 226 224t ilmenite, 5738t rutile, 5978t zircon (McKeague & Paterson, 1957)	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach, beach ridge, barrier dune and high dune heavy mineral sand deposits. Resources are within the Agnes Waters National Park.
Bayfield	20km N of Yeppoon	Abandoned prospect	Not mined	3.7Mt rutile, 21Mt ilmenite, 3.7Mt zircon (Strategic Minerals Corporation NL, 2004)	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach, beach ridge, barrier dune and high dune heavy mineral sand deposits. Resources are within the Byfield National Park.
Bribie Island	57km NNE of Brisbane	Abandoned prospect	Not mined	327 500t rutile, 475 000t zircon, 21 000t ilmenite (Cooper, 1990a)	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach and beach ridge heavy mineral sand deposits. Any remaining resources are alienated by National Park and urban development.
Colmer Point	36.7km ENE of Coen	Abandoned prospect	Not mined	0.36Mt rutile, 4.08Mt ilmenite, 1.02Mt zircon (Frank, 1987)	Palaeodune and beach ridge sands/ Modern Coastal Deposits	Palaeodune and beach ridge heavy mineral and silica sand deposits; within National Park
Cooloola	50.5km ENE of Brisbane	Abandoned mine, prospect	62 500t rutile, 78 700t zircon, 2500t ilmenite, 110t monazite (1956-1977)	3Mt of mineral sand containing unknown grades of ilmenite, rutile and zircon (O'Flynn & Krosch, 1987)	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach, beach ridge, barrier dune and high dune heavy mineral sand deposits. Remaining resources are within the Cooloola National Park.
Eulogie Park Prospect	50km W of Gladstone	Prospect	Not mined	Surface mineable resources of ferrigabbro ore exceeding 100Mt at an average 25% titanomagnetite and ilmenite (15.4 to >21% Fe and 1.9 to >4% Ti) (Thiess Contractors Pty Ltd, 1989).	Eulogie Park Gabbro/ Permo-Triassic Igneous Provinces	Layered gabbro complex and derived alluvial and eluvial material. The deposit has been investigated as a source of iron ore, magnetite for coal washing and heavy minerals for abrasive blast cleaning; currently held under mineral development licence by Belmont Park Investments Pty Ltd and Panorama Ridge Pty Ltd.
Fraser Island (and Inskip Point)	46km ESE of Maryborough	Abandoned mine	188 522t rutile, 147 140t zircon, 323.7t monazite (1965-1976)	866 400t rutile, 2 914 600t ilmenite, 893 300t zircon (Cooper, 1990a)	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach, beach ridge, barrier dune and high dune heavy mineral sand deposits. Remaining resources are within the Fraser Island National Park.
Gold Coast (and South Stradbroke Island)	S of Brisbane	Abandoned mines	232 738t rutile, 315 060t zircon, 14 294t ilmenite, 241t monazite (1941-1987)	Not reported	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach and beach ridge heavy mineral sand deposits. Any remaining resources are alienated by urban development or National Park.
Goondicum	20km SE of Monto	Care and maintenance	18 503t ilmenite (2004-2009)	Goondicum Crater - 3.94Mt ilmenite (Monto Minerals NL, 2005); Jack Goody - 8.28Mt ilmenite (Monto Minerals NL, 2003)	Goondicum Gabbro/ Wandilla Province; Quaternary alluvium and eluvium/ Cainozoic Alluvial and Colluvial Deposits	Layered gabbro complex and associated eluvium and alluvium. The Goondicum mine was operated by Monto Minerals NL but is now owned by Belridge Enterprises Pty Ltd which is aiming to redevelop the project.

Table 4 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Lode Rutile	150km W of Cairns	Abandoned mine, prospect	1.7t rutile (1953-1955)	Confidential	Nundah Granodiorite/ Pama Province	Intrusive-related rutile-quartz veins. Current mining leases held by Premier Mining Pty Ltd.
Middle Island	33.6km NE of Miriamvale	Prospect	Not mined	346 032t ilmenite, 21 085t zircon, 5271t rutile (McKeague & Paterson, 1957)	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach, beach ridge, barrier dune and high dune heavy mineral sand deposits. Exploration Permits held by Monto Minerals Ltd.
Moreton Island	55km NE of Brisbane	Abandoned mine	3047t rutile, 3312t zircon (1957-1958)	2 080 300t ilmenite, 702 700t rutile, 694 100t zircon (Cooper, 1990a)	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach, beach ridge, barrier dune and high dune heavy mineral sand deposits. Remaining resources are within the Moreton Island National Park.
Mount Perry Rutile Prospect	6.4km E of Mount Perry	Prospect	Not mined	1.51Mt rutile (Stuart, 1991)	Aranbanga Volcanic Group/ South East Queensland Volcanic and Plutonic Province	Disseminated rutile and zircon in quartzite and hydrothermally altered volcanics. Within the Mount Perry Resources Reserve.
North Stradbroke Island	40km E of Brisbane	Operating mine (Enterprise and Yarraman mines)	4 271 527t ilmenite, 3 091 442t rutile,2 474 958t zircon, 3091t monazite (1949-2009)	Enterprise - 1.29Mt rutile, 4.74Mt ilmenite, 1.09Mt zircon; Yarraman - 0.33Mt rutile, 0.8Mt ilmenite, 0.25Mt zircon; Amity Swamp – 24 516t rutile, 54 000t ilmenite, 24 516t zircon (Consolidated Rutile Limited, 2006)	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach, beach ridge, barrier dune and high dune heavy mineral sand deposits. Currently mined by Sibelco Australia Ltd, with minor additional ilmenite and rutile production from ACI Operations Pty Ltd's Myora silica sand mine. The Queensland Government has announced that mining will be phased out by 2025 and most of the island will be declared a National Park.
Rodd's Peninsula	40km N of Miriamvale	Abandoned prospect	23 385t ilmenite, 174t rutile, 5915t zircon (1969-1975)	455 000t ilmenite, 70 000t zircon, 30 000t rutile (Wallis & Oakes, 1990)	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach, beach ridge, barrier dune and high dune heavy mineral sand deposits. Remaining resources are within a National Park.
Sunshine Coast	100km N of Brisbane	Abandoned prospect	Minor mining only	828 800t rutile, 801 700t zircon, 2 299 100t ilmenite (Cooper, 1990a)	Beach, beach ridge and dune sands/ Modern Coastal Deposits	Beach and beach ridge heavy mineral sand deposits. Any remaining resources are alienated by urban development.
Urquhart Point	11.5km W of Weipa	Active prospect	Not mined	2.78Mt at 3% heavy minerals for 194 600t heavy minerals (>30 % zircon and rutile) (Matilda Minerals Ltd, 2008)	Palaeodune and beach ridge sands/ Modern Coastal Deposits	Beach, beach ridge, barrier dune and high dune heavy mineral sand deposits. Current exploration by Matilda Minerals Ltd.
Wateranga	25.3km SE of Mount Perry	Prospect	Not mined	Unconsolidated ores total 146Mt at 5% ilmenite, 0.2% zircon, and 0.1% rutile. Hard rock resources are 345Mt at ~7.3% ilmenite and 1% zircon, with potential for an additional 450Mt of hard rock ore (sourced from Queensland Industrial Minerals Ltd website, April 2009).	Wateranga Gabbro/ Permo-Triassic Igneous Provinces	Layered gabbro complex and derived alluvial and eluvial material. Held under Exploration Permit and Mining Lease application by Oresome Australia Pty Ltd.

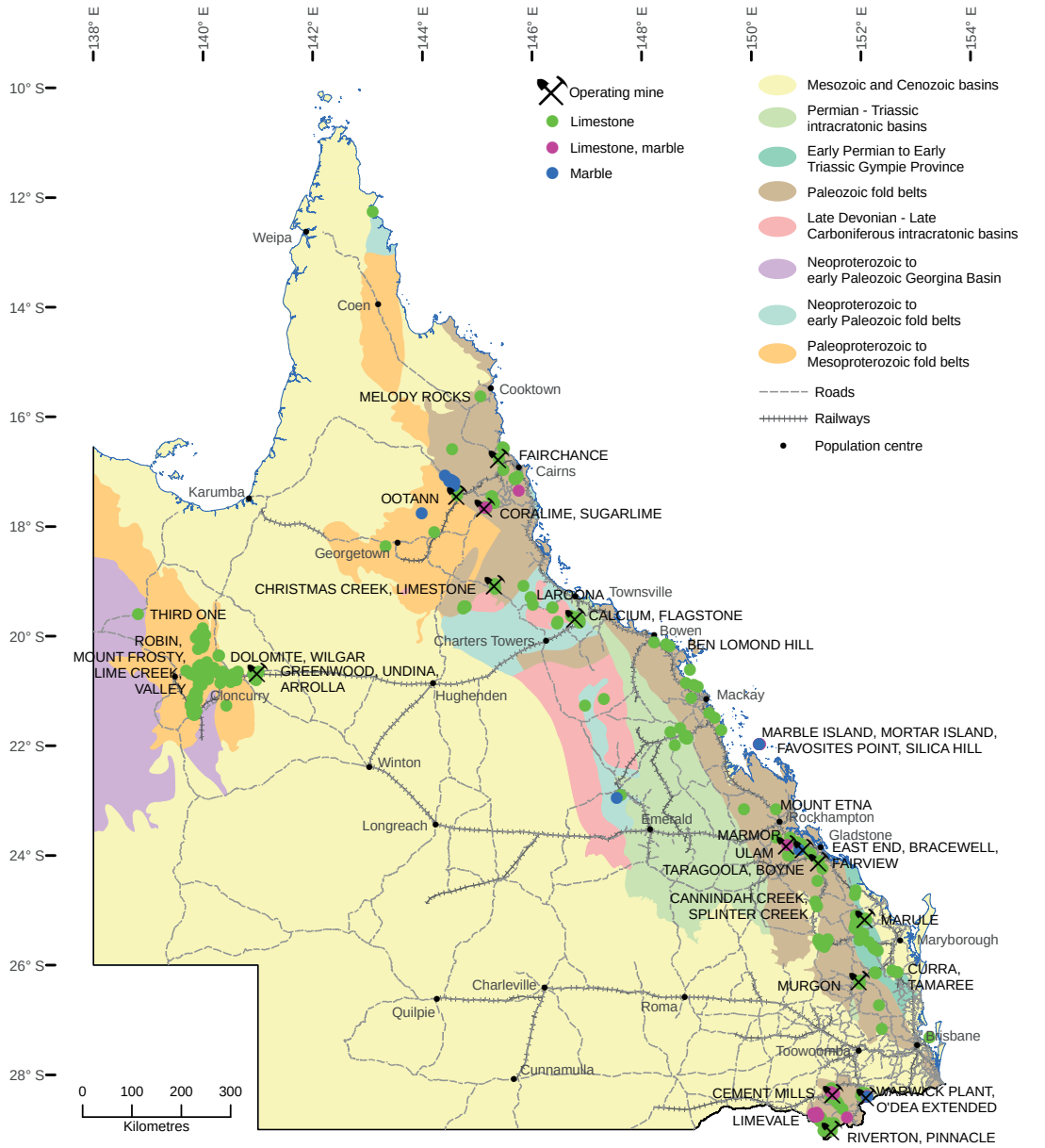

Figure 10: Limestone occurrences and deposits

MAGNESITE

Magnesite (magnesium carbonate) is the most important source mineral for producing magnesia (magnesium oxide). Crude magnesite is used in chemicals and agriculture. To form calcined magnesia, magnesite is crushed, screened, washed and sorted before being heated to 700–1000°C. Calcined magnesia is used in the manufacture of paints, paper, plastics, rubber, oil, pharmaceuticals, fertilisers and building materials. Deadburned magnesia (produced at 2000°C) and electrofused magnesia (produced at 3000°C) are used mainly in the refractory industry to line furnaces used in the production of steel, cement and glass.

Magnesite commonly occurs in veins and irregular masses derived from the alteration of serpentinite through the action of groundwater containing carbonic acid. Magnesite formed in this manner has a compact cryptocrystalline form. Queensland's

Table 5: Significant limestone deposits in Queensland

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Arrolla	46.8km E of Cloncurry	Prospect	None	8.25Mt limestone (sourced from non-current MDL 280 application documentation)	Toolebuc Formation/ Eromanga Basin	Sedimentary limestone deposit was investigated as a source of high purity limestone for mineral processing at Ernest Henry but was never mined.
Ben Lomond Hill	26.4km SE of Bowen	Prospect	101.6t limestone (1915-1917)	0.285t limestone (Australian Mining Engineering Consultants, 1996)	Edgecumbe beds/ Campwyn Subprovince	Sedimentary limestone deposit is held under exploration permit by Proserpine Lime Pty Ltd.
Boyne Limestone	28.4km SSE of Calliope	Prospect	Not mined	100Mt limestone (Metallica Minerals Limited, 2004)	Yarwun beds/ Rockhampton Subprovince	Sedimentary limestone deposit is held under mining leases by Phoenix Lime Pty Ltd (Metallica Minerals Ltd).
Bracewell Marble	40km NW of Gladstone	Prospect	Not mined	6Mt marble (Weedon, 1991)	Mount Alma Formation/ Rockhampton Subprovince	Cement Australia Pty Ltd holds mining leases over this sedimentary limestone/marble deposit.
Calcium	40km S of Townsville	Operating mine	36 350t lime, 9 884 225t limestone (1926-1994, 1996-1997, 2006-2010)	1Mt limestone (Unpublished correspondence from David Mitchell Ltd to Department of Mines and Energy, 1999)	Burdekin Formation/ Burdekin Basin	Sedimentary limestone deposit is quarried by BM Webb Quarries Pty Ltd to produce lime and limestone. Area was mined historically for limestone for cement production in Townsville.
Cannindah Creek Limestone	105km SSW of Gladstone	Prospect	Not mined	83.3Mt limestone (Biggs, 1985)	Rockhampton Group/ Rockhampton Subprovince	Sedimentary limestone deposit.
Cement Mills	175km SW of Brisbane	Operating mine	1 475 073t limestone (1915-1969, 1998-2010)	Confidential	Texas beds/ Texas Subprovince	Sedimentary limestone deposit is quarried by Equipment & Machinery Sales Pty Ltd. Historically, this was a major source of limestone for cement manufacture in Brisbane.
Christmas Creek Limestone	150km WNW of Townsville	Operating mine	597 879.9t limestone (1996-2010)	Not reported	Perry Creek Formation/ Camel Creek Subprovince	Sedimentary limestone deposit is quarried by Zinaback Pty Ltd to produce lime, limestone and decorative aggregate.
Coralime	4.5km NE of Mount Garnet	Operating mine	174 790.75t limestone (2000-2010)	Not reported	Chillagoe Formation/ Hodgkinson Province	Sedimentary limestone deposit is quarried by Miriwinni Pulverised Lime Pty Ltd to produce agricultural lime.
Curra Limestone	13.1km NW of Gympie	Abandoned mine	492 203t limestone, 273 360t aggregate (1914-1992, 1996-2000)	Not reported	South Curra Limestone/ Gympie Province	Sedimentary limestone deposit was quarried by Tamaree Lime Pty Ltd to produce burnt lime, quick lime and construction material.
Dolomite (plus Dingo and Salmon)	7.8km WSW of Cloncurry	Abandoned mine	107 048t limestone (1911-1920, 1960-1963)	Not reported	Unnamed meta-dolerite/ Mitakoodi Domain	Irregular to lenticular body of massive crystalline calcite, veins and breccia was mined for cupriferous limestone flux for Hampden and Mount Isa smelters.
East End	30km NW of Gladstone	Operating mine	23 849 306t limestone (1996-2010)	120Mt limestone	Erebus beds/ Mount Holly Subprovince	Sedimentary limestone deposit is quarried by Cement Australia Pty Ltd for limestone and clay for cement production in Gladstone.

Table 5 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Fairchance	12.0km SE of Mount Molloy	Operating mine	152 236.75t limestone (1900-1995, 2000-2010)	Not reported	Hodgkinson Formation/ Hodgkinson Province	Sedimentary limestone deposit was originally quarried for flux for Mount Molloy copper smelter. Deposit is now quarried by Zinaback Pty Ltd.
Fairview Limestone	25km SW of Gladstone	Prospect	Not mined	29Mt limestone (Metallica Minerals Limited, 2009c)	Mount Holly beds/ Yarrol Province	Sedimentary limestone deposit is held under mining lease and mineral development licence by Phoenix Lime Pty Ltd (Metallica Minerals Ltd)
Favosites Point	160km NNW of Rockhampton	Abandoned prospect	Not mined	0.254Mt limestone (Shepherd, 1955)	Erebus beds/ Mount Holly Subprovince	Sedimentary limestone deposit.
Flagstone	40km S of Townsville	Prospect	Not mined	34Mt limestone (Hamilton, 1994)	Burdekin Formation/ Burdekin Basin	Sedimentary limestone deposit is held under a mineral development licence by ACN Mining Pty Ltd.
Greenwood	51.2km E of Cloncurry	Operating mine	289 516t limestone (2003-2007)	Confidential	Toolebuc Formation/ Eromanga Basin	Sedimentary limestone deposit is quarried by Xstrata to supply metallurgical flux for Mount Isa smelters.
Laroona Lime	80km W of Townsville	Care and maintenance	59 835.8t limestone (1996-2008)	Not reported	Mount Podge Limestone/ Burdekin Basin	Sedimentary limestone deposit is held under mining lease bym.J. Wilkins.
Lime Creek	51.2km W of Cloncurry	Abandoned mine, prospect	276 575.4t limestone (1968-1981, 1997-1998)	Not reported	Argylla Formation/ Mary Kathleen Domain	Lenticular body of Cu-Mo-calcite mineralisation was mined as limestone flux for the Mount Isa smelters.
Limestone	150km W of Townsville	Prospect	Not mined	3.8Mt limestone (Unpublished correspondence from David Mitchell Ltd to Department of Mines and Energy, 1999)	Perry Creek Formation/ Camel Creek Subprovince	Sedimentary limestone deposit is held under current mining lease by Zinaback Pty Ltd.
Limevale Quarry	225km SW of Brisbane	Abandoned mine	40 978t limestone (1939-1988, 1996-1999)	15Mt limestone (Unpublished correspondence from David Mitchell Ltd to Department of Mines and Energy, 1999)	Texas beds/ Texas Subprovince	Sedimentary limestone deposit is held under mining lease by Unimin Lime (NSW) Pty Ltd and has produced marble dimension stone and limestone in the past.
Marble Island	160km NNW of Rockhampton	Abandoned mine	3048t marble	0.122Mt limestone (Shepherd, 1955)	Erebus beds/ Mount Holly Subprovince	Sedimentary limestone deposit.
Marmor	55km NE of Gladstone	Abandoned mine, prospect	1 814 691t limestone	5.2Mt limestone (Krosch, 1990a)	Mount Alma Formation/ Rockhampton Subprovince	Sedimentary limestone deposit was mined for use as road base and in agricultural lime production. Current mining leases are held by Unimin Australia Ltd (Sibelco Australia Ltd).
Marule Lime	22km WNW of Childers	Operating mine	35 531t limestone (1997-2010)	0.4Mt limestone (Krosch, 1990a)	Gympie Group/ Gympie Province	Sedimentary limestone deposit is mined by KD Scarlett to produce pulverised limestone for the local sugar industry.

Table 5 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Melody Rocks	150km NNW of Cairns	Prospect	Not mined	>100Mt limestone (Burban, 1985)	Hodgkinson Formation/ Hodgkinson Province	Sedimentary limestone deposit was investigated by Queensland Metals Corporation NL in the 1980s for possible development of a cement clinker plant. Current mining lease held by CI Doxford and RJ Thomas.
Mortar Island	160km NNW of Rockhampton	Abandoned mine	300t marble (around 1904)	0.67Mt limestone (Shepherd, 1955)	Mount Holly beds/ Yarrol Province	Sedimentary limestone deposit.
Mount Etna	25km NNW of Rockhampton	Abandoned mine	729 369t limestone (1997-2004)	70Mt limestone (Louthean Publishing Pty Ltd & Minmet Australia Pty Ltd, 1998)	Mount Alma Formation/ Rockhampton Subprovince	Sedimentary limestone deposit was quarried for cement and lime production in Rockhampton.
Mount Frosty	45.3km E of Mount Isa	Abandoned mine	164 948t limestone (1961-1967)	Not reported	Unnamed meta-dolerite/ Mary Kathleen Domain	Irregular body of massive calcite, veins and breccia with minor Cu mineralisation was mined as metallurgical flux for the Mount Isa smelters.
Murgon	6km SE of Murgon	Operating mine	1 128 378t limestone	3.11Mt limestone (Unpublished correspondence from David Mitchell Ltd to Department of Mines and Energy, 1999; Martin, 1977)	Maronghi Creek beds/ Yarraman Subprovince	Sedimentary limestone deposit is quarried by Unimin Lime (NSW) Pty Ltd to produce lime, crushed limestone and decorative aggregate.
O'Dea Extended	130km SW of Brisbane	Operating mine	1 348 122t limestone	0.85Mt limestone (Unpublished correspondence from David Mitchell Ltd to Department of Mines and Energy, 1999)	Rosenthal Creek Formation/ Silverwood Province	Sedimentary limestone deposit is quarried by Unimin Lime (NSW) Pty Ltd to produce crushed limestone, decorative limestone aggregate and marble dimension stone.
Ootann	125km WSW of Cairns	Operating mine	124 068t lime and 68 820t limestone (1972-1975, 1996-2010)	35Mt limestone (sourced from Phoenix Lime website www.phoenixlime.com.au)	Chillagoe Formation/ Hodgkinson Province	Sedimentary limestone deposit is quarried by Phoenix Lime Pty Ltd (Metallica Minerals Ltd) to produce agricultural lime.
Pinnacle Limestone Deposit	225km W of Brisbane	Abandoned mine, prospect	92 661t limestone	2Mt limestone (O'Toole, 1979b)	Texas beds/ Texas Subprovince	Sedimentary limestone deposit is held under mining lease by Unimin Lime (NSW) Pty Ltd.
Riverton Quarry	220km SW of Brisbane	Operating mine	1 209 011 r limestone, 407t marble, 70 798t aggregate (1982-1988, 1998-2010)	400Mt limestone (O'Toole, 1979a)	Texas beds/ Texas Subprovince	Sedimentary limestone deposit is quarried by Unimin Lime (NSW) Pty Ltd to produce limestone for agricultural lime, glass making, stock feed and stone dusting. Limestone aggregate is also produced.
Robin	29.5km ENE of Mount Isa	Abandoned mine, prospect	531 986t limestone (1967-1976)	Not reported	Corella Formation/ Kalkadoon-Leichhardt Domain	Calcite lens was worked for metallurgical flux. Current lease is held by Lawlor Contracting Pty Ltd.

Table 5 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Silica Hill	160km NNW of Rockhampton	Abandoned prospect	Not mined	0.199Mt limestone (Shepherd, 1955)	Erebus beds/ Mount Holly Subprovince	Sedimentary limestone deposit.
Splinter Creek Limestone	95km SSW of Gladstone	Prospect	Not mined	78.6Mt limestone (Biggs, 1985)	Splinter Creek Formation/ Rockhampton Subprovince	Sedimentary limestone deposit.
Sugarlime	5.5km NE of Mount Garnet	Abandoned mine, prospect	115 405t limestone (1996-2000)	Not reported	Hodgkinson Formation/ Hodgkinson Province	Sedimentary limestone deposit is held under mining lease by Miriwinni Pulverised Lime Pty Ltd.
Tamaree Limestone	6.6km N of Gympie	Abandoned mine	115 694.7t limestone, 21 999t lime, 7470.9t burnt lime (1916-1969, 1996-2001)	Not reported	South Curra Limestone/ Gympie Province	Sedimentary limestone deposit was quarried by Tamaree Lime Pty Ltd to produce burnt lime and quick lime.
Taragoola	25km SW of Gladstone	Operating mine	4 874 325t limestone (1996-2010)	Not reported	Calliope beds/ Calliope Subprovince	Sedimentary limestone deposit is mined by Frost Enterprises Pty Ltd to produce limestone for cement making, construction and agricultural use, and for supply to Queensland Alumina Ltd.
Third One (Undilla)	130km N of Mount Isa	Prospect	91 645.8t limestone (1998-2003)	10.65Mt limestone (Land and Resources Tribunal Queensland, 2003)	V-Creek Limestone/ Georgina Basin	Sedimentary limestone deposit was quarried for acid mine drainage neutralisation at Gunpowder. Current lease is held by Lawlor Contracting Pty Ltd. A larger lease has been applied for by Queensland Octane Pty Ltd , which proposes to set up a cement and lime plant in Mount Isa.
Ulam Marble	60km NW of Gladstone	Operating mine	1 618 294t limestone	Not reported	Ginger Creek Member/ Mount Morgan Subprovince	Sedimentary limestone deposit is mined by Omya Australia Pty Ltd for use as an industrial filler in plastics, paper and rubber. The Bajool plant also produces stonedust for coal mines and agricultural lime.
Undina No.5	45.4km E of Cloncurry	Abandoned mine, prospect	153 810.8t limestone (1996-1998)	Not reported	Toolebuc Formation/ Eromanga Basin	Sedimentary limestone deposit was quarried by Mount Isa Mines to supply metallurgical flux for Mount Isa smelters. Current lease held by Xstrata.
Valley	28.9km ENE of Mount Isa	Abandoned mine	171 189t limestone (1967-1977)	Not reported	Corella Formation/ Kalkadoon-Leichhardt Domain	Calcite veins were mined for metallurgical flux.
Warwick Plant	130km SW of Brisbane	Care and maintenance, prospect	101 331t limestone (1997-2007)	0.5Mt limestone (Unpublished correspondence from David Mitchell Ltd to Department of Mines and Energy, 1999)	Rosenthal Creek Formation/ Silverwood Province	Sedimentary limestone deposit is held under mining lease by Unimin Lime (NSW) Pty Ltd.
Wilgar	17.3km WNW of Cloncurry	Abandoned mine	107 248t limestone (1950-1958)	Not reported	Overhang Jaspilite/ Mitakoodi Domain	Lenticular calcite bodies were mined to supply metallurgical flux to the Mount Isa smelters.

major magnesite deposits all occur in Tertiary sedimentary basins north-west of Rockhampton (Figure 11). Queensland's current magnesite resources and reserves total >239Mt (von Gnielinski, 2010).

The only operating mine, Kunwarara, is considered to be the world's largest known resource of cryptocrystalline nodular magnesite — a high quality ore. At Kunwarara, Late Tertiary to Quaternary River gravels and sands of a former north-flowing river system host nodular magnesite, with high-grade 'bone-type' magnesite delineated in five main zones. The source of the magnesium carbonate is the weathering of serpentinised ultramafic rocks (Princhester Serpentinite) that form low hills adjacent to the deposit (Geological Survey of Queensland, 1978; Burban, 1990; Milburn & Wilcock, 1994; Jones, 1995; Milburn & Wilcock, 1998; Smart, 1999c; Wilcock, 2003). The nearby Oldman South, Yaamba and Herbert Creek magnesite deposits formed in a similar environment.

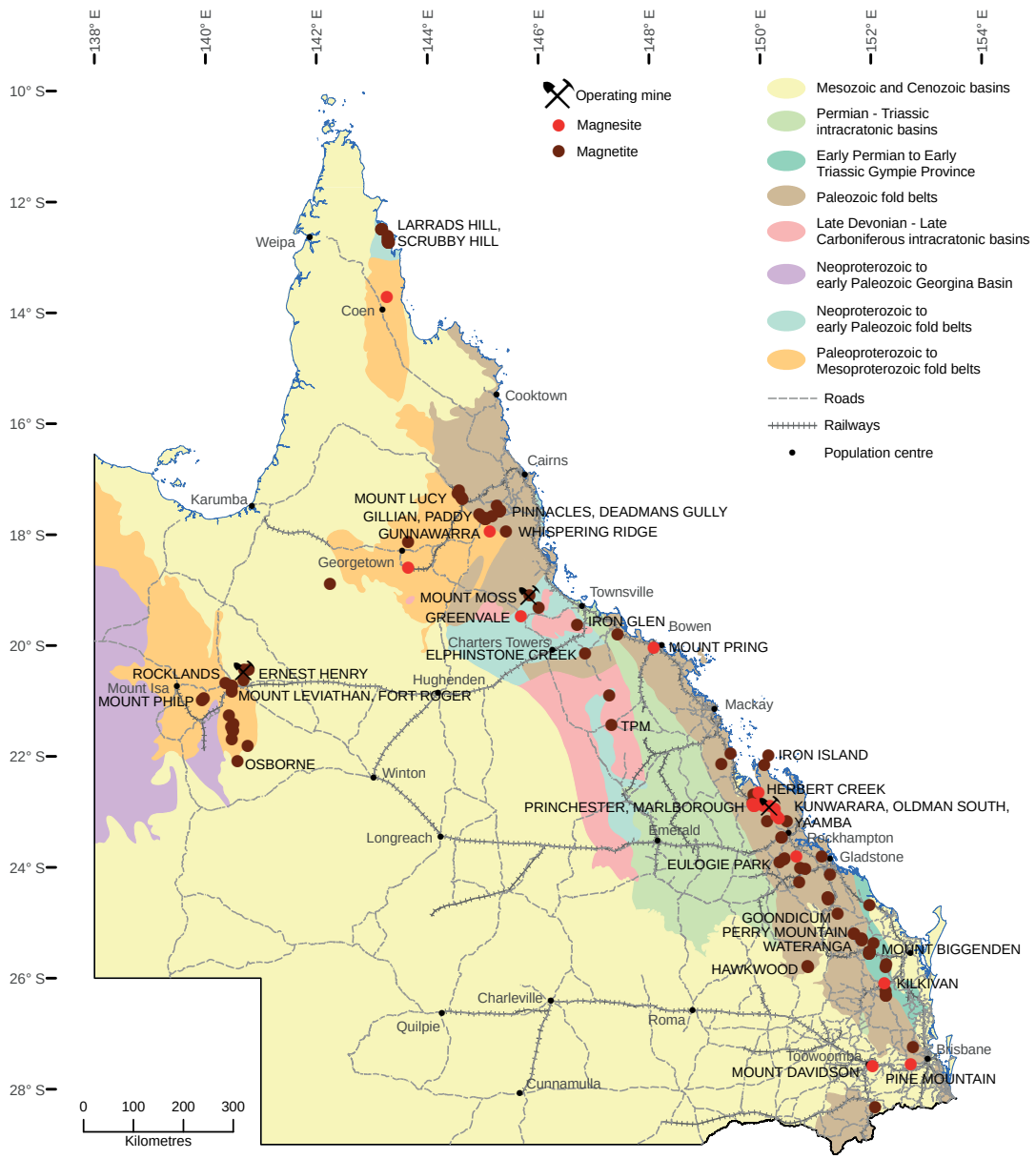

Figure 11: Magnesite and magnetite occurrences and deposits

Queensland Magnesia Pty Ltd mines the Kunwarara deposit and holds the adjoining Oldman South and Yaamba deposits. Magnesite is processed at the Parkhurst plant in Rockhampton where high-grade deadburned and electrofused magnesia products are produced for the global refractory market and calcined magnesia is produced for a wide range of applications.

The *in situ* resources of medium- to high-grade cryptocrystalline magnesite at Kunwarara place Queensland in a prime position to take up a significant world market share of magnesium production in the future. Production from this deposit between 1994 and 2010 totalled 6 591 239t of magnesite; 2009–10 production was 275 819t. Queensland Magnesia Pty Ltd's website gives 'run of mine' resources as >87Mt of magnesite.

The Princhester Magnesite deposit, with indicated and inferred resources of 2.53Mt of magnesite (Mount Grace Resources Ltd, 2002), formed by *in situ* weathering of the Princhester Serpentinite (Ridgway, 1941; Cuttler, 1958; Brooks, 1964b; Geological Survey of Queensland, 1978; Jones, 1995). Lachlan Star Ltd holds mining leases over part of the deposit.

Minor magnesite occurs associated with lateritic nickel deposits developed in serpentinites in the Gunnawarra, Greenvale, Mount Pring (Saint-Smith, 1919a; Geological Survey of Queensland, 1978), Kilkivan (Denmead, 1944) and Pine Mountain (Connah, 1962) areas. Magnesite at Mount Davidson, near Toowoomba, is the result of weathering of Tertiary basalt (Ball, 1911a). Similar mineralisation is common in weathered basalts in south east and central Queensland.

MAGNETITE

Magnetite is used by the Australian coal industry to provide a dense medium in the coal washing process. Until 1999, most of the magnetite used in Queensland was supplied from the Mount Biggenden mine in south-east Queensland. Magnetite from Mount Biggenden was supplanted by cheaper imported magnetite.

Magnetite skarns occur throughout the Tasman Orogenic Zone (for example, Mount Moss, Mount Biggenden), as do magnetite-and titanomagnetite-bearing layered gabbro complexes (for example, Goondicum, Hawkwood) and their eluvial and alluvial products (Figure 11, Table 6). Significant magnetite resources are also associated with many of the iron oxide-copper-gold deposits (for example, Ernest Henry, Osborne) and hematite-magnetite ironstone lenses and bodies (for example, Mount Philp, Mount Leviathan) in the Eastern Fold Belt Province of the Mount Isa Inlier. Hematite schists of the Sefton Metamorphics (misnamed "banded iron formations" in early company reports) of the Iron Range Province in far north Queensland also contain magnetite. Queensland magnetite and ironstone deposits have been described by Cameron (1903), Ball (1904b), Reid (1919), Dunstan (1920a), Brooks (1956), Brooks (1957a), Brooks (1970), Bruvel & others (1995) and Wallis (2008).

Table 6: Significant magnetite deposits in Queensland

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Deadmans Gully	18.5km WNW of Ravenshoe	Abandoned mine, prospect	Not reported	0.4Mt at 34.89% Fe (Consolidated Tin Mines Limited, 2010)	Hodgkinson Formation/ Hodgkinson Province; Nettle Granite/ Kennedy Province	Tin skarn deposit. Current exploration by Consolidated Tin Mines Ltd.
Elphinstone Creek	3.3km SW of Ravenswood	Deposit	Not mined	1.12m^3 at 20kg/m^3 magnetite for 51 800t magnetite (Switzer, 1988)	Quaternary alluvium/ Cainozoic Alluvial and Colluvial Deposits.	Alluvial deposit. Preliminary testing indicated that the magnetite is suitable for coal washing.
Ernest Henry	38km NE of Cloncurry	Operating Cu-Au mine	No magnetite produced	17Mt at 22.6% magnetite (open cut) and 88Mt at 27.9% magnetite (underground) for a total of 28.38Mt magnetite (Xstrata Plc, 2010)	Mount Fort Constantine Volcanics/ Canobie Domain	Breccia hosted iron oxide copper-gold deposit. Ernest Henry is owned by Xstrata Copper and has been producing copper and gold since 1997. The mine is in the process of transitioning from open cut to underground operations. Magnetite will be produced from underground Cu-Au ore and potentially from tailings for steel making. The first magnetite shipment was in June 2011.
Eulogie Park Prospect	50km W of Gladstone	Prospect	Not mined	Surface mineable resources of ferrigabbro ore exceeding 100Mt at an average 25% titanomagnetite and ilmenite (15.4 to >21% Fe and 1.9 to >4% Ti) (Thiess Contractors Pty Ltd, 1989).	Eulogie Park Gabbro/ Permo-Triassic Igneous Provinces	Layered gabbro complex and derived alluvial and eluvial material. The deposit has been investigated as a source of iron ore, magnetite for coal washing and heavy minerals for abrasive blast cleaning; currently held under mineral development licence by Belmont Park Investments Pty Ltd and Panorama Ridge Pty Ltd.
Fort Roger	14.8km S of Cloncurry	Deposit	Not mined	0.23Mt magnetite (Kreutzer, 1981)	Marimo Slate/ Marimo-Staveley Domain	Fault infill of hematite-magnetite-quartz ironstone. Unoxidised magnetite would be suitable for coal washing.
Gillian	105km SW of Cairns	Abandoned mine, Prospect	Not reported	3Mt at 29.72% Fe (Consolidated Tin Mines Limited, 2010)	Chillagoe Formation/ Hodgkinson Province; Hammonds Creek Granodiorite/ Kennedy Province	Tin skarn deposit. Held under mineral development licence by Consolidated Tin Mines Ltd.
Goondicum Crater Ilmenite	112km SSE of Gladstone	Care and maintenance	4900t titanomagnetite (2007-2009)	79Mt at 2.85% titanomagnetite (2.26Mt titanomagnetite; Monto Minerals NL, 2005)	Goondicum Gabbro/ Wandilla Province	Layered gabbro complex and derived alluvial and eluvial material. This deposit was being mined by Monto Minerals NL to provide a range of industrial minerals before the company went in voluntary administration in 2008. Titanomagnetite was being trialled for coal washing. Belridge Enterprises Ltd acquired the project and has completed a feasibility study aimed at redevelopment.

Table 6 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Hawkwood	272km NW of Brisbane	Prospect	Not mined	2.6Mt at 23% titanomagnetite (598 000t titanomagnetite; Johnson & Chiu Chong, 1971)	Hawkwood Gabbro, Delubra Quartz Gabbro/ Rawbelle Batholith	Layered gabbro complex and derived alluvial and eluvial material. Currently being evaluated by joint venture of Eastern Iron Ltd and Rugby Mining Pty Ltd
Iron Glen	41km SSW of Townsville	Abandoned mine, active prospect	36 416t ironstone (1955-1969)	Not reported	Fanning River Group/ Burdekin Basin	Magnetite skarn deposit. Mined historically as source of ironstone for cement manufacture. Current exploration by Iron Glen Holdings Ltd.
Iron Island	135km SE of Mackay	Abandoned mine	400 090t magnetite (1907-1921)	2Mt magnetite (Ball, 1904b)	Erebus beds/ Mount Holly Subprovince	Magnetite skarn deposit. Mined historically by Mount Morgan Gold Mining Company Ltd for flux. Iron Island is now within the Great Barrier Reef Marine Park.
Larrads Hill	27km NW of Portland Roads	Deposit	Not mined	2.69Mt at 46.1% Fe and 2.5% Mn (The Broken Hill Proprietary Company Limited, 1962)	Sefton Metamorphics/ Iron Range Province	Manganiferous iron formation overlies magnetite-hematite quartzite lenses in schist; magnetite content is highly variable. Deposit is now within the Iron Range National Park.
Mount Biggenden	38.4km ENE of Gayndah	Operating mine producing crushed aggregate and road base material	740 462.3t magnetite (1942-1954, 1967-1999)	Essentially mined out	Gympie Group/ Gympie Province	Magnetite skarn deposit. Originally mined for gold, copper and bismuth. Mined by Commercial Minerals Pty Ltd to produce magnetite for coal washing. Currently operated to produce crushed aggregate from the waste dumps.
Mount Leviathan	3.6km WSW of Cloncurry	Deposit	Not mined	2Mt at 57% Fe (Dunstan, 1920a)	Mitakoodi Quartzite/ Mitakoodi Domain	Fault infill of hematite-magnetite-quartz ironstone. Unoxidised magnetite may be suitable for coal washing.
Mount Lucy	128km WSW of Cairns	Prospect	45 344t ironstone (1903-1942)	>3Mt at least 60% iron ore (Intermet Resources Limited, 2010)	Chillagoe Formation/ Hodgkinson Province; Lucy Granite/ Kennedy Province	Magnetite skarn deposit. Mount Lucy was mined historically to provide flux for the Chillagoe smelters. Magnetite at Mount Lucy is very high-grade, with up to 70.18% Fe and very low phosphorus and silica.
Mount Moss	100km W of Townsville	Operating mine	90 741t magnetite (2008-2010)	20Mt at 41% Fe, 0.35% Cu and 0.35% Zn for 8.2Mt Fe, 70 000t Cu and 70 000t Zn (Geological Survey of Queensland, 2011)	Perry Creek Formation/ Camel Creek Subprovince	Magnetite-base metal skarn.Mt Moss Mining Pty Ltd produces magnetite for steel production and coal washing.
Mount Philp	54.4km ESE of Mount Isa	Prospect	Not mined	4.165Mt at 36.6% Fe and 39% Si (Carter & Brooks, 1955)	Corella Formation/ Mary Kathleen Domain	Fault infill of hematite-magnetite-quartz ironstone. Unoxidised magnetite may be suitable for coal washing. Currently being evaluated for hematite ore by Kings Minerals NL.

Table 6 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Osborne	195km SE of Mount Isa	Care and maintenance (Cu-Au mine)	No magnetite produced	15.5Mt tailings at 35% magnetite (Coe & Evans, 2008)	Soldiers Cap Group/ Kuridala-Selwyn Domain	Ironstone and breccia hosted iron oxide copper-gold deposit. Osborne is now owned by Ivanhoe Australia Ltd; previous owner Barrick Gold Corporation had been producing copper and gold from here since 1995. Barrick had proposed to produce magnetite from Cu-Au ore and mine tailings for use in steel production and coal washing. Ivanhoe Australia has not yet stated whether it will pursue magnetite production when Cu-Au production resumes.
Paddy		Abandoned mine, prospect	Not reported	0.1Mt at 58.4% Fe (Connah, 1955)	Chillagoe Formation/ Hodgkinson Province	Magnetite skarn deposit. Current exploration by Intermet Resources Ltd.
Perry Mountain Ironstone	6.3km ESE of Mount Perry	Abandoned mine	Not reported	101 600t at 34% Fe (Reid, 1919)	Aranbanga Volcanic Group/ South East Queensland Volcanic and Plutonic Province	Transported ironstone deposit developed on hematite-magnetite quartzite bed. This deposit was mined by the Queensland Copper Company Ltd in 1902 to supply ironstone flux for the Mount Perry copper smelters.
Pinnacles	6km NE of Mount Garnet	Abandoned mine, prospect	Not reported	1.87Mt at 17.5% Fe (Consolidated Tin Mines Limited, 2010)	Hodgkinson Formation/ Hodgkinson Province; Pinnacles Granite/ Kennedy Province	Comprises four tin skarn deposits – Wafer, Sniska, Hartog and Llahsram. Current exploration by Consolidated Tin Mines Ltd.
Rocklands	15km W of Cloncurry	Prospect	Not mined	157Mt at 2.9% magnetite (Cudeco Limited, 2010a)	Mitakoodi Quartzite/ Mitakoodi Domain	Breccia hosted iron oxide copper-gold deposit. Testing by Cudeco Ltd has shown that magnetite associated with the Cu-Au ore is acceptable for coal washing.
Scrubby Hill	30km NW of Portland Roads	Occurrence	Not mined	100 000t at 33.4% Fe and 14.3% Mn (The Broken Hill Proprietary Company Limited, 1962)	Sefton Metamorphics/ Iron Range Province	Manganiferous iron formation overlies magnetite-hematite quartzite lenses in schist; magnetite content is highly variable. Deposit is now within the Iron Range National Park.
TPM	5.4km SSW of Mount Coolon	Prospect	Not mined	60 960t magnetite (Chiu Chong & Sedgman, 1972)	Anakie Metamorphic Group/ Anakie Orogen	Magnetite-Cu-Au skarn deposit. Drummond Gold Ltd is investigating the Cu-Au potential. Previous explorers have been interested in the magnetite for coal washing.
Wateranga	25.3km SE of Mount Perry	Prospect	Not mined	Hard rock resources are 345Mt at ~23% magnetite, with potential for an additional 450Mt of hard rock ore (sourced from Queensland Industrial Minerals Ltd website, April 2009).	Wateranga Gabbro/ Permo-Triassic Igneous Provinces	Layered gabbro complex and derived alluvial and eluvial material. Currently being evaluated by Queensland Industrial Minerals Ltd.
Whispering Ridge Magnetite Prospect	37km S of Ravenshoe	Prospect	Not mined	Confidential	Chillagoe Formation/ Hodgkinson Province	Magnetite skarn deposit. Pre-feasibility study carried put for supply of magnetite for coal washing.

Queensland's only current magnetite producers are Mount Moss, 100km west of Townsville, which produces magnetite for domestic consumption as a coal washing medium and for export to China for steel making and Ernest Henry, near Cloncurry, which produced its first shipment of magnetite in June 2011. Queensland production in 2009–10 was 87 513t.

MANGANESE

Manganese is used in the steel, ferroalloy, metallurgical, dry cell battery, glass making, paint and chemical industries. The main ore is pyrolusite (manganese dioxide). Queensland is not a manganese producer but has produced small quantities of manganese in the past, particularly during the World Wars. Numerous small deposits are scattered along the east coast and in the north-west (Figure 12).

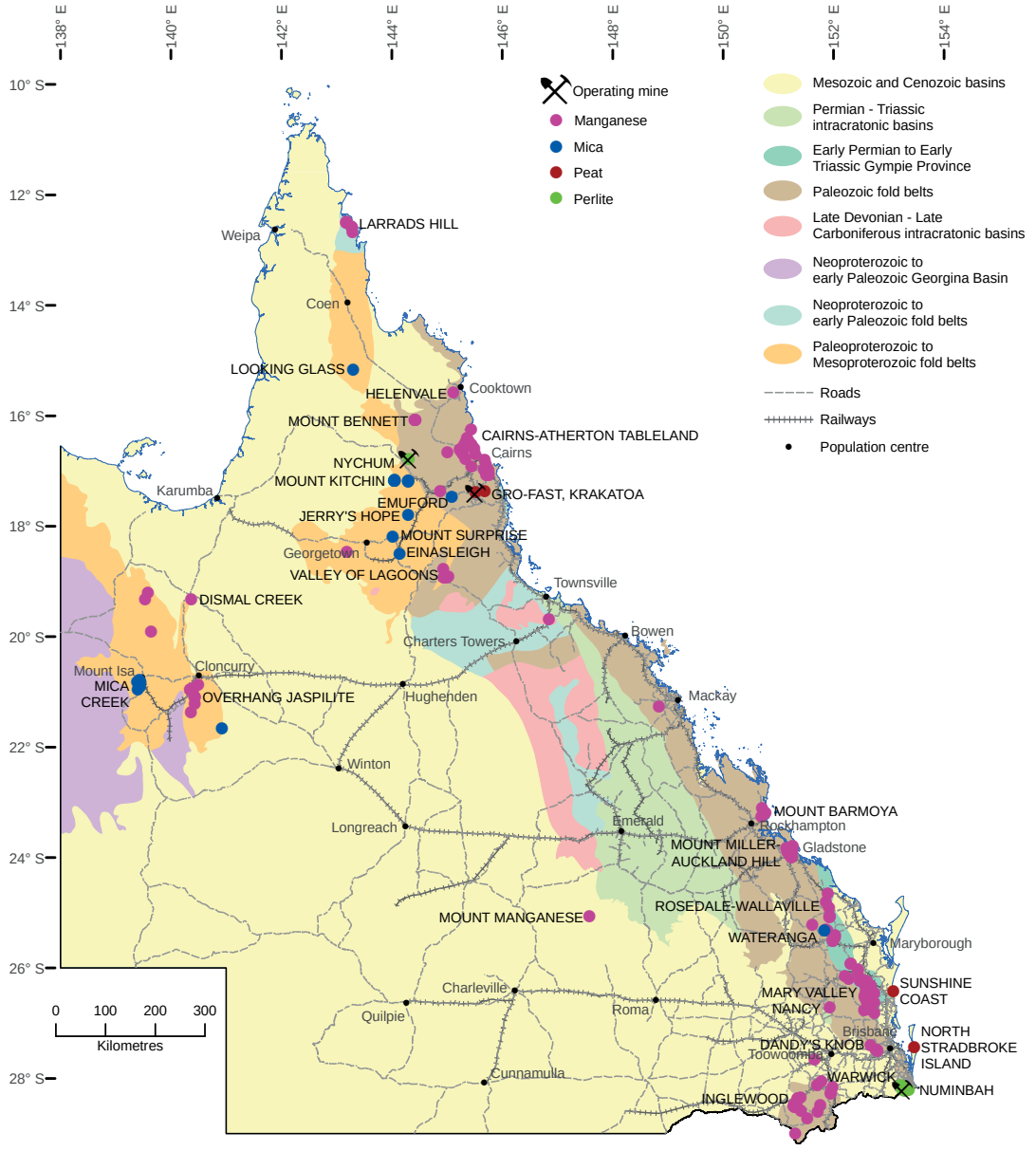

Figure 12: Manganese, mica, peat and perlite occurrences and deposits

Manganiferous iron formation overlies magnetite-hematite quartzite lenses in schist of the Sefton Metamorphics in the Larrads Hill area on Cape York Peninsula (Denaro & Morwood, 1992). Known resources at Larrads Hill, Lunch Hill, North Pig Hole Hill, Pig Hole Hill and Scrubby Hill total 2.79Mt at 45.7% Fe and 2.4% Mn; silica and alumina grades are ~6.1–23.5% and 5.8–9.6%, respectively (The Broken Hill Proprietary Company Limited, 1962). The best grade material is a residual capping and its derived scree. The deposits are now within the Iron Range National Park.

Numerous, small manganese deposits, some of which have been mined historically, occur in the Overhang Jaspilite and overlying Marimo Slate south-west of Cloncurry (Brooks, 1962a; Denaro & others, 2003; Denaro & others, 2004a). These deposits comprise manganese oxides (braunite, pyrolusite and psilomelane) produced by supergene enrichment of manganiferous jaspilite along faults and shear zones. The Overhang deposit produced 7270t of ore at average grades of ~48.3% MnO_2 for use in the Mary Kathleen acid leach uranium treatment plant from 1959 to 1962. The remaining resource is 29 000t at 29.2% Mn, 34.9% SiO_2, 2.8% Fe and 2.7% Al_2O_3 (Portman Mining Limited, 1991). Manganese oxides were also produced from the Nero mine for use at Mary Kathleen (Denaro & others, 2004a).

Manganese is commonly associated with cobalt deposits and with some copper deposits in the Mount Isa — Cloncurry region. Asbolite has been reported from the Kajabbi, Dugald River and Soldiers Cap areas (Carter & others, 1961).

Pyrolusite and hematite nodules occur as secondary concretions up to 150mm diameter in an outcrop of Allaru Mudstone (Carpentaria Basin) at Dismal Creek, 155km north of Cloncurry (Dampier Mining Company Ltd, 1981).

Mount Manganese, 116km south-west of Springsure, is a supergene enriched Co-Mn deposit in the early Jurassic Evergreen Formation of the Eromanga Basin. Mineralisation comprises cobaltiferous manganese wad in brecciated sandstone (Gould, 1996).

Manganese mineralisation is common in turbiditic and other sediments of the Tasman Orogenic Zone. Deposits occur as small lenses of manganese oxides of supergene enrichment and possibly volcanogenic/exhalative origin associated with jasper, chert, arenite and psammite of the:

- Hodgkinson Formation in the Helenvale, Mount Bennett and Cairns – Atherton Tableland areas (Jensen, 1919; Denmead, 1949)
- Wairuna Formation in the Valley of Lagoons area
- Wandilla Formation in the Mount Barmoya area (Geological Survey of Queensland, 1978)
- Doonside and Wandilla Formations in the Mount Miller – Auckland Hill area (Ball, 1904b; Ball, 1915; Dunstan, 1917c; Dunstan, 1921b; Dunstan, 1926; Geological Survey of Queensland, 1978; Morwood, 2003)

- Gympie Group in the Rosedale–Wallaville area (Ball, 1904c; Dunstan, 1917c; Dunstan, 1921b; Dunstan, 1926; Denaro & others, 2007)
- Maronghi Creek beds at the Nancy mine
- Amamoor beds in the Mary Valley area (Dunstan, 1917c; Dunstan, 1921b; Dunstan, 1926; Shepherd, 1939; Burns, 1961; Brooks, 1962b; Barker & others, 1993; Randall & others, 1996)
- Neranleigh-Fernvale beds at Dandy's Knob
- Texas beds in the Inglewood and Warwick areas (Ball, 1904b; Ball, 1904c; Dunstan, 1917c; Dunstan, 1926; Dunstan, 1921b; Denaro, 1989).

Significant Queensland production of manganese oxides includes:

- 23 496t from the Mount Miller – Auckland Hill area between 1882 and 1960 (used for smelting at Mount Morgan and Charters Towers; (Morwood, 2003)
- >40 000t from the Mary Valley deposits between 1908 and 1966 (used for steel making, dry cell batteries, brick making, and for gold and uranium extraction processes; Barker & others, 1993; Randall & others, 1996)
- 788t from the Inglewood and Warwick areas between 1917 and 1964 (used for steel making and battery manufacture; Robertson, 1974; Denaro, 1989).

MICA

Muscovite mica is common in pegmatites in north-west and northern Queensland (Figure 12). Some mining was carried out historically on a small scale to produce mica sheets for electrical insulation and the manufacture of fireproof and metallic paints, wallpapers, rubber, roofing compounds and lubricants (Dunstan, 1926).

Books of muscovite mica up to 300mm across were mined from segregated granite pegmatite dykes and veins (Mica Creek Pegmatite) at Mica Creek, south of Mount Isa from 1922 to 1927, when some 635kg was produced (Dunstan, 1916; Dunstan, 1920b; Brooks & Shipway, 1960; Brooks & Shipway, 1961; Denaro & others, 2001). Muscovite mica also occurs as books up to 100mm across in pegmatite veins in the Soldiers Cap Group 26km north of Cannington Homestead.

In 1942, a parcel of a few hundred kilograms was made up from 3.5t of split muscovite mica from the Looking Glass deposit, near Dixie Homestead on Cape York Peninsula, and sent to Melbourne. Mica book up to 250mm across occur in quartz blows and pegmatite dykes within the Proterozoic Holroyd Metamorphic Group (Ball, 1943; Culpeper & Burrows, 1992).

The Mount Kitchin mica deposits, west of Mungana, are pegmatites in the Silurian Nundah Granodiorite (Owen, 1942; Morton & Ridgway, 1944). Mica books up to 350mm across were produced but the deposits did not persist to any great depth. Muscovite also occurs in pegmatites in the Silurian Blackman Gap Complex at Jerry's Hope, near Lyndbrook Siding (Lam & others, 1989), and in the Proterozoic Einasleigh

Metamorphics 33km west of Mount Surprise and near Einasleigh (Dunstan, 1916; Dunstan, 1920b; Ridgway, 1945c; Barker & others, 1997).

In 1958, 10t of muscovite mica was produced from pegmatitic segregations in greisen in the Carboniferous Bloodwood Granite near Emuford. Mica books were up to 120mm across (Dash & others, 1991).

Queensland Industrial Minerals Ltd's Wateranga project, in south-east Queensland, comprises eluvial, alluvial and hard-rock deposits containing high-Al feldspar, apatite, ilmenite, mica (muscovite, phlogopite) and magnetite, with minor corundum, zircon and rutile. These deposits are associated with the Wateranga Gabbro (Brooks, 1970; Evans & others, 1993).

PEAT

Tableland Peat Pty Ltd produces peat for potting and garden mixes from the Gro-Fast lease, 14km south-south-east of Atherton (Figure 12). The peat is a sedimentary deposit accumulated in a swamp in the crater of a cinder cone within the Cainozoic Atherton Basalt Province. Production from 1996 to 2010 totalled 21 331.5t. The product is sold primarily to large wholesale nurseries in north Queensland. The Krakatoa lease, 18km to the east, is held by Bamboo Plantations of Australia Ltd and hosts a similar deposit.

Peat materials in swamps on the Sunshine Coast are low quality decomposed sedge peats and are suitable for potting mix additives or soil conditioners; the high mud content is likely to make processing or upgrading difficult. Areas considered to have potential are inland swamps adjacent to Eudlo Creek near Woombye and, possibly, a large open swamp inland from Coolum (Willmott & Warrell, 1984). Peat is also known to occur on North Stradbroke Island (Cribb, 1958).

PERLITE

Perlite is a form of volcanic glass that expands by up to 30 times its original volume when heated to temperatures between 727°C and 1127°C to form an artificial pumice. Expansion occurs by the vaporisation of the 2–6% combined water in perlite's structure, producing a light cellular material with excellent insulating properties. Expanded perlite has a very low thermal conductivity and a loose weight that can be as low as ~40kg/m^3. Commercially, any volcanic glass that will 'pop' on heating to form a lightweight frothy material is called perlite. Perlite is used as a refractory mineral, an insulator, as a filter medium and in horticulture.

Perlite is often associated with Tertiary age rhyolitic lava flows. Two major perlite deposits are currently being mined in Queensland — the large Nychum (Wrotham) perlite deposit, 50km north-west of Chillagoe in far north Queensland, and the smaller Numinbah (Agee) deposit in the McPherson Range, south-east of Beechmont in southern Queensland (Figure 12; Bruvel & others, 2001). Queensland perlite is of a high quality compared with similar quality products that are available only from

Mexico. Queensland is Australia's only perlite producing state; total Queensland perlite production in 2009–10 was 6616t.

The Nychum deposit is 6.5km long, 3km wide and 30m thick, with outcropping material displaying a thin bloom of aluminium oxide, the only indication of weathering. The perlite occurs as discrete layers in the Early Permian Nychum Volcanics of the Kennedy Province. The resource at Nychum may contain up to 700Mt. Current mining is by small open cuts and total recorded production is 43 548t perlite from 1996 to 2010. Nychum expanded perlite is brilliant white in comparison with the grey colour of Numinbah perlite. Present perlite processing is achieving an expanded product with a density of ~50kg/m^3. Perlite from Nychum is also used as ultra lightweight aggregate in plaster and concrete, as a prime ingredient in insulating board and ceiling tiles, and as loose fill insulation.

The Numinbah deposit is a zone of volcanic glass within the Tertiary Lamington Group of the Lamington Volcanic Subprovince (Willmott & others, 1978). Intermittent mining has occurred for ~30 years; production from 1993 to 2010 was 79 867.3t perlite. The perlite is expanded in Sydney after road transport from the mine. Numinbah perlite contains the ideal amount of water for expansion and produces a physically strong product. Expansion produces a 15-fold increase in volume. Perlite also occurs in rhyolite flows of the Lamington Volcanic Subprovince at Beechmont and Springbrook.

PHOSPHATE

Phosphate occurs as apatite in igneous rocks, as phosphorites in sedimentary rocks and as guano (Draper, 1996).

Queensland's known phosphate rock resources total 1.7Bt from a series of large marine sedimentary phosphorites that are hosted by Early to Middle Cambrian rocks of the Georgina Basin (Table 7, Figures 13 and 14). The Beetle Creek Formation and Border Waterhole Formation are the main hosts and consist of sequences of phosphatic siltstone (phosphorite) and chert that overlie limestone, sandstone and conglomerate (Russell, 1967; de Keyser, 1969a; de Keyser, 1969b; Thomson & Russell, 1971; de Keyser & Cook, 1972; Rogers & Keevers, 1976; Cook, 1976; Cook, 1986; Southgate, 1988; Freeman & others, 1990; Southgate & Shergold, 1991; Draper, 1996; Wallis, 2001b). Commercial phosphate rock is calcium phosphate together with various impurities, including calcium and magnesium carbonates, iron oxides, clay, silica and fluorine. The major use of phosphate rock is in the manufacture of fertilisers. Phosphate is also used to manufacture phosphorous used in high purity products such as detergents, fire retardants, pesticides, food acids, animal feedstocks, toothpaste, plasticisers, paint additives and rust converter (Draper, 1996).

Total phosphate production in Queensland in 2009–10 was 2 132 465t of phosphate rock that was processed into high quality diammonium phosphate and monoammonium phosphate fertiliser products for domestic and export markets at a fertiliser plant at the Phosphate Hill mine, 135km south-south-east of Mount Isa in

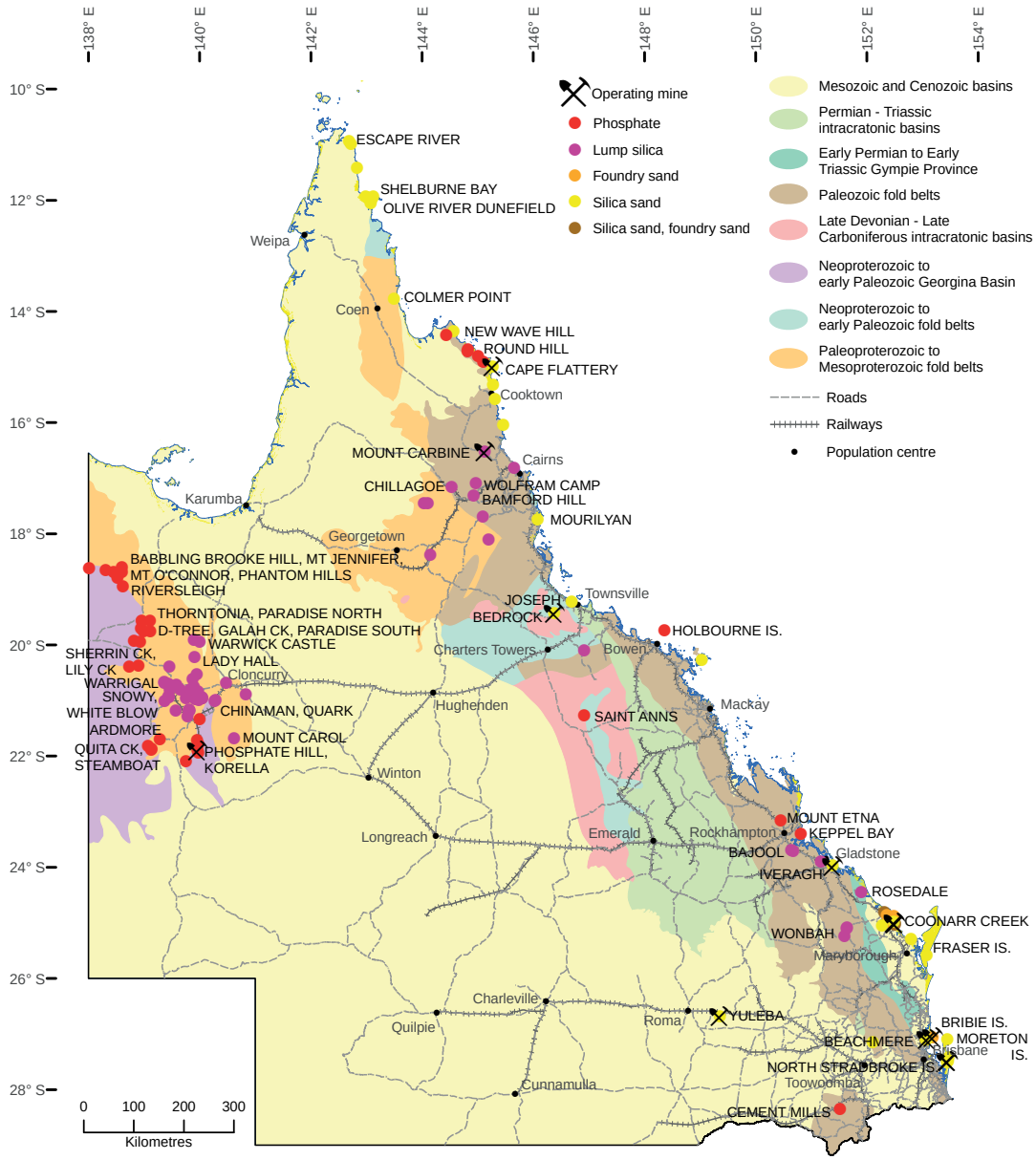

Figure 13: Phosphate and silica occurrences and deposits

north-west Queensland (von Gnielinski, 2010). This operation is Queensland's most significant industrial mineral in terms of production value.

Phosphate rock was first produced at Phosphate Hill from 1975 to 1978 by Broken Hill South. WMC Ltd acquired the deposit in 1980 and subsidiary Queensland Phosphate Ltd resumed production from 1981 to 1983. In 1996, WMC Fertilizers commenced development of a new mine at Phosphate Hill with the construction of an acid plant at Mount Isa, ammonia, phosphoric acid, beneficiation and granulation plants at Phosphate Hill, and storage and port facilities at Townsville. Production commenced in January 2000.

Processing of phosphate rock involves reacting phosphoric acid with liquid ammonia in different proportions to produce high analysis monoammonium phosphate (MAP) and diammonium phosphate (DAP) fertilisers. BHP Billiton acquired the Phosphate

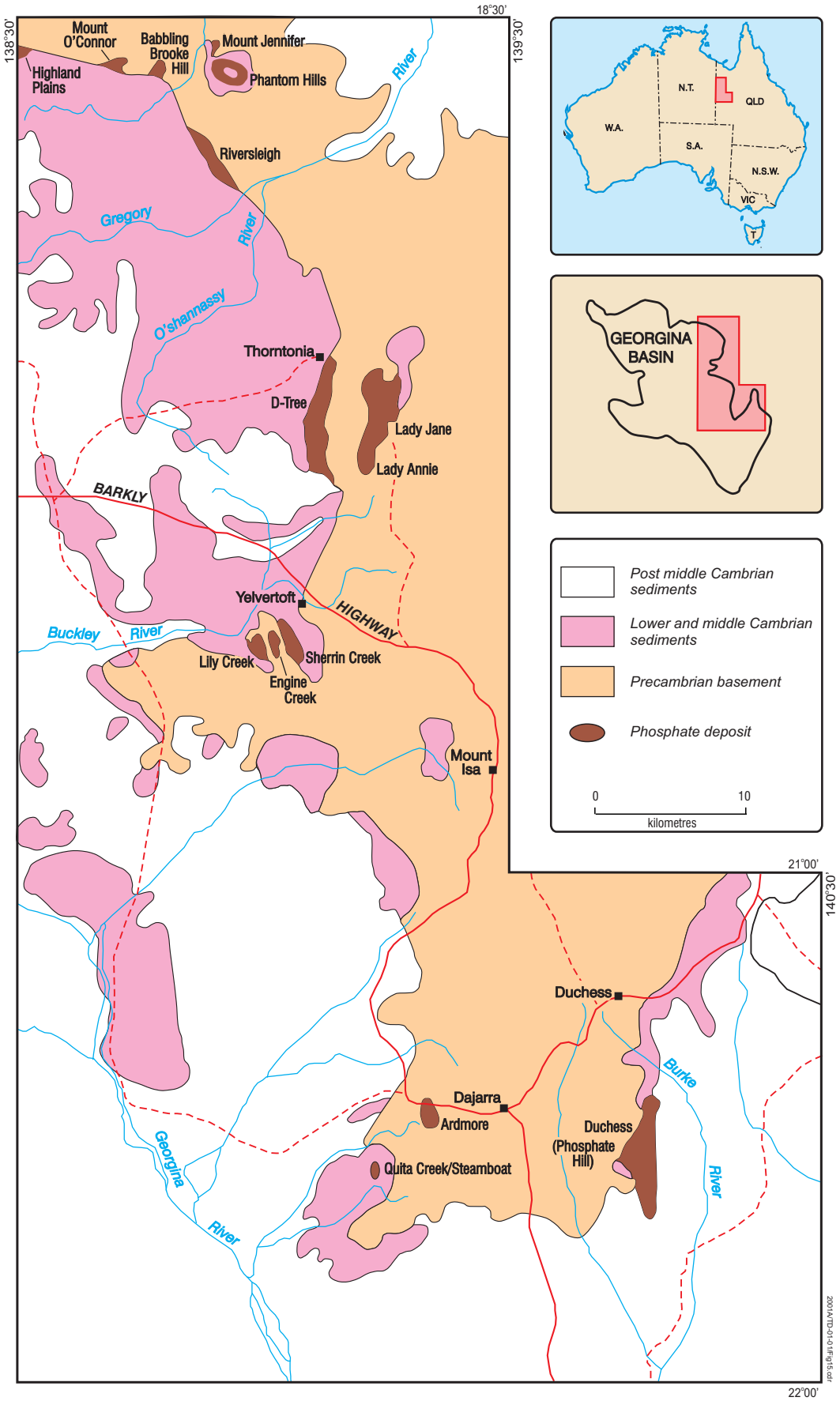

Figure 14: Distribution of phosphate deposits, Mount Isa region (after Draper, 1996)

Hill operation in 2005 and sold it to Incitec Pivot Limited, Australia's biggest fertiliser manufacturer and supplier, in August 2006.

There has been renewed interest in phosphate exploration in north-west Queensland due to the growing global demand for phosphate fertilisers.

Legend International Holdings Incorporated is proposing the development of phosphate rock in north-west Queensland, commencing with the Paradise South (Lady Annie), Paradise North (Lady Jane) and D-Tree deposits. Legend proposes to produce an average of 5Mtpa of phosphate rock concentrate at 30 to 34% P_2O_5. Legend has also completed an economic feasibility study for the development of sulphuric acid, phosphoric acid, DAP/MAP and aluminium fluoride plants. The company is undertaking detailed studies, including transport of product to port by road and or rail. Legend has an off-take agreement with IFFCO (Indian Farmers Fertilizer Corporation), India's largest fertiliser company, for 4Mtpa of concentrated rock phosphate.

Krucible Metals Ltd has applied for a mining lease over its Korella deposit, adjacent to Phosphate Hill, following a positive scoping study for the production of direct shipping ore. Korella phosphate is higher grade that at Phosphate Hill, being a fault-bounded zone of phosphate enrichment; a zone of yttrium enrichment has also been outlined. Exploration within this area is continuing.

Only minor phosphate occurrences are known in eastern Queensland:

- Apatite and secondary phosphate minerals occur in phosphatic lenses in chert of the Hodgkinson Formation in the Round Hill and New Wave Hill areas north of Cooktown (Denaro & others, 1992).
- Phosphatised coral (guano) was mined on Holbourne Island north of Bowen (Saint-Smith, 1919b; Reid, 1944; Geological Survey of Queensland, 1978).
- Phosphate occurs in calcareous feldspathic sandstone of the Saint Anns Formation in the Drummond Basin. The rocks contain up to 4% P_2O_5 (Doutch, 1966, Denaro & others, 2004b).
- Phosphate occurs as cave fillings (bat guano) in limestone of the Texas beds in the Cement Mills (Gore) area in south-east Queensland (Ball, 1917) and in limestone of the Mount Alma Formation at Mount Etna near Rockhampton (Dunstan, 1904; Geological Survey of Queensland, 1978). Quantities and grades are low.
- Apatite and variscite occur in altered slates of the Shoalwater and Wandilla Formations at the mouth of Cawarral Creek and on the islands of Keppel Bay near Rockhampton (Dunstan, 1904; Geological Survey of Queensland, 1978).

Table 7: Significant phosphate deposits in Queensland

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Ardmore	109km S of Mount Isa	Prospect	Not mined	47Mt at 15.6% P_2O_5 for 7.33Mt P_2O_5 (Freeman and others, 1990)	Beetle Creek Formation/ Georgina Basin	Held under mining lease by Incitec Pivot Ltd.
Babbling Brook Hill	230km NW of Mount Isa	Prospect	Not mined	38Mt at 16.8% P_2O_5 for 6.38Mt P_2O_5 (Rogers, 1986	Border Waterhole Formation/ Georgina Basin	Held under exploration permit by Pacific Mines Ltd (Summit Resources Pty Ltd).
D-Tree	115km N of Mount Isa	Prospect	Not mined	305Mt at 15% P2O5 for 45.83Mt P2O5 (Mt Isa Metals Limited, 2009)	Beetle Creek Formation/ Georgina Basin	D-Tree includes the Bean Tree, North Galah Creek, South Galah Creek, Slate Creek, D-Tree North and D-Tree West deposits. Held under mining lease and exploration permits by Legend International Holdings Incorporated. Legend has delineated a direct shipping ore resource of 1.035Mt at 29.4% P2O5, 3% Fe2O3 and 2.7% Al2O3 (Mt Isa Metals Limited 2009). Feasibility studies are in progress.
East Galah Creek	105km N of Mount Isa	Prospect	Not mined	20.7Mt at 18.3% P_2O_5 for 3.79Mt P_2O_5 (IMC Development Corporation, 1970)	Beetle Creek Formation/ Georgina Basin	Subject to exploration permit applications.
Highland Plains	255km NW of Mount Isa	Prospect	Not mined	84Mt at 13.4% P_2O_5 for 11.26Mt P_2O_5 (Rogers, 1986)	Border Waterhole Formation/ Georgina Basin	Held under exploration permit by King Eagle Resources Pty Ltd (joint venture with Legend International Holdings Incorporated).
Holbourne Island	34km ENE of Abbot Point	Abandoned mine	2537.5t phosphate rock (1918-1922)	Potential for 30 000 to 40 000t of low to medium grade (~20% P_2O_5) phosphate rock (Reid, 1944)	Phosphatic coralline rock/ Modern Coastal Deposits	Phosphatised coral (guano).
Korella	145km SSE of Mount Isa	Prospect	Not mined	19.3Mt at 19% P_2O_5 for 3.67Mt P_2O_5 (Krucible Metals Ltd, 2009)	Beetle Creek Formation/ Georgina Basin	Held under mining lease application and exploration permits by Krucible Metals Ltd. Resource includes 5Mt at 30.8% P2O5 (Krucible Metals Ltd 2009). Scoping study shows potential for development of direct shipping ore without need for beneficiation.
Lily Creek	86km NW of Mount Isa	Prospect	Not mined	191Mt at 14.9% P_2O_5 for 28.46Mt P_2O_5 (Draper, 1996)	Beetle Creek Formation/ Georgina Basin	Held under exploration permit by King Eagle Resources Pty Ltd (joint venture with Legend International Holdings Incorporated).
Mount Jennifer	230km N of Mount Isa	Prospect	Not mined	20.7Mt at 15.3% P_2O_5 for 3.16Mt P_2O_5(Rogers, 1986)	Border Waterhole Formation/ Georgina Basin	Held under exploration permit by MMG Mining Ltd.
Mount O'Connor	235km N of Mount Isa	Prospect	Not mined	15Mt at 17.4% P_2O_5 for 2.61Mt P_2O_5 (Rogers, 1986)	Border Waterhole Formation/ Georgina Basin	No current tenure
Paradise North (Lady Jane)	120km NNW of Mount Isa	Prospect	Not mined	185.7Mt at 17.6% P_2O_5 for 34.74Mt P_2O_5(Freeman and others 1990); includes 15Mt at 23.9% P_2O_5 (Legend International Holdings Incorporated, 2010)	Beetle Creek Formation/ Georgina Basin	Held under mining lease application and exploration permit by Legend International Holdings Incorporated. Legend has delineated a direct shipping ore resource of 7.3Mt at 28.12% P2O5 (Legend International Holdings Incorporated 2010). Feasibility studies are in progress.

Table 7 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Paradise South (Lady Annie Phosphate)	105km NNW of Mount Isa	Prospect	64 663t rock phosphate (1972-1974)	293Mt at 16.6% P_2O_5 for 48.64Mt P_2O_5 (Freeman and others 1990); includes 72Mt at 16.9% P_2O_5 (Legend International Holdings Incorporated, 2010)	Beetle Creek Formation/ Georgina Basin	Pilot plant operated by Broken Hill South Ltd produced some phosphate rock in 1972 to 1974. Held under mining lease application and exploration permit by Legend International Holdings Incorporated. Feasibility studies are in progress.
Phantom Hills	220km NW of Mount Isa	Prospect	Not mined	45.4Mt at 16% P_2O_5 for 7.26Mt P_2O_5 (Rogers, 1986)	Border Waterhole Formation/ Georgina Basin	Within Century mining leases held by MMG Mining Ltd.
Phosphate Hill	138km SSE of Mount Isa	Operating mine	18 322 171t rock phosphate (1975-1978, 1981-1982, 2000-2009)	127.6Mt at 23.2% P_2O_5 for 29.65Mt P_2O_5 (BHP Billiton Plc, 2006)	Beetle Creek Formation (Monastery Creek Phosphorite Member)/ Georgina Basin	Mine is operated by Incitec Pivot Ltd. Phosphate rock is mined and combined with sulphuric acid (supplied from Mount Isa) to produce phosphoric acid (with gypsum as a by-product). Ammonia (produced from natural gas) is added to the phosphoric acid to form ammonium phosphate fertilisers.
Quita Creek	134km SSW of Mount Isa	Prospect	Not mined	30Mt at 7.42% P_2O_5 for 2.23Mt P_2O_5 (Draper, 1996)	Beetle Creek Formation/ Georgina Basin	Held under exploration permit by King Eagle Resources Pty Ltd (joint venture with Legend International Holdings Incorporated).
Riversleigh	200km N of Mount Isa	Prospect	Not mined	11.4Mt at 14.4% P_2O_5 for 1.64Mt P_2O_5 (Rogers, 1986)	Border Waterhole Formation/ Georgina Basin	Held under exploration permit by MMG Mining Ltd.
Sherrin Creek	71km NW of Mount Isa	Prospect	Not mined	175Mt at 16.5% P_2O_5 for 28.88Mt P_2O_5 (Draper, 1996)	Beetle Creek Formation/ Georgina Basin	Held under exploration permit by King Eagle Resources Pty Ltd (joint venture with Legend International Holdings Incorporated).
Steamboat – Blazan Creek	132km SSW of Mount Isa	Prospect	Not mined	24Mt at 17.7% P_2O_5 for 4.25Mt P_2O_5 (Hackett, 1979)	Beetle Creek Formation/ Georgina Basin	Held under exploration permit by King Eagle Resources Pty Ltd (joint venture with Legend International Holdings Incorporated).
Thorntonia	125km NNW of Mount Isa	Prospect	Not mined	47.4Mt at 18.1% P_2O_5 for 8.58Mt P_2O_5 (IMC Development Corporation, 1970)	Beetle Creek Formation/ Georgina Basin	Held under exploration permit by Legend International Holdings Incorporated.

SELENIUM

Selenium is a non-metal that is chemically related to sulphur and tellurium; elemental selenium is rare in nature. It mainly occurs in sulphide ores such as pyrite, where it partially replaces sulphur. Selenide and selenate minerals are rare. The main uses for selenium are in glassmaking, chemicals and pigments. Selenium can also be used in semiconductors and photocells but has generally been replaced by silicon semiconductors.

Edwards & Carlos (1954) found that copper ore from the Duchess mine in north-west Queensland contained an unusually high proportion of selenium. The copper ore at Mount Isa could also be a source of selenium (Carter & others, 1961). Selenium also occurs in the Wilgar Cu-Au-Mo polymetallic deposit, 17.3km west-north-west of Cloncurry.

The silver selenide mineral naumannite has been found in a rich pocket of ore in limestone at O'Briens Soak near Duchess (Figure 15). A sample assayed 24.8% Se (McGillivray, 1919).

Selenium is also known from the Montalbion group of silver mines north of Irvinebank (Dash & others, 1991).

SILICA

Silica, or silicon dioxide, is one of the most common minerals in the earth's crust. In nature, it occurs as a crystalline mineral in many and varied forms, most commonly as clear or white quartz (Carmichael & Cooper, 1996). An essential mineral commodity for the manufacture of glass, chemicals and cement and in the foundry industry, silica sand is one of Queensland's most important industrial minerals. Silica sand is also used for refractory, filtration and abrasive purposes. Most of Queensland's silica sand deposits are located along the east coast (Figure 13). The major deposits contain about 99% silica and one per cent heavy minerals. Over 90% of Queensland's production is exported. High purity lump silica can be used to produce silicon that is used in the manufacture of electronic applications such as silicon chips. Lump silica is also used for metallurgical flux and ferro-silicon alloys.

Lump silica

Queensland's lump silica deposits occur in quartzites and quartz lodes and pipes (Table 8). Production in 2009–10 totalled 64 106t, all from the Mount Carbine mine in north Queensland.

Very pure recrystallised quartzite of the Warrina Park Quartzite was mined at the Warrigal mine, east of Mount Isa, for use a flux in the Mount Isa smelters. Very large resources are present (Sawers & Cooper, 1985).

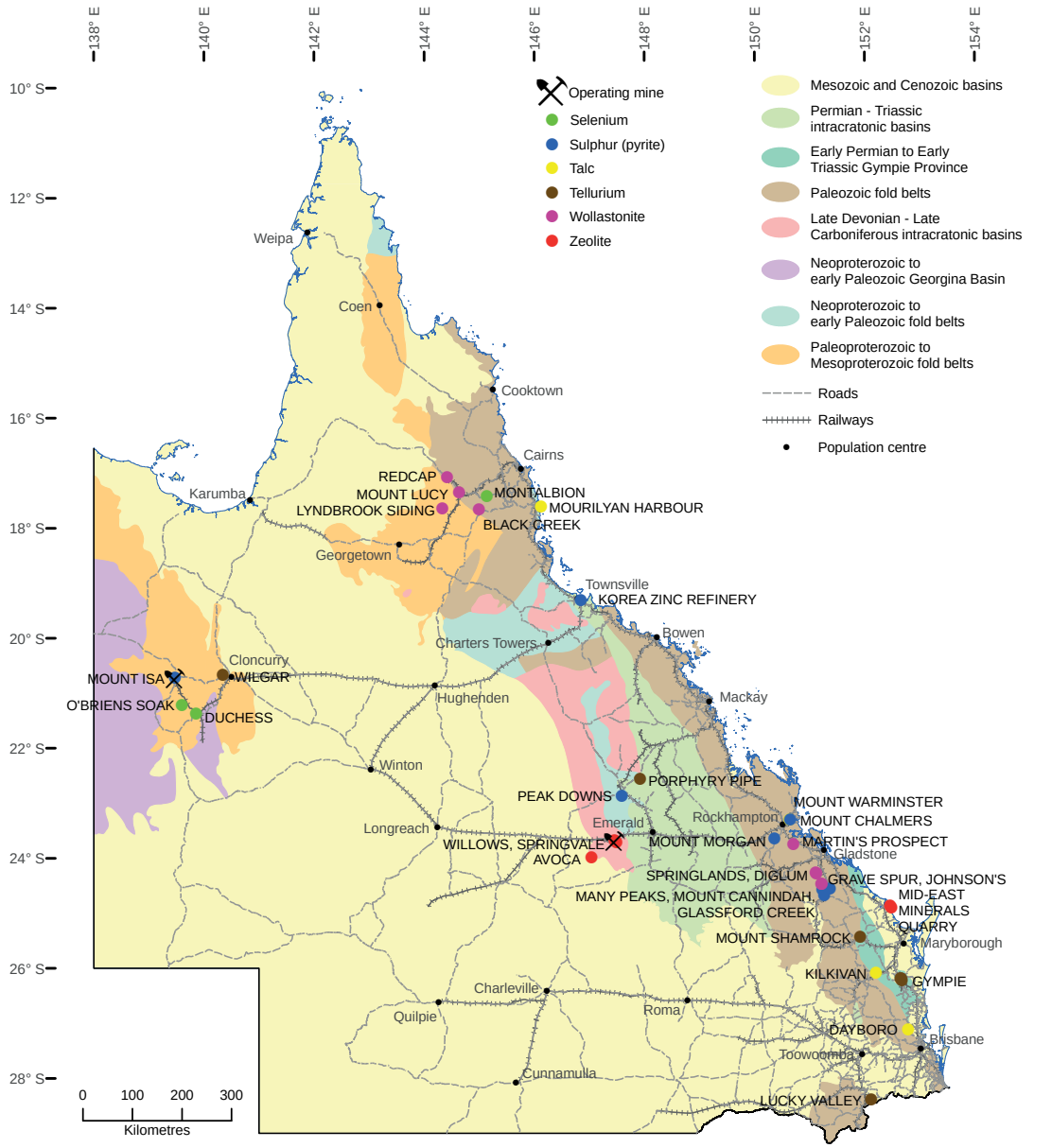

Figure 15: Selenium, sulphur, talc, tellurium, wollastonite and zeolite occurrences and deposits

Considerable quantities of siliceous, low-grade copper ores have been used in the past as silica flux in the Mount Isa copper smelters (Connah, 1976; Krosch, 1981b). A sugary textured quartzite at Chillagoe was once used as a source of silica flux for local smelting operations (Sawers & Cooper, 1985).

Quartz lodes are prominent in the Hodgkinson Formation near Mount Carbine in north Queensland.Mt Carbine Quarries Pty Ltd is currently producing lump silica from the waste dumps at the old Mount Carbine tungsten mine. The Mount Holmes tungsten-tin deposit to the south also has potential for the production of lump silica.

Massive fault fillings of quartz of varying purity form prominent ridges up to 200m high along many of the major faults in the Mount Isa – Cloncurry region (Sawers & Cooper, 1985).

Quartz pipes in the Bajool area are the most promising lump silica source in Queensland. Three pipes of pure white to colourless quartz occur in a quartz diorite of probable Late Permian age. Minor tonnages were produced historically for metallurgical flux for Mount Morgan (Connah, 1976; Geological Survey of Queensland, 1978). The quartz would be suitable for production of ferro-silicon alloys and silicon metal and has 99.8% silica, 50ppm Fe and 10ppm P (Sawers & Cooper, 1985).

Small quartz pipes at Wonbah north of Mount Perry, Rosedale north of Bundaberg, and Bamford Hill and Wolfram Camp south-west of Mareeba are also prospective (Sawers & Cooper, 1985).

Silica and foundry sands

Queensland silica and foundry sand production in 2009–10 was 2.04Mt, of which 70% came from the Cape Flattery operations in far north Queensland. Current Queensland resources and reserves of silica and foundry sands total >1.5 Bt (Table 9) but most resources are now within National Parks and other reserves.

Silica sand deposits fringe the Queensland coastline as Pleistocene to Holocene coastal deposits that average ~3km wide, extend up to 12km inland and average 25–30m in thickness. Large sand masses form as high transgressive or parabolic dunes, as beach ridge barriers parallel to the coast and as tidal delta sands (Cooper, 1993; Bruvel, 2001b).

Beach ridge barrier deposits formed parallel to the coast, incorporating former beach strand lines. Large transgressive parabolic sand dunes were initiated by blowouts of beach ridges and evolved under conditions of persistent south-easterly winds on an exposed coastal aspect, with sand supplies continually provided by an erosional shoreline during marine transgressions.

The Cape Flattery Silica Mine is Queensland's largest producer of silica sand and has resources of >200Mt within a large dunefield that covers ~580 km^2 north of Cooktown and consists predominately of white, sharp featured, transgressive, elongate-parabolic active dunes stabilised by vegetation. The dunes occupy a low interdune sandplain that is 5–10m above sea level and are interspersed with numerous dune lakes and swamps. Cape Flattery Silica Mines Pty Ltd, a wholly owned subsidiary of Mitsubishi Corporation, is the world's biggest silica sand producer and global exporter of silica sand.

Silica and foundry sands are also currently produced from North Stradbroke Island, Iveragh near Tannum Sands, Beachmere, Coonarr Creek south of Bundaberg, and Bribie Island. Silica sand is produced by washing the clay from a poorly consolidated sandstone at Yuleba and from weathered granite at Bedrock Silica west of Townsville.

Table 8: Significant lump silica deposits in Queensland

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Bajool	65km NW of Gladstone	Abandoned mine, Prospect	10 000t lump silica (1940-1961)	50 800t lump silica (Reid, 1943)	Bajool Quartz Diorite/ Permo-Triassic Igneous Provinces	Quartz pipes. Mined intermittently by Mount Morgan Ltd for smelting flux. Now held under mining lease by Optiquartz Pty Ltd.
Blockade	41.9km ENE of Mount Isa	Abandoned mine, prospect	70 945t lump silica (1970-1975)	Not reported	Leichhardt Volcanics/ Mary Kathleen Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters. Now held under mining lease by Kilo Copper Pty Ltd.
Bulonga	55.3km WSW of Cloncurry	Abandoned mine	1985t lump silica (1976-1979)	Not reported	Cone Creek Metabasalt Member/ Mitakoodi Domain	Quartz breccia. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Chinaman	39.5km SW of Cloncurry	Abandoned mine	45 523t lump silica (1970-1973)	Not reported	Cone Creek Metabasalt Member/ Mitakoodi Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
China Wall	59.1km ESE of Mount Isa	Deposit	Not mined	Substantial but unquantified resources of lump silica	/ Mary Kathleen Domain	Silica-flooded fault zone.
Fountain Range	52.6km ESE of Mount Isa	Deposit	Not mined	Substantial but unquantified resources of lump silica with estimated 1Mt of fairly pure silica per vertical metre (Derrick and others, 1977)	/ Mary Kathleen Domain	Silica-flooded fault zone.
Hardway	42.4km E of Mount Isa	Abandoned mine	39 099t lump silica (1973-1976)	Not reported	Corella Formation/ Mary Kathleen Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Hidden Valley	2.1km WSW of Mount Isa	Abandoned mine	22 400t lump silica	Not reported	Magazine Shale/ Leichhardt River Domain	Quartz lode. Silica was used as a flux in the Mount Isa copper smelters. Deposit is within Xstrata's Mount Isa mining lease.
Lady Ethleen	54.1km ESE of Mount Isa	Abandoned mine	493t lump silica (1978)	Not reported	Argylla Formation/ Mary Kathleen Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Lady Hall	71.3km NE of Mount Isa	Abandoned mine	25 791t lump silica (1974-1975)	Not reported	Corella Formation/ Mary Kathleen Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Lady Jenny	54.3km ESE of Mount Isa	Abandoned mine	93 557t lump silica (1976-1981)	Not reported	Argylla Formation/ Mary Kathleen Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Lady Rose	53.9km ESE of Mount Isa	Abandoned mine	12 639.6t lump silica (1975)	Not reported	Argylla Formation/ Mary Kathleen Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Mount Carbine	75km N of Cairns	Operating mine	381 983t lump silica (2007-2010)	Not reported	Hodgkinson Formation/ Hodgkinson Province	Sheeted quartz-wolframite vein system.Mt Carbine Quarries Pty Ltd is producing lump silica from the waste dumps.
Mount Hope	59km SE of Mount Isa	Abandoned mine	309 175t lump silica (1963-1973)	Not reported	Magna Lynn Metabasalt, Argylla Formation/ Mary Kathleen Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Mount Rhonda	52.5km NE of Mount Isa	Abandoned mine	3398t lump silica (to end 1979)	Not reported	Corella Formation/ Mary Kathleen Domain	Quartz veins. Silica was used as a flux in the Mount Isa copper smelters.

Table 8 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Orient	18.5km ESE of Mount Isa	Abandoned mine	1646.8t lump silica (1975)	Not reported	Leichhardt Volcanics/ Kalkadoon-Leichhardt Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Quark	86km ESE of Mount Isa	Abandoned mine	1998t lump silica (up to 1997)	Not reported	Cone Creek Metabasalt Member/ Mitakoodi Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Rosebud Extended	51.5km SSE of Mount Isa	Abandoned mine	10 431t lump silica (1973-1975)	Not reported	Argylla Formation/ Mary Kathleen Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Snowy	22.7km SSW of Mount Isa	Abandoned mine, prospect	3100t lump silica	Not reported	Eastern Creek Volcanics/ Leichhardt River Domain	Quartz lode. Silica was used as a flux in the Mount Isa copper smelters. Currently held under mining lease by Xstrata.
Sylvia May	36.3km ESE of Mount Isa	Abandoned mine	4221t lump silica (1954-1957)	Not reported	Argylla Formation/ Mary Kathleen Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
Warrigal	9.7km E of Mount Isa	Abandoned mine	239 707t lump silica (1974-1981)	Not reported	Mount Guide Quartzite/ Leichhardt River Domain	Quartzite and quartz filling a fault zone were mined by Kalkadoon Mining for silica flux, which was sold to Mount Isa Mines Ltd.
Warwick Castle	110km NW of Cloncurry	Abandoned mine	1904t lump silica (1974-1976)	Not reported	Leichhardt Volcanics, Kalkadoon Granodiorite/ Kalkadoon-Leichhardt Domain	Quartz lode. Cupriferous silica was used as a flux in the Mount Isa copper smelters.
White Blow	8.7km SSW of Mount Isa	Abandoned mine	8000t lump silica (up to 1971)	Not reported	Surprise Creek Formation/ Leichhardt River Domain	Quartz lode. Silica was used as a flux in the Mount Isa copper smelters. Deposit is within Xstrata's Mount Isa mining lease.

Table 9: Significant silica and foundry sand deposits in Queensland

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Beachmere		42km N of Brisbane	Operating mine	317 124t foundry sand and silica sand (1996-1997, 2000-2009)	>15Mt silica sand (Geological Survey of Queensland, 2011)	Cainozoic dune beach ridge sands/ Modern Coastal Deposits	Operated by Southern Pacific Sands (Pacific Silica Pty Ltd), which produces sand suitable for the foundry, construction, glass making, filtration, horticultural, and golf course and sporting oval construction industries.
Bedrock Silica		45km W of Townsville	Operating mine	2987t silica sand (2000-2008)	Not reported	Speed Creek Granite/ Kennedy Province	Residual silica sand deposit formed by weathering of granite. Mining leases are held by Bedrock Landscapes Supplies Qld Pty Ltd.
Bribie Island		50km NNE of Brisbane	Operating mine	12 996t foundry sand and silica sand (1997-2009)	Potential 8Mt silica sand (Cooper, 1993)	Cainozoic palaeodune and beach ridge sands/ Modern Coastal Deposits	Operated by CMI Industrial Pty Ltd to produce foundry sands for Toowoomba Metal Technologies' Toowoomba foundry.
Cape Flattery Silica Mine		200km NNW of Cairns	Operating mine	40 312 288t silica sand (1968-2010)	200Mt silica sand at 99% silica (Cooper, 1993)	Cainozoic dune sands/ Modern Coastal Deposits	Silica sand is mined by Cape Flattery Silica Mines Pty Ltd. High quality silica sand is produced for the glass making foundry and chemical industries. The majority is exported to Japan. The mine resource is part of a much larger resource estimated at 1000Mt in 1999.
Colmer Point		36.7km ENE of Coen	Abandoned prospect	Not mined	192Mt silica sand (Frank, 1987)	Cainozoic palaeodune and beach ridge sands/ Modern Coastal Deposits	Palaeodune and beach ridge heavy mineral and silica sand deposits. The resources are now within a National Park.
Coonarr Creek	Coonarr Creek leases	20km SE of Bundaberg	Abandoned mine, prospect	86 198.3t foundry sand (1969-1981, 1996-2002)	Confidential	Cainozoic dune and beach ridge sands/ Modern Coastal Deposits	Held under mining leases by Tall Metals Pty Ltd.
	Longbeach	19.4km SE of Bundaberg	Abandoned mine, prospect	13 585.3t foundry sand (1972-1981, 1996-1997, 2000-2002)	Not reported	Cainozoic dune and beach ridge sands/ Modern Coastal Deposits	Held under mining lease by Bundaberg Metals Industries Pty Ltd.
	Sunstate Sand Leases	19km SE of Bundaberg	Operating mine	169 954.2t silica sand and foundry sand (1996-2010)	Confidential	Cainozoic dune and beach ridge sands/ Modern Coastal Deposits	High grade sand with ~99.8 % silica. Mined by Earth Commodities Bundaberg Pty Ltd for filtration sand, foundry sand, adhesives and grouts, and building and landscaping products.
	Toowoomba Foundry Coonarr Sand	19.8km SE of Bundaberg	Abandoned mine, prospect	8655.3t foundry sand (1972-1981, 1996-2006)	Not reported	Cainozoic dune and beach ridge sands/ Modern Coastal Deposits	Held under mining lease by CMI Industrial Pty Ltd.

Table 9 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Escape River Area		39km SE of Cape York	Abandoned prospect	Not mined	30Mt silica sand at >99.7% silica (Goudie, 1977)	Cainozoic dune sands/ Modern Coastal Deposits	Silica sand from the Escape River dunefield meets specifications for foundry moulding and high quality glass manufacturing. The resources are now within a National Park.
Fraser Island		40km E of Maryborough	Abandoned prospect	Not mined for silica sand	Potential 500Mt silica sand (Cooper, 1993)	Cainozoic dune sands/ Modern Coastal Deposits	High-grade silica sand resources are now within the Fraser Island National Park.
Iveragh		20km SE of Gladstone	Operating mine	2 057 758t (1991-2010)	4Mt silica sand (Queensland Department of Mines and Energy, 1998)	Cainozoic dune and beach ridge sands/ Modern Coastal Deposits	Silica sand is mined by Cement Australia Pty Ltd for the manufacture of cement clinker.
Joseph		13.4km WNW of Townsville	Abandoned mine	81 225t silica sand (1972-1983)	Not reported	Cainozoic dune sands/ Modern Coastal Deposits	Not currently under tenure.
Moreton Island		55km NE of Brisbane	Abandoned prospect	Not mined for silica sand	407Mt silica sand (Cooper, 1993)	Cainozoic dune sands/ Modern Coastal Deposits	Resources are now within the Moreton Island National Park.
Mourilyan Silica Sand		90km S of Cairns	Prospect	Not mined	10.7Mt silica sand at 99% silica (Cooper, 1993)	Cainozoic dune sands/ Modern Coastal Deposits	Dune and beach ridge silica sand deposit. Silica sand was mined for use in concrete blocks, brick mortar, Si-lime bricks and furnace linings.
North Stradbroke Is.	Amity	40km E of Brisbane	Prospect	Not mined	~32Mt silica sand	Cainozoic dune sands/ Modern Coastal Deposits	Lease held by ACI Operations Pty Ltd
	Myora	40km E of Brisbane	Operating mine	5 620 963.5t silica sand (1996-2009)	45Mt silica sand (Cooper, 1993)	Cainozoic dune sands/ Modern Coastal Deposits	ACI Operations Pty Ltd produce high quality silica sand for glass making.
	Vance	45km E of Brisbane	Operating mine	916 879.8t silica sand (2004-2008)	Confidential	Cainozoic dune sands/ Modern Coastal Deposits	Operated by Sibelco Australia Ltd.
Olive River Dunefield		South of Shelburne Bay	Abandoned prospect	Not mined	48.7Mt silica sand (Cooper & Sawers, 1990)	Cainozoic dune sands/ Modern Coastal Deposits	Silica sand from the Olive River dunefield meets specifications for foundry moulding and high quality glass manufacturing. The resources are now within a National Park.
Shelburne Bay		13.7km WNW of Cape Grenville	Abandoned prospect	Not mined	8.76Mt silica sand with >99% silica and <0.2% heavy minerals (Cooper & Sawers, 1990); potential 143Mt silica sand (Cooper, 1993)	Cainozoic dune sands/ Modern Coastal Deposits	Silica sand from Shelburne Bay meets specifications for foundry moulding and high quality glass manufacturing. The resources are now within a National Park.
Yuleba		8km S of Yuleba	Operating mine	Not reported	Not reported	Undifferentiated Cainozoic sediments/ Cainozoic Sedimentary Cover	Yuleba Minerals Pty Ltd process poorly consolidated kaolinitic sandstone to remove the clay and produce a highly spherical silica sand product that is marketed for filtration sand and building products.

SULPHUR

Sulphur is an important element that is used in the manufacture of sulphuric acid, sulphur dioxide and sodium sulphite for bleaching wood fibres and removing lignin from wood pulp in paper manufacturing, and sulphur-bearing organic chemicals. It is used in the manufacturing of gunpowder, matches and explosives, rubber, dyes and as an insecticide and fungicide.

Queensland's sulphur production is in the form of sulphuric acid. Sulphuric acid is an industrial acid used to manufacture phosphate and ammonium phosphate fertilisers and for the extraction of nickel in nickel laterite ores using pressure acid leach. Other uses include manufacturing chemicals, paints, detergents, explosives and pharmaceuticals.

The Mount Isa silver-lead zinc mine (Figure 15) produced 598 142t sulphur from 1996 to 2002 and 132 627t in 2004–05. Sulphuric acid is currently produced from the gases emitted from the copper smelter using a catalytic contact sulphuric acid plant and railed to Phosphate Hill where it is used in processing phosphate rock for fertiliser manufacture. Sulphuric acid for fertiliser manufacture at Phosphate Hill is also railed from the Korea Zinc refinery near Townsville.

In the periods 1942–43 and 1949–71, a total of 532 068t of pyrite was produced at Mount Morgan as a by-product of copper-gold mining. Up to 1965, the pyrite was used mainly in the manufacture of sulphuric acid at Brisbane. Some pyrite was exported to Japan after 1965. After 1971, small tonnages were sold from a stockpile to meet requirements in steel and glass manufacture. A large potential resource remains in the tailings dump from the flotation concentration plants (Geological Survey of Queensland, 1978).

Other potential sources of pyrite in central Queensland include the Many Peaks, Mount Chalmers. Mount Cannindah, Peak Downs and Glassford Creek copper deposits (Geological Survey of Queensland, 1978).

TALC

Talc is a hydrated magnesium silicate. It is a secondary mineral produced by metamorphism or metasomatism of magnesium-rich rocks such as dolomite, peridotite and pyroxenite. It is commonly associated with ores of tin, iron, manganese, zinc, copper, lead, gold, silver, tungsten and molybdenum. Steatite (soapstone) is a common component of serpentinites. Talc is used in firebricks and electrical and heat insulators. Powdered talc is used in manufacturing paper, talcum powder, lubricants, soaps and fire-proof paints.

No significant talc deposits are known in Queensland. Talc occurs as an accessory mineral in ores at Mount Amos near Cooktown, Ebagoolah, the Herberton, Walsh and Tinaroo mineral fields, Chillagoe-Mungana area, Warwick goldfields, Mount Garnet, Mount Leyshon, Clermont goldfield, Charters Towers goldfield, Ravenswood,

Kangaroo Hills mineral field, Yatton goldfield and Mount Britton goldfield (Dunstan, 1913).

In 1953, 30t of steatite was produced from a serpentinite-hosted gold-talc-asbestos deposit in the Rocksberg Greenstone near Dayboro in south-east Queensland (Figure 15; Anonymous, 1967).

Talc schist of the Barnard Metamorphics crops out on the southern side of the Mourilyan Harbour entrance (Anonymous, 1967). Specimens showed moderate to fairly good grades (de Keyser, 1964). Highly talcose schist also crops out 6.4km west-north-west of Kilkivan (Anonymous, 1967).

Small masses of talc with fine flakes of very pure quality have been found in the Chalmers Formation at Mount Warminster, east of Rockhampton (Dunstan, 1913; Anonymous, 1967).

TELLURIUM

Tellurium is a metalloid that is chemically related to sulphur and selenium. Elemental tellurium is rare in nature; it more commonly occurs as tellurides of gold. The main commercial source of tellurium is as a by-product of copper and lead refining. Tellurium is used in steels and copper and lead alloys, solar panels, semiconductors, rewritable optical discs, computer memory chips, ceramics, glass optical fibres, rubber vulcanisation and electric blasting caps.

Queensland has minor tellurium occurrences only (Figure 15). Gold tellurides and the silver telluride hessite are common in the mesothermal quartz veins of the Gympie Goldfield (Dunstan, 1913). Gold tellurides have been identified in alluvial deposits in the Luck Valley Goldfield near Warwick. Dunstan (1913) noted that the bismuth telluride joseite occurs at the Mount Shamrock gold mine, 40.7km south-east of Mount Perry. Rock chip samples from Porphyry Pipe, 42km north-east of Clermont, have assayed up to 16ppm Te (Ekstrom, 1995). Drilling at the Wilgar Cu-Au-Mo polymetallic deposit, 17.3km west-north-west of Cloncurry, has intersected up to 700ppm Te (CuDeco Limited, 2010b).

WOLLASTONITE

Wollastonite is a fibrous calc-silicate mineral that is used world-wide in the ceramics and glass industries, as a filler or extender in paint, rubber and plastics, as an abrasive, as a substitute for asbestos, and as a welding flux. Queensland has numerous undeveloped wollastonite deposits that have primarily formed within skarn mineral assemblages (Figure 15). No serious attempts have been undertaken to define the wollastonite resources of Queensland (von Gnielinski, 2010).

The largest wollastonite deposits are scattered along the outcrop extent of the Chillagoe Formation (Hodgkinson Province) where granitic intrusions have developed broad zones of skarn-related calc-silicate alteration. Wollastonite is associated with

calc-silicate skarns at Black Creek (Lam & others, 1988), Redcap (Sawers & Cooper, 1985) and Mount Lucy (Dunstan, 1906b; Sawers & Cooper, 1985). The Black Creek deposit is under mining lease application by Calcifer Industrial Mineral Pty Ltd. Mount Lucy is within a mining lease held by Ralph de Lacy.

Minor wollastonite has been found with garnet in gneiss of the Blackman Gap Complex 24.5km north-north-west of Lyndbrook Siding (Lam & others, 1989).

At Martin's Prospect, 11.5km west-south-west of Raglan, wollastonite occurs in bands up to 2m thick in lenticular limestone skarn outcrops of the Mount Holly beds. Wollastonite forms ~50% of the rock; the remainder comprises calcite, silica, tremolite, rhodocrosite and epidote. Resources have been estimated as ~10 000 tonnes of ore per vertical metre (Cribb, 1953; Geological Survey of Queensland, 1978; Sawers & Cooper, 1985).

Wollastonite occurs in skarns in the Rockhampton Group at Springlands, Diglum, Grave Spur and Johnson's, 50km south-south-west and 70km south of Gladstone (Morwood, 2002a). Minor occurrences have been reported from the Biggenden, Pine Mountain and Kilkivan areas (Dunstan, 1913).

ZEOLITE

Zeolites are hydrated aluminosilicate minerals of the alkaline and alkaline-earth metals. By having an open crystalline framework with a network of channels and cavities, zeolites possess a very large surface area. This large surface area gives them great absorptive properties. Fluids with molecules too large to enter the channels are excluded, enabling the zeolite to act as a molecular sieve. The crystal structure has a net negative charge, so it can adsorb and exchange positively charged cations. These crystal structure properties, combined with high surface areas, give zeolites a high cation exchange capacity. Chabazite and clinoptilolite are the two out of the 48 minerals in the zeolite group that have commercial applications. Naturally-occurring commercial zeolites are used world-wide in pet litter, animal feed, horticultural applications, wastewater clean-up, odour control, gas absorbents, catalysts, oil absorbents, aquaculture and water purification. Animal feed, horticultural and pet litter applications dominate demand.

Three significant zeolite resources have been recognised in Queensland, namely, the Willows Zeolite Mine, Avoca and Springvale, west of Emerald in central Queensland (Figure 15). These deposits are altered waterlain ash-fall tuffs of the early Carboniferous Ducabrook Formation in the Drummond Basin.

The Willows deposit is currently the only operating zeolite mine. It produced 16 545t of zeolite from 1995 to 2010 and is currently operated by Queensland Zeolite Pty Ltd. Zeolite Australia Pty Ltd holds a mining lease over the Springvale deposit but has not yet worked it. The Avoca lease is held by Currumbin Sand and Gravel Pty Ltd and has not been developed. Total known Queensland zeolite resources and reserves are ~18.5Mt (von Gnielinski, 2010).

Subeconomic zeolite has been recorded as cavity-fill and the groundmass of volcanic lavas, altered granites, and volcaniclastic rocks in Queensland and is common in Cainozoic basalts, for example, the Hummock Basalt in the Mid-East Minerals Quarry east of Bundaberg.

METALS

ALUMINIUM

Aluminium is the most widely used non-ferrous metal. Its low density, corrosion resistance, high electrical and thermal conductivity, and the high strength to weight ratio of aluminium alloys make it important in a wide range of applications, including automotive and marine fabrication, the aerospace industry, packaging, construction, electrical goods and household items.

Bauxite, the primary ore for aluminium, is a pisolitic and concretionary ore of aluminium and iron hydroxides formed by lateritic processes. The ore is formed in alkaline conditions in tropical and sub-tropical climates from deep weathering processes over a considerable time period and involves the migration of rainwater through porous aluminous rocks that are usually low in free quartz and high in feldspar. Bauxite comprises varying proportions of hydrous aluminium oxides, primarily the minerals gibbsite ($Al(OH_3)$), boehmite ($AlO(OH)$) and diaspore ($HAlO_2$). Iron and silica are also commonly present in bauxite. Bauxite occurs in several forms; the most common are pisolites and round concretionary grains. Gibbsite and boehmite form almost all of the commercially worked aluminium ores. The key issues in terms of bauxite quality are the alumina content and mineralogy and total reactive silica content. The alumina content and mineralogy drive the amount of alumina and therefore aluminium that will ultimately be recovered from a given tonne of bauxite whereas silica is an impurity that must be removed using caustic soda in the process of refining bauxite to alumina. The alumina mineralogy determines the ease with which the alumina can be refined from the bauxite. Although the percentage of aluminium contained within gibbsite is about one third of that in boehmite, the lower grade gibbsite releases its aluminium more easily than boehmite and is therefore lower cost to refine and a cheaper source of aluminium. Gibbsite ore can be treated at a lower temperature than boehmite ore (120°C compared with 170°C). Also, alumina liberation from gibbsite requires less caustic soda, which is a major cost item in the alumina refining process. Gibbsite and boehmite are white, but the presence of iron usually imparts a red earthy colour.

Bauxite is treated using the Bayer process, which involves heating in caustic soda. The aluminium trihydrate dissolves leaving a residue of insoluble iron and titanium oxides. The aluminium trihydrate ($Al_2O_3.3H_2O$) is dried to produce a white powder termed ‘alumina’. The iron and titanium oxide residue is called ‘red mud’. Two tonnes of bauxite yield one tonne of alumina. Aluminium is produced from alumina in a special electrolytic furnace called a Hall-Heroult cell. The cell is lined with carbon and filled with cryolite. Alumina dissolves in the cryolite when an electric current is

passed through the mixture from carbon blocks suspended in the cell. The electric current breaks up the molecular structure of the alumina and molten aluminium collects at the base of the cell. Processing alumina into aluminium is very energy intensive, requiring ~14 000 DC kWh of electricity to produce 1 tonne of aluminium. Depending on the mineralogy of the ore, it takes 2.2–3.25t of bauxite to produce one tonne of aluminium. Aluminium is supplied in rolled, extruded and forged shapes and castings.

Queensland's significant bauxite deposits (classified as medium to large) all occur within the Karumba Basin along the western coastal fringe of Cape York Peninsula (Figure 16) and contain known reserves/resources totalling >5Bt of bauxite (Table 10). Queensland's largest bauxite deposits are mined near Weipa in far north Queensland, then shipped to Gladstone to be processed at two alumina refineries. Alumina is smelted at nearby Boyne Island to produce aluminium. The Weipa mine produced 17 889 697t of metallurgical grade bauxite in 2009–10.

Bauxite in the Karumba Basin occurs within the topmost of four recognised zones (ferricrete zone, mottled zone, pallid zone and saprolite), within the 20–30m thick laterite weathering profile (Evans, 1975; Schaap, 1990; Carmichael & Jones, 1996). The ferricrete zone comprises iron-cemented soil overburden (~0.5m thick) and a 1–5m thick bauxite layer underlain by a basal 1–2m of ironstone.

The bauxite layer comprises uncemented to poorly cemented pisolites of gibbsite and boehmite with small amounts of kaolinite and quartz. The ratio of gibbsite to boehmite is ~4:1. The matrix, although bauxitic, has a high silica content (up to 12% total silica) in the form of sand and silt sized quartz grains. Silica is removed by wet screening during beneficiation. The basal ironstone layer consists of goethite and hematite nodules with varying amounts of kaolin and quartz. Ironstone is much harder than the overlying bauxite layer and forms the cut-off point for mining.

Elsewhere in Queensland, poor quality low-grade bauxite occurs in laterite profiles developed on Tertiary basalts and sediments.

Minor, dissected pisolitic laterite with up to 23% Al is developed on Tertiary sediments in the Broken River Province at Duck Creek, 23.5km north of Camel Creek Homestead (Young, 1979; Barker & others, 1997). Similarly, bauxite is developed on Tertiary sediments of the Biloela Formation in the Kroombit area, 28.8km south-east of Biloela (Ball, 1903).

Small areas of bauxitic laterite are developed on Tertiary basalt flows in the Childers, Kinellan Plateau and Binjour Plateau areas (Shepherd & Connah, 1947; Denaro & others, 2007) and at Boat Mountain, Yarraman, Kingaroy, Mount Wooroolin and Kumbia (Shepherd & Connah, 1947), where the deposits form the highest plateaux of residual duricrust. Australian Bauxite Ltd intersected zones of gibbsite bauxite averaging 5.2m at 44.4% Al_2O_3 and 2.8% SiO_2 from drilling on the Binjour Plateau (Australian Bauxite Limited, 2011).

Bauxitic laterite is developed on basalts of the Main Range Volcanics in a belt extending from Toowoomba north-north-east to Hampton and at Maryvale (Shepherd & Connah, 1948). Low-grade pisolitic and concretionary bauxite deposits at Mount Tamborine are developed on basalts of the Lamington Volcanic Group (Ball, 1940a; Ball, 1940b; Martin, 1975). Some material was mined from 1950 to 1967 to manufacture aluminium sulphate for water clarification.

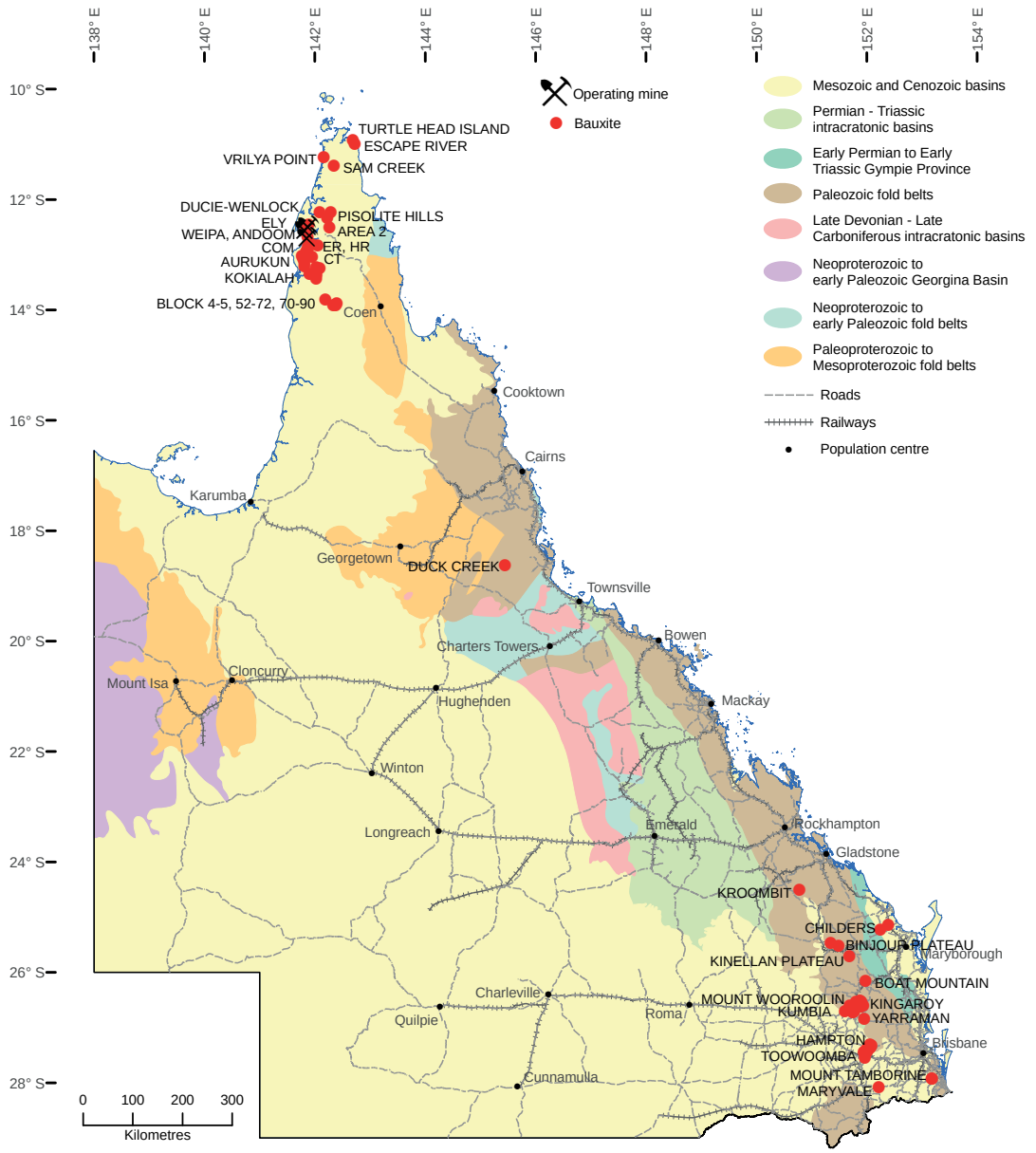

Figure 16: Bauxite occurrences and deposits

Table 10: Significant bauxite deposits of Queensland

Name	Location	Status	Total historical production of metallurgical bauxite (years)	Known resources (source)	Host formation/ Province	Comments
Area 2 Deposit	42.0km ENE of Weipa	Abandoned prospect	Nil	1.4Mt *in situ* bauxite grading 54% Al_2O_3 and >9% reactive silica (Minenco Pty Ltd, 1972)	Bulimba Formation/ Karumba Basin	No current tenure.
Aurukun Bauxite Project (Coconut Pod, Tappelbang Pod, Possum Pod, North Watson)	32km NNE of Aurukun	Active prospect	Nil	439Mt *in situ* bauxite for 325Mt beneficiated bauxite grading 53.6% Al_2O_3 and 7.4% reactive silica (from Department of Infrastructure and Planning website)	Bulimba Formation/ Karumba Basin	Held under mineral development licence by Chalco Australia Pty Ltd. A Development Agreement with the Queensland Government was terminated in June 2010.
Block 4-5	70.6km SE of Aurukun	Active prospect	Nil	4.3Mt *in situ* bauxite grading 52% Al_2O_3 and 10.4% reactive silica (MacGeehan, 1972)	Bulimba Formation/ Karumba Basin	Held under exploration permit by Gulf Alumina Ltd.
Block 52-72	92.4km SE of Aurikun	Active prospect	Nil	3.5Mt *in situ* bauxite grading 52% Al_2O_3 and 10.4% reactive silica (MacGeehan, 1972)	Bulimba Formation/ Karumba Basin	Held under exploration permit by Gulf Alumina Ltd.
Block 70-90	89.8km SE of Aurukun	Active prospect	Nil	8.8Mt *in situ* bauxite grading 52% Al_2O_3 and 10.4% reactive silica (MacGeehan, 1972)	Bulimba Formation/ Karumba Basin	Held under exploration permit by Gulf Alumina Ltd.
COM Area	19.0km SSW of Weipa	Abandoned prospect	Nil	5.1Mt *in situ* bauxite (Rawlins, 1973)	Bulimba Formation/ Karumba Basin	Within mining lease held by Rio Tinto Alcan.
CT Area	29.9km SSW of Weipa	Abandoned prospect	Nil	0.9Mt *in situ* bauxite, including 0.3Mt grading >40% Al_2O_3 and <8% reactive silica (Rawlins, 1973)	Bulimba Formation/ Karumba Basin	No current tenure.
Ducie-Wenlock	50km NNE of Weipa	Active prospect	Nil	540Mt *in situ* bauxite (von Gnielinski, 2010)	Bulimba Formation/ Karumba Basin	Held under mining lease by Alcan South Pacific Pty Ltd (Rio Tinto Alcan).
ER Area	21.0km SE of Weipa	Abandoned prospect	Nil	0.7Mt *in situ* bauxite grading >35% Al_2O_3 and <12% reactive silica (Rawlins, 1973)	Bulimba Formation/ Karumba Basin	Within exploration permit application by Cape Alumina Pty Ltd.
Escape River Area	39.0km SE of Cape York	Sterilised deposit	Nil	280Mt *in situ* bauxite grading 35–40% Al_2O_3 and 12-15% total silica (Miller, 1957)	Helby beds/ Karumba Basin	Now within a National Park
Hampton	25km NNE of Toowoomba	Abandoned prospect	Nil	>0.25Mt grading 9–42% alkali soluble Al_2O_3 (Owen, 1954; Cranfield and others, 1976)	Main Range Volcanics/Main Range-Lamington Basalt Province	Generally alienated by development.
HR Area–	15.1km S of Weipa	Abandoned prospect	Nil	14.55Mt *in situ* bauxite grading >35% Al_2O_3 and <15% reactive silica, including 7Mt grading 44% Al_2O_3 and 7.5% reactive silica (Rawlins, 1973)	Bulimba Formation/ Karumba Basin	Within exploration permit application by Cape Alumina Pty Ltd.

Table 10 (continued)

Name	Location	Status	Total historical production of metallurgical bauxite (years)	Known resources (source)	Host formation/ Province	Comments
Kokialah Area	18.8km E of Aurukun	Abandoned prospect	Nil	176.5Mt *in situ* bauxite grading 53.2–55.3% Al_2O_3 and 7.7-8.2% reactive silica (The Shell Company of Australia Limited, 1983)	Bulimba Formation/ Karumba Basin	No current tenure.
Mount Tamborine	53km SSE of Brisbane	Abandoned mine	24 172.7t bauxite (1941–1967)	1.54Mt grading 35–41% alkali soluble Al_2O_3 (Owen, 1954; Cranfield & others, 1976)	Beechmont Basalt/ Main Range-Lamington Basalt Province	Mined historically for production of aluminium sulphate for water clarification. Deposits now alienated by development.
Pisolite Hills	50.1km NE of Weipa	Active prospect	Nil	132.4Mt *in situ* bauxite for 87.3Mt beneficiated bauxite grading 53.1% Al_2O_3 and 7.5% reactive silica (Cape Alumina Pty Ltd, 2010)	Bulimba Formation/ Karumba Basin	Held under mining lease by Cape Alumina Pty Ltd. Cape Alumina has announced that the project is unviable following the Queensland Government's declaration of the Wenlock River Basin under the Wild Rivers Act.
Sam Creek	56km SSW of Bamaga	Active prospect	Nil	0.9Mt *in situ* bauxite grading <45% Al_2O_3 (Hansen & Clappison, 1972)	Bulimba Formation/ Karumba Basin	Held under exploration permit by Charlotte Australia Holdings Pty Ltd.
Turtle Head Island	31.2km SE of Cape York	Sterilised deposit	Nil	60Mt *in situ* bauxite (Willmott & others, 1969)	Helby beds/ Karumba Basin	Now within a National Park
Vrilya Point	46.0km SW of Bamaga	Active prospect	Nil	100Mt *in situ* bauxite grading 44–45% Al_2O_3 and ~7% reactive silica (Morroy, 1983)	Bulimba Formation/ Karumba Basin	Within mining lease held by Rio Tinto Alcan.
Weipa Bauxite Mine (includes Andoom and Ely)	Weipa	Operating mine	409.7Mt bauxite (1960-2010)	3588Mt *in situ* bauxite (Rio Tinto Plc, 2009)	Bulimba Formation/ Karumba Basin	Mined by Rio Tinto Alcan.

ANTIMONY

Antimony is an element transitional between metallic and non-metallic forms. Its main uses are in metal alloys (for lead-acid storage batteries, die casting, type metal, solders, anti-friction bearings, cable coverings, roofing sheets, ammunition and foil), fire retardants, fireworks, pottery, glass, plastics, rubber and fabrics.

The main antimony mineral is stibnite (antimony sulphide). Native antimony has been reported to occur in small quantities at a few localities, mainly in the Hodgkinson Province. Antimony deposits can be classified as simple (structurally-controlled antimony-gold-quartz veins) or complex (Wallis, 1991; Wallis, 1993a). Almost all antimony mineralisation in Queensland is of the simple type and is characterised by a high variability in grade along the vein system.

Small scale mining of high-grade antimony vein deposits has occurred intermittently since 1873. Total historical Queensland production up to 2005 is ~8285t of antimony metal and concentrates.

The Antimony Reward, Northcote and Retina deposits in north Queensland are the largest defined resources in the State (Figure 17). Republic Gold Ltd's Northcote Project contains measured, indicated and inferred resources of 3.978Mt at 0.24% Sb and 2.0g/t Au for a total of 9547t Sb and 7956kg (255 789oz) Au (Republic Gold Limited, 2005). Future antimony production may come from the development of these and other small to medium-sized gold-antimony deposits in the Hodgkinson Province (Table 11).

Simple Deposit Style

Quartz-stibnite veins of the simple type are widely distributed in eastern Queensland, with concentrations in the Hodgkinson and Broken River Provinces and, to a lesser extent, in the Gympie Province (Figure 17). The main centres of past antimony production include the Neardie mine (north-east of Gympie), the Northcote deposits, and the Woodville and Mitchell River (Retina mine) areas (west of Cairns in far north Queensland). Deposits are also located in the Cooktown, Kimba, Herberton, Broken River and Amanda Bel goldfield areas. In many cases, antimony lodes have been mined for their gold content only.

The simple deposit style typically consists of lenticular, structurally-controlled quartz veins containing massive stibnite with or without associated gold and accessory pyrite. Mineralisation is not restricted to any particular unit or rock type, but an association with gold is a feature in most metasedimentary host rock terrains in Queensland. Individual deposits rarely contain more than several thousand tonnes of ore. A metamorphic origin is favoured for the deposits in the Hodgkinson and Broken River Provinces (Theale & others, 1989; Golding & others, 1990).

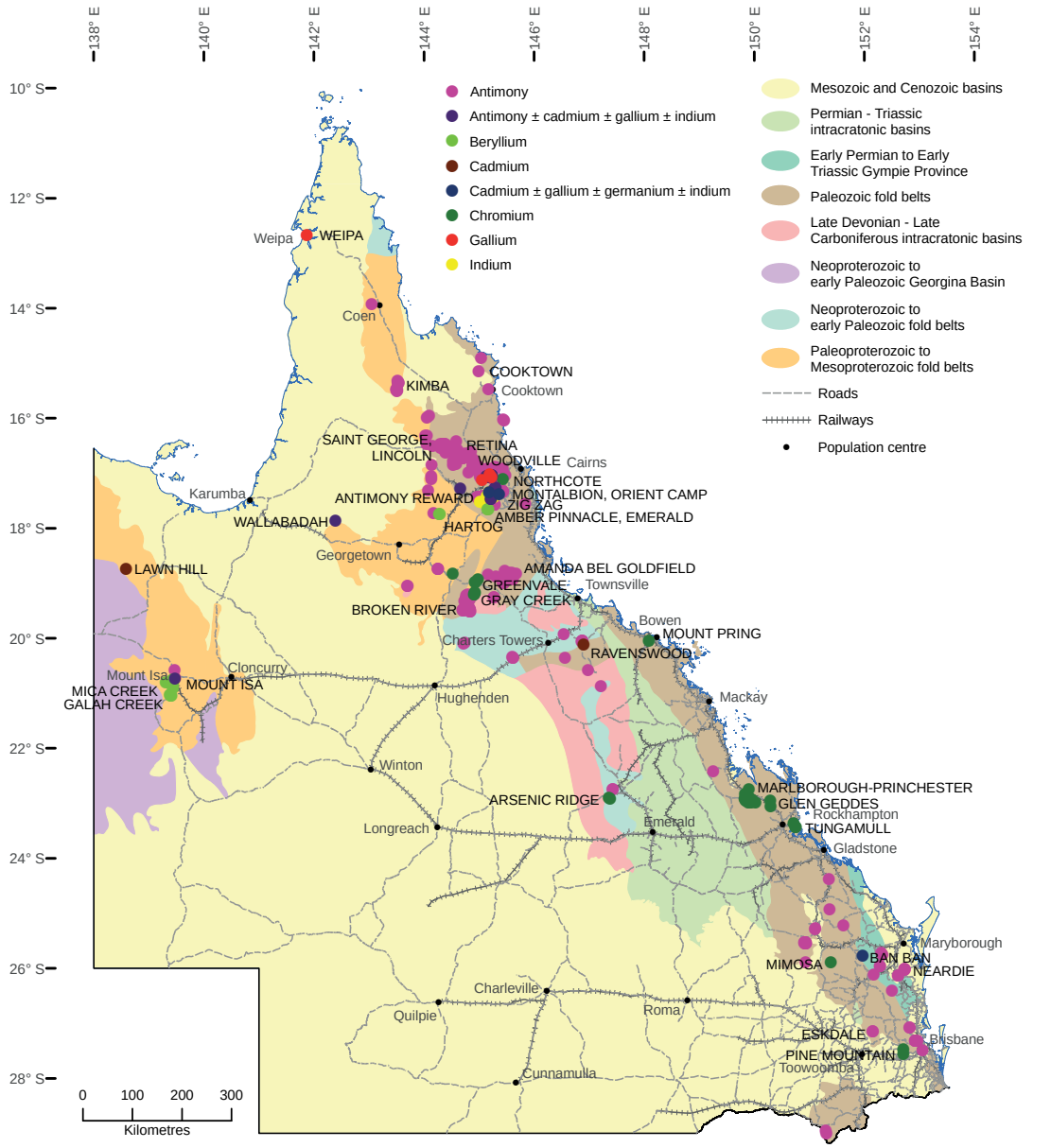

Figure 17: Antimony, beryllium, cadmium, chromium, gallium, germanium and indium occurrences and deposits

Complex Deposit Style

Complex deposit types, where antimony is a subordinate component of precious and base metal deposits, include high-level porphyry to epithermal deposits and Carlin or replacement-style deposits. Mount Isa is the most important example of a complex style of antimony deposit in Queensland. The most important antimony mineral in complex deposit styles is friebergite, which occurs as distinct microscopic grains usually enclosed in galena. At Mount Isa, antimony also occurs in a silver-rich variety of tetrahedrite and galena with an Sb:Ag ratio of ~1. Average antimony head grades in lead-zinc ore at Mount Isa are 0.01%; Mount Isa copper concentrates average 0.00015% Sb. Hilton ores average 0.03% Sb for lead concentrate and 0.004% Sb for zinc concentrate (Wallis, 1991; Wallis, 1993a).

Table 11: Significant antimony deposits of Queensland

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Antimony Reward		6.5km NE of Emuford	Abandoned mine, abandoned prospect	9.1t Sb	~112 700t at 11.7% Sb for 13 197t Sb (Announcement by Southern Antimony NL to Sydney Stock Exchange in 1971))	Featherbed Volcanic Group/ Kennedy Province	Mesothermal Sb-quartz veins in volcaniclastic sediments. Deposit was held under exploration permit by Kangaroo Metals Ltd (now Kangaroo Resources Ltd) but the permit has expired.
Eskdale		16km NNE of Crows Nest	Abandoned mine	Not recorded	~3000t at 2.9% Sb for 87t Sb (Krosch, 1973)	Eskdale Granodiorite/South East Queensland Volcanic and Plutonic Province	Epithermal Sb-Au-quartz veins. No current tenure.
Lincoln		50.2km SSE of Maytown	Abandoned mine	Not recorded	Maximum potential 22 000t at <3% Sb to 30m depth for <660t Sb (Taylor, 1971)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in arenite. Held under exploration permit by Republic Gold Ltd.
Mount Isa Copper Mine		1.3km W of Mount Isa	Operating mine	90t Sb (1996-2005). Sb production from Cu ores not reported in recent years.	Sb resources not reported	Urquhart Shale/ Leichhardt River Domain	Brecciated sediment hosted Cu deposit in shale and dolomite. Operated by Xstrata Plc.
Mount Isa Silver-lead Mine		1.3km W of Mount Isa	Operating mine	2652t Sb (1996–2005). Sb production from zinc concentrates not reported in recent years.	Sb resources not reported	Urquhart Shale/ Leichhardt River Domain	Sediment-hosted Ag-Pb-Zn lodes. Operated by Xstrata Plc.
Neardie		20.7km NNE of Gympie	Abandoned mine	1160t of hand-picked stibnite and liquated antimony sulphide (1873–1906)	12 700t at 2.47% Sb for 314t Sb (Siemon, 1974)	Kin Kin beds/ Kin Kin Subprovince	Mesothermal Sb-Au-quartz veins in sandstone, shale and phyllite. No current tenure.
Northcote	Belfast Hill	18.4km NE of Dimbulah	Abandoned mine, active prospect	Not recorded	269 000t at 0.38% Sb and 1.27g/t Au for 1031t Sb and 341kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in arenite. Under mining lease application by Republic Gold Ltd.
	Black Bess	17.6km NNE of Dimbulah	Abandoned mine, active prospect	8.4t Sb and 127.4kg Au (1926–1944, 1992)	787 000t at 0.45% Sb and 2.38g/t Au for 3591t Sb and 1875kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in pelite. Under mining lease application by Republic Gold Ltd.
	East Leadingham	19.4km NE of Dimbulah	Abandoned mine, active prospect	156.8kg Au (1991–1992)	557 000t at 0.16% Sb and 2.29g/t Au for 885t Sb and 1275kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in greywacke and siltstone. Under mining lease application by Republic Gold Ltd.

Table 11 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Northcote (continued)	Emily	19.8km NE of Dimbulah	Abandoned mine, active prospect	3t Sb and 57.67kg Au (1878-1992)	764 000t at 0.08% Sb and 2.04g/t Au for 598t Sb and 1558kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in greywacke, slate, phyllite and schist. Under mining lease application by Republic Gold Ltd.
	Emily South	19.3km NE of Dimbulah	Abandoned mine, active prospect	44.32kg Au (1991-1992)	222 000t at 0.04% Sb and 2.26g/t Au for 86t Sb and 501kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in arenite and argillite. Under mining lease application by Republic Gold Ltd.
	Ethel	18.1km NNE of Dimbulah	Abandoned mine, active prospect	67.6t Sb and 25.02kg Au (1892-1950, 1991-1992)	843 000t at 0.24% Sb and 1.89g/t Au for 2035t Sb and 1596kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in arenite. Under mining lease application by Republic Gold Ltd.
	Navan Hill	18.6km NE of Dimbulah	Abandoned mine, active prospect	Not reported	86 000t at 0.07% Sb and 1.47g/t Au for 58t Sb and 124kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in arenite and phyllite. Under mining lease application by Republic Gold Ltd.
	Tunnel Hill	20km NNE of Dimbulah	Abandoned mine, active prospect	Not reported	450 000t at 0.27% Sb and 1.77g/t Au for 1236t Sb and 797kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in greywacke and siltstone. Under mining lease application by Republic Gold Ltd.
Retina (Big A)		63km W of Mount Carbine	Abandoned mine, active prospect	389t Sb, 106.32kg Au and 8.12kg Ag (1890–1970, 1998-2002)	45 000t at 5% Sb for 2250t Sb (Linde, 1972)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in schist and greywacke. Held under mining lease by Republic Gold Ltd.
Saint George		47.1km S of Maytown	Abandoned mine	Not reported	5750t at 3.1% Sb for 178t Sb (Taylor, 1971)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in arenite and phyllite. Under exploration permit application by Australia Minerals and Mining Group Ltd.
Woodville		4km ESE of Mount Mulligan	Abandoned mine	1266t antimony ore and concentrate (1889–1952)	Sb resources not reported	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in greywacke, shale and arenite. Held under exploration permit by Delfos Minerals Pty Ltd.
Zig Zag		21.5km WNW of Ravenshoe	Abandoned mine, active prospect	70.6t Sb concentrates (1950–1988)	Sb resources not reported	Go Sam Granite/ Kennedy Province	Mesothermal Sb-Au-quartz veins in granite. Held under exploration permit by North Queensland Metals Ltd.

BERYLLIUM

Beryllium is an alkaline earth metal that is used in lightweight structural components for aircraft, missiles, space vehicles and communication satellites, radiation windows for X-ray tubes, particle beam accelerators, mirrors for telescopes and optical guidance systems, precision instrumentation, high frequency speaker drivers, and semiconductors for electronic applications. Commercial applications face technical challenges due to the toxicity of beryllium-bearing dusts. The more significant beryllium minerals include bertrandite, beryl, chrysoberyl and phanakite.

Queensland's most significant beryllium deposits are in the Mica Creek and Galah Creek areas, south of Mount Isa, where beryl crystals up to 1m long and 300 mm across occur in segregated granite pegmatite dykes and veins of the Mica Creek Pegmatite, a phase of the Sybella Granite (Figure 17; Shepherd, 1946; Brooks, 1957b; Brooks & Shipway, 1960; Brooks & Shipway, 1961; Brooks, 1963; Zimmerman, 1964; Brooks, 1965b; Brooks, 1984). The demand for beryllium during World War II resulted in the opening up of some of these deposits in 1943. Production up until 1961 totalled ~139t of beryl, mainly from the Welcome Strike, Bong Bong, Big River, Big Beryl, Hexagon, Beryl King and Beryl Queen mines (Brooks, 1984; Denaro & others, 2001; Denaro & others, 2003). Resources at Big River are of the order of 114 000t at 0.15% BeO to 15m depth (O'Dea, 1964).

Beryl occurs in quartz pegmatite lodes at Amber Pinnacle and Emerald, north-west of Lyndbrook Siding; 6t of selected ore grading 12% beryl was produced from the Emerald deposit in 1965 (Lam & others, 1989).

Minor beryl occurs in a tin skarn in the Hodgkinson Formation at Hartog, 6.6km north-east of Mount Garnet. Rock chip samples averaged 0.1% Be (Marshall, 1973b). A skarn at the nearby 4 Ways prospect assayed 2070ppm Be (Marshall, 1973a).

CADMIUM, GALLIUM, GERMANIUM AND INDIUM

Cadmium is a transition metal that is a minor component in most zinc ores. The main uses for cadmium are in nickel-cadmium batteries and cadmium telluride solar panels. Other uses include lasers, television phosphors, fluorescence microscopy, semiconductors and control rods for nuclear reactors. Traditional uses as a pigment, corrosion resistant plating on steel and plastics stabiliser have declined due to cadmium's toxicity.

Gallium is a post-transition metal. Elemental gallium does not occur in nature but gallium salts occur in trace amounts in bauxite and sphalerite ores. Gallium is used in semiconductors, microwave circuitry, infrared applications, light emitting diodes and diode lasers, solar cells, alloys, fuel cells, pharmaceuticals and radiopharmaceuticals.

Germanium is a semi-metallic element that is mined primarily from sphalerite; it is also recovered from silver, lead and copper ores. Germanium is used in

semiconductors, fibre-optic and infrared optic systems, polymerisation catalysts, electronics, solar cells and nanowires.

Indium is a post-transition metal. Elemental indium rarely occurs in nature and sphalerite ores are the main source of indium compounds. Indium's main applications are in liquid crystal displays and touch screens; it is also used in lubricants, electronics, semiconductors, low melting point alloys, lead-free solders, thermal interfaces in microprocessors, medical imaging, low pressure sodium vapour lamps and control rods for nuclear reactors.

Queensland's main occurrences of these metals are in zinc, copper, silver-lead, tin and antimony ores in north-west and north Queensland; gallium also occurs in Cape York Peninsula bauxites (Figure 17). The only recorded production is 5030t of cadmium from the Mount Isa silver-lead-zinc mine between 1996 and 2005. Mount Isa zinc ore also contains 10–40ppm Ga (Brooks, 1984).

Greenockite (cadmium sulphide) occurs associated with sphalerite in the Ravenswood goldfield. Cadmium has been detected in the Zn-Pb-Ag ores at Lawn Hill (Dunstan, 1913) and in silver-lead ore at Orient Camp (Dash & others, 1991). Geochemical scans of core from Gold Aura Limited's Wallabadah polymetallic Zn-Pb-Cu-Sn-Sb-Au prospect, north of Croydon, have detected 0.4m at 0.198% Cd (Gold Aura Limited, 2007).

Weipa bauxite averages ~70ppm gallium oxide and is a potential source of this metal (Brooks, 1984). However, it is not considered to be economic to recover it during refining at Gladstone. Gallium occurs in concentrations of up to 16ppm in quartz-gold, quartz-stibnite, tin-tungsten and quartz-fluorite veins in the Hodgkinson Formation in the Northcote and Irvinebank areas (Dash & others, 1991).

The gossan at the Ban Ban zinc skarn in south-east Queensland has an average grade of 159ppm Cd, 8.2ppm Ga, 4.3ppm Ge and 4.3ppm In (Denaro & others, 2007). The primary ore has not been assayed for these elements.

Indium has been detected in numerous deposits in the Herberton and Mareeba districts. It has been recorded as a significant trace element in cassiterite in the Herberton area (Greaves & others, 1971) and occurs in subeconomic concentrations in the UNA group of tin-copper-silver mines, the Montalbion group of silver-lead mines and the Orient Camp group of silver-lead mines. At Orient Camp, indium is present in concentrations of ~120ppm and occurs mainly substituting in sphalerite, stannite, chalcopyrite, cassiterite and sulpho-salts of Sn, Pb, Cu and Sb. It also occurs as discrete minerals such as indite, roquestite, sakuraiite and dzalindite (Dash & others, 1991). The Baal Gammon prospect, 6.4km west of Herberton, contains resources of 5 482 000t at 0.2% Sn, 29g/t Ag, 0.8% Cu and 29g/t In for 10 964t Sn, 156 907kg Ag, 43 420t Cu and 159 087kg In (Monto Minerals Limited, 2011). The Isabel prospect, 2.5km west of Herberton, contains 48 000t at 140g/t In for 6720kg In (Resource Information Unit Ltd, 2000).

CHROMIUM

The only ore mineral of chromium is the spinel group mineral chromite. Chromium is used in the forms of chromite, ferrochromium and chromium in the production of ferrous and non-ferrous alloys, refractories and chemicals. Chromite is found in podiform, stratiform and detrital deposits. Chromite deposits in Queensland are mainly of the podiform type, occurring in serpentinised ultrabasic rocks along the east coast (Figure 17; Krosch, 1990c).

Detrtial chromite near Mareeba in north Queensland was traced to a foliated talcose rock in the Hodgkinson Formation (Connah, 1953).

A narrow belt of serpentinised ultrabasics (Sandalwood Serpentinite and Gray Creek Complex), extending south-westerly from Greenvale into the Gray Creek area, contains two significant chromite prospects and several smaller lenses. Massive chromite occurs as irregular lenses and disseminated chromite occurs in bands in the serpentinite (Lam, 1995). Potential resources have been estimated as ~31 500t of massive chromite ore at Gray Creek North, 20 000t of massive ore and 200 000t of disseminated ore at Gray Creek South and 35 000t of high-grade ore in alluvial, eluvial and colluvial material shed from the outcrops (Saul & Grant, 1987; Krosch, 1990c). Ni-Co laterites developed on serpentinites in the Greenvale area are enriched in Cr (up to 3%).

Belts of serpentinite stretch from Marlborough, north-west of Rockhampton, to Tungamull to the south-east of the city. Small chromite pods in this belt provided Queensland's total past production of >14 000t chromite at grades of 28–36% chromic oxide (Ridgway, 1943a; Geological Survey of Queensland, 1978). The most significant lenses are at Racecourse (~5500t), Nine Mile Creek (~7600t), Mount Redcliffe and Spring Creek near Marlborough, the Large Lode (~86 000t at 28% Cr_2O_3) near Princhester, North Pointer (~8500 t) near Glen Geddes, and Elgalla and Balnagowan near Tungamull (Pratt 1985). Exploration has located >40 chromite occurrences, possibly of refractory grade (Krosch, 1990c).

Minor podiform chromite occurs in serpentinite at Mount Pring (Saint-Smith, 1919a; Geological Survey of Queensland, 1978), Grasstree Mountain (Geological Survey of Queensland, 1978; Lam & Garrad, 1993), Mimosa (D'Aguilar Gold Limited, 2009), and Pine Mountain (Ridley, 1969).

COPPER

Copper is a reddish-brown, malleable, ductile transition metal. It is resistant to corrosion and is a good conductor of electricity and heat. The metal has a variety of uses, particularly in the electrical, chemical, motor vehicle, marine, plumbing and information technology industries. It is also used to manufacture coins, jewellery, radiators, heaters, cooking utensils and chemical compounds such as those for the control of fungi. Hardness and strength may be improved by alloying with tin to produce bronze and with zinc to produce brass.

Queensland is Australia's largest copper producing state, and Queensland's major base metal deposits contain 11% of Australia's economic demonstrated resources. In 2009–10, Queensland produced 973 412t of copper concentrates (containing 214 877t Cu, 1615kg Au and 47 414kg Ag) and 675t copper precipitates (containing 169t Cu); 1065t copper was produced from lead concentrates. The Mount Isa mine in north-west Queensland is the state's major source of copper. Most of the copper concentrate is treated at the copper smelter in Mount Isa, which has a capacity of 300 000 tonnes of anode copper a year. Copper metal is refined in Townsville and exported through the city's port.

The world-class base metal terrain of the Mount Isa Inlier also hosts significant deposits such as Ernest Henry, Osborne and Mount Elliott. Exploration beneath shallow Mesozoic cover rocks fringing the outcropping part of the inlier has identified several major mineral deposits. Significant discoveries have also been made beneath known outcrops and abandoned mine workings.

Major copper deposits within Queensland occur in six main mineralisation styles: brecciated sediment-hosted copper, breccia-hosted and structurally-controlled Proterozoic Cu and iron oxide-Cu-Au, volcanic-hosted massive sulphide and porphyry copper (Figure 18, Table 12). Queensland's copper deposits and resources have been described by Horton (1978, 1982), Kay (1985), Sawers (1990), Wallis (1993b, 1996, 1998b, 1999, 2001a) and Geological Survey of Queensland (2011).

Vein deposits

Copper-bearing veins in various geological settings are common throughout Proterozoic and Palaeozoic Queensland. In the past, hundreds of small mines were developed on shallow deposits, the majority of which had well developed zones of supergene enrichment. In most cases, the underlying primary ore was too low grade to be worked profitably. With modern exploration and mining techniques, many of these veins systems are proving to contain substantial primary copper resources.

Brecciated Sediment-Hosted Copper deposits

Copper mineralisation in the Western Fold Belt Province of the Mount Isa Inlier is largely hosted by brecciated dolomitic, pyritic and carbonaceous sediments, or brecciated sandstone proximal to regional fault/shear zones. The Mount Isa copper deposit is the largest copper deposit in Queensland. Copper mineralisation at Mount Isa is hosted by 'silica-dolomite' rocks of the Urquhart Shale, adjacent to the lead-zinc lodes to the east of the Mount Isa Fault zone.

The Mount Isa mine is one of the world's largest underground mining complexes and is managed as two separate businesses, Xstrata copper and Xstrata Zinc. The Mount Isa copper mines comprise the Enterprise (3000 and 3500) and X41 (1100 and 1900) underground orebodies.

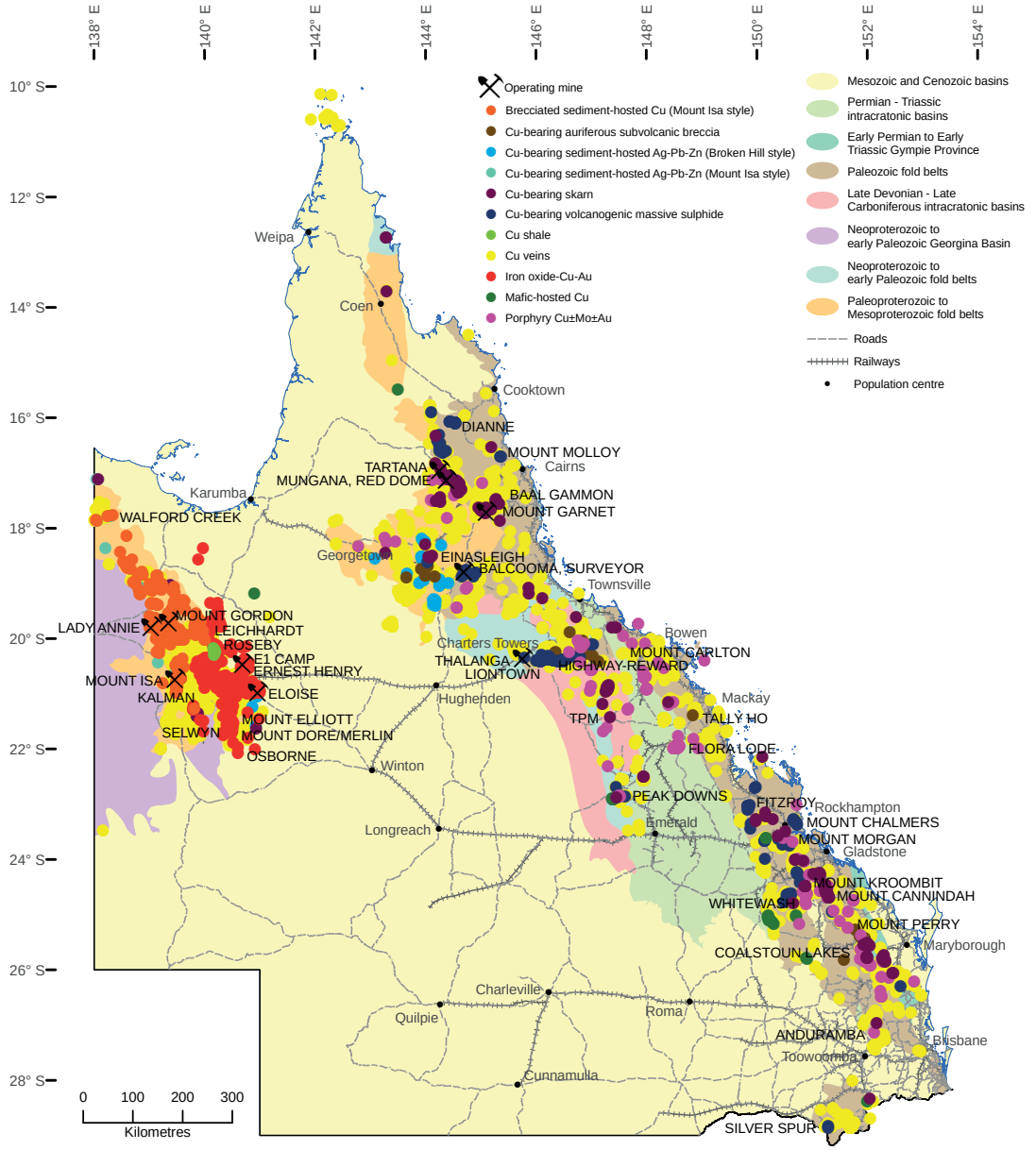

Figure 18: Copper occurrences and deposits

Other significant resources of this type in the Mount Isa Inlier include the Esperanza and Mammoth deposits (Mount Gordon mine) and Mount Oxide, 120km north of Mount Isa. These deposits are within and adjacent to the Mount Gordon Fault Zone.

Iron oxide Cu–Au deposits

Iron oxide–copper–gold mineralisation occurs mainly in the Eastern Fold Belt Province of the Mount Isa Inlier. Deposits in these systems are associated with relatively high temperature, iron- (magnetite and/or hematite) rich hydrothermal alteration systems that are spatially and temporally related to felsic plutons of the Williams-Naraku and Wonga Batholiths and have a variety of forms, including vein networks, breccias, disseminations and replacements. They are localised in dilatant zones of structures active during pluton emplacement and cooling and are hosted

by oxidised sedimentary and volcanic packages. These host rocks include banded iron formation and ironstone, carbonaceous slate and phyllite, metasiltstone, schist and ferruginous arenite, with metamorphic grades ranging from greenschist to upper amphibolite facies.

Alteration systems containing the Cu-Au mineralisation are characterised by Fe-rich calc-silicate (calcic amphibole + pyroxene, + carbonate + scapolite) assemblages along with alkali feldspar + biotite-bearing parageneses. This alteration fills dilatant sites such as veins and breccias and is commonly magnetite-rich, giving rise to strong positive magnetic anomalism.

Ernest Henry, Osborne, Selwyn, Mount Elliott, E1 Camp and Eloise are the major copper–gold deposits of this style in the Eastern Fold Belt Province. Primary iron-rich mineral associations vary from oxidised (for example, magnetite at Ernest Henry and Osborne and hematite at Selwyn) to reduced (for example, pyrrhotite at Eloise). Ernest Henry is hosted in variably altered, brecciated felsic volcanic rocks with primary mineralisation forming a magnetite-carbonate gangue. Magnetite makes up 20–25% of the primary ore.

Smaller deposits of this style are localised along major shears and faults throughout the Eastern Fold Belt Province, with or without associated ironstone bodies. Discovery of deposits such as Ernest Henry, Osborne, Eloise and E1 in the early 1990s beneath thin cover of the Eromanga and Carpentaria Basins on the eastern edge of the Mount Isa Inlier was largely due to advancements in geophysical techniques, as well as better targeting based on improved understanding of these systems.

Volcanogenic Massive Sulphide deposits

Major volcanogenic massive sulphide copper deposits within Queensland are generally of medium size and occur predominantly within the Late Cambrian to early Ordovician rocks of the Thalanga Province in northern central Queensland. Examples include Thalanga, Highway-Reward, Dry River South, Balcooma and Surveyor. Several smaller VMS deposits, such as Mount Molloy and Dianne, occur in the Hodgkinson Province in north Queensland.

Thalanga and Highway-Reward are hosted by the Seventy Mile Range Group. The Thalanga deposit, although zinc rich, contained significant copper and has a tabular geometry, with rhyolitic volcanic rocks in the footwall and dacite and andesite in the hanging wall of the open pit. The Highway-Reward deposit consists of pipe-like, copper- and gold-rich massive sulphide (pyrite, chalcopyrite) orebodies in rhyolitic to dacitic lavas and volcaniclastic rocks.

The Balcooma, Dry River South and Surveyor deposits occur in the Balcooma Metavolcanic Group. Mineralisation is rich in copper and contains significant zinc, lead, silver and gold. The deposits in the Balcooma Metavolcanic Group are interpreted as being about the same age as the deposits in the Seventy Mile Range Group.

The Mount Morgan Au-Cu orebody occurs in a belt of Middle Devonian volcanics and sediments forming a roof pendant in a Late Devonian tonalite intrusion in the Yarrol Province. Although genesis has long been controversial, Mount Morgan is now generally regarded as being an end-member of the general class of VMS deposits. This world-class deposit sustained almost continuous mining between 1882 and 1990, producing 215 268kg of gold bullion and 78 788kg of fine gold, 360 616t of copper and 36 842kg of silver from 50Mt of ore (including treatment of tailings). Further exploration at Mount Morgan has defined only limited extensions to the mineralisation.

Porphyry Copper deposits

The most significant porphyry copper style deposit in south-east Queensland is at Coalstoun Lakes, where Late Permian diorite-monzonite porphyry stocks and large breccia pipes of the South-East Queensland Volcanic and Plutonic Province intrude altered sedimentary and volcanic rocks (Good Night beds) of the Wandilla Province. Mineralisation at Coalstoun Lakes is subeconomic due to its low average copper grade of 0.29%. Several weakly mineralised porphyry systems have been recognised along the east coast of Queensland, for example, Anduramba, Chinaman Creek, Mount Cannindah, Whitewash (Horton, 1978, 1982).

Porphyry systems also occur in the Hodgkinson Province in north Queensland. Kagara Zinc has delineated significant Cu-Au mineralisation at Red Dome and Mungana associated with skarns and their related porphyry intrusions.

Skarns

Significant historical copper production has come from Cu-bearing skarns associated with late Palaeozoic and Mesozoic porphyry intrusions along the east coast of Queensland, particularly in the Chillagoe area.

Copper is also associated with skarn-like Broken Hill style Ag-Pb-Zn deposits in north-west Queensland.

Other deposit styles

Minor copper mineralisation occurs in auriferous subvolcanic breccia systems such as Kidston, Mount Wright and Mount Rawdon.

Cu-bearing weathered shales of the Roseby Project in north-west Queensland exhibit similarities to Zambian Copper Belt deposits.

Layered gabbro complexes such as Hawkwood commonly contain accessory copper.

Table 12: Significant copper deposits of Queensland

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Anduramba Prospect		14km NNE of Crows Nest	Abandoned mine, active prospect, feasibility study	Not reported	31.6Mt at 0.05% Mo, 0.014% Cu and 4.7g/t Ag for 17 083t Mo, 149 395kg Ag and 4338t Cu (D'Aguilar Gold Limited, 2008b)	Eskdale Granodiorite/ South East Queensland Volcanic and Plutonic Province	Porphyry Cu-Mo deposit in granite. Held under Mineral Development Licence by Archer Resources Pty Ltd (D'Aguilar Gold Ltd).
Answer		138km SE of Mount Isa	Abandoned mine, active prospect	1030.3t Cu, 11.06kg Au (1911-1920, 1967-1976)	Not calculated	Answer Slate/ Marimo-Staveley Domain	Cu-Au vein in slate, phyllite and schist. Held under Mining Lease by North Queensland Mines Pty Ltd (Queensland Mining Corporation Ltd).
Baal Gammon		6.4km W of Herberton	Abandoned mine, active prospect	88.4t cassiterite (1892-1949)	5 482 000t at 0.2% Sn, 29g/t Ag, 0.8% Cu and 29g/t In for 10 964t Sn, 156 907kg Ag, 43 420t Cu and 159 087kg In (Monto Minerals Limited, 2011)	Hodgkinson Formation/ Hodgkinson Province	Cassiterite-Cu-Ag-In-quartz veins and stockworks in meta-arenite and porphyry intrusive. Held under Mining Lease by North Queensland Metals Ltd (Conquest Mining Ltd/ Monto Minerals Ltd). Kagara Ltd proposes to commence mining copper ore in 2011.
Barbara	North Lode	51km NE of Mount Isa	Abandoned mine, active prospect	29.85t Cu (1970-1075)	1.99Mt at 1.16% Cu, 2.22g/t Ag, 0.026% Co and 0.1g/t Au for 23 124t Cu, 4424 kg Ag, 512t Co and 199kg Au (Syndicated Metals Limited, 2010)	Leichhardt Volcanics/ Mary Kathleen Domain	Shear zone hosted veins and breccia in schist and volcanics. Held under Exploration Permit by Syndicated Metals Ltd and Mt Isa Metals Ltd.
	South Lode	51km NE of Mount Isa	Abandoned mine, active prospect	Not recorded	3.34Mt at 1.57% Cu, 2.67g/t Ag, 0.03% Co and 0.19g/t Au for 52 338t Cu, 8905kg Ag, 910t Co and 631kg Au (Syndicated Metals Limited, 2010)	Leichhardt Volcanics/ Mary Kathleen Domain	Shear zone hosted veins and breccia in schist and volcanics. Held under Exploration Permit by Syndicated Metals Ltd and Mt Isa Metals Ltd.
Beacon Prospect		33.3km W of Cloncurry	Inactive prospect	Not mined	3Mt at 0.2% Cu for 6000t Cu (Scott, 1982)	Milo beds/ Tommy Creek Domain	Skarn in limestone, calc-silicate rocks and metasiltstone. Held under Exploration Permit by Mount Isa Mines Ltd and Sovereign Metals Ltd.
Big One		160km N of Mount Isa	Abandoned mine, inactive prospect	Not recorded	79 347t at 2.2% Cu for 1746t Cu (Resource Information Unit Ltd, 1996)	Lochness Formation/ Mount Oxide Domain	Brecciated sediment-hosted Cu in sandstone and quartzite. Held under Mining Lease by Coffee Gold NL.
Blockade		41.9km ENE of Mount Isa	Abandoned mine, inactive prospect	1125.9t Cu, 70 945t silica (1955-1975, 1996-1997)	Not calculated	Leichhardt Volcanics/ Mary Kathleen Domain	Shear-hosted Cu-quartz veins in rhyolite and schist. Held under Mining Lease by Kilo Copper Pty Ltd.
Chieftan		32.5km WNW of Mungana	Abandoned mine, active prospect	2016t Cu, 69.6kg Au, 2712kg Ag (1898–1917)	Not calculated	Dargalong Metamorphics/ Yambo Subprovince	Shear-hosted Cu-quartz veins in gneiss and schist. Held under Mining Lease by Ozmin Resources Pty Ltd (Axiom Mining Ltd).

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Chinaman Creek Prospect		7.8km S of Mount Perry	Active prospect	Not mined	Estimated 200Mt at 0.2% Cu for 400 000t Cu (Lacy, 1980)	Tenningering Granodiorite/ South East Queensland Volcanic and Plutonic Province	Porphyry Cu-Mo-Au deposit in granodiorite. Held under Exploration Permit by Acapulco Mining Pty Ltd (D'Aguilar Gold Ltd).
Cloncurry Copper Project	Great Australia	1.8km S of Cloncurry	Abandoned mine, active prospect	12 953t Cu, 283.8kg Au (18681946, 1953–1968, 1996–2002)	2.2Mt at 1.54% Cu and 0.13g/t Au for 33 980t Cu and 294kg Au (Exco Resources Limited, 2010)	Corella Formation/ Canobie Domain; Staveley Formation/ Soldiers Cap Domain	Iron oxide-Cu-Au deposit in sandstone, dolerite and calc-silicate rocks. Held under Mining Lease by Great Australian Operations Pty Ltd (Exco Resources Ltd).
	Jasper Block	1.9km NNE of Cloncurry	Abandoned mine, active prospect	Not recorded	1.4Mt at 1.0% Cu and 0.04% Co for 14 000t Cu and 490t Co (Exco Resources NL, 2006)	Toole Creek Volcanics/ Canobie Domain	Iron oxide-Cu-Au deposit in jasper, quartzite, limestone and metasediments. Held under Exploration Permit by Exco Resources Ltd.
	Kangaroo Rat	29.6km ESE of Cloncurry	Abandoned mine, active prospect	31.8t Cu, 2.1kg Au (1927–1930, 1962, 1980)	0.875Mt at 1.65% Cu and 1g/t Au for 14 437t Cu and 875kg Au (Exco Resources Limited, 2010)	Toole Creek Volcanics/ Soldiers Cap Domain	Shear zone hosted veins in shale, amphibolite and quartzite. Held under Mining Lease by Exco Resources Ltd.
	Mount Colin	48.5km W of Cloncurry	Abandoned mine, active prospect	24.4t Cu (1963–1966)	1.49Mt at 2.5% Cu for 36 868t Cu (Exco Resources Limited, 2010)	Corella Formation/ Mary Kathleen Domain	Shear zone hosted veins in jasper and calc-silicate rocks. Held under Mining Lease by Exco Resources Ltd.
	Taipan	2.2km SSW of Cloncurry	Active prospect	Not mined	1.46Mt at 0.8% Cu and 0.1g/t Au for 11 680t Cu and 146kg Au (Exco Resources Limited, 2010)	Wiggle Waterhole Metagabbro/ Canobie Domain	Iron oxide-Cu-Au deposit in dolerite. Held under Mining Lease by Great Australian Operations Pty Ltd (Exco Resources Ltd).
	Turpentine	115km WNW of Cloncurry	Active prospect	Not mined	1.842Mt at 1% Cu and 0.2g/t Au for 18 555t Cu and 375kg Au (Exco Resources Limited, 2010)	Corella Formation/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in metasediments. Held under Mining Lease application by Boomarra Mines Pty Ltd (Exco Resources Ltd).
	Victory-Flagship	38.1km SE of Cloncurry	Abandoned mine, active prospect	43.2t Cu, 26.8kg Au (–1958, 19731976)	0.196Mt at 1.2% Cu and 1.4g/t Au for 2352t Cu and 274kg Au (Exco Resources Limited, 2010)	Toole Creek Volcanics/ Soldiers Cap Domain	Shear zone hosted veins in shale. Held under Exploration Permit by Exco Resources Ltd.
Coalstoun Lakes		24.6km E of Gayndah	Active prospect	Not mined	Estimated 85.58Mt at 0.29% Cu for 245 614t Cu (Metallica Minerals Limited, 2004)	Good Night beds/ Wandilla Province; unnamed diorite/ South East Queensland Volcanic and Plutonic Province	Porphyry Cu-Mo-Au deposit in metasediments and diorite. Held under Exploration Permit by Newcrest Operations Ltd.
Copper Knob		1.3km N of Ravenswood	Abandoned mine, active prospect	3.28t Cu, 5.3kg Au, 0.89kg Ag (1906–1920, 1943)	2.16Mt at 0,11% Cu, 0.82g/t Au, 0.2% Zn and 4.3g/t Ag for 2468t Cu, 1783kg Au, 4340t Zn and 9312kg Ag (Haoma Mining NL, 1999)	Jessop Creek Tonalite/ Pama Province	Shear-hosted veins in tonalite. Held under Mining Lease by Kitchener Mining NL.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Desolation		116km ESE of Mount Isa	Abandoned mine, active prospect	Not recorded	70 000t at 1.32% Cu for 924t Cu (Matrix Metals Limited, 2003)	Staveley Formation/ Marimo-Staveley Domain	Shear-hosted veins in shale and quartzite. Held under Mineral Development Licence by Matrix Metals Ltd.
Dianne		81km NW of Mount Carbine	Abandoned mine, inactive prospect	18 000t Cu, 1000kg Ag (1980-1984)	Not calculated	Hodgkinson Formation/ Hodgkinson Province	Volcanogenic massive sulphide deposit in shale and greywacke. Held under Mining Lease by Dianne Mining Corporation Pty Ltd.
Duchess		1km SSW of Duchess	Abandoned mine, active prospect	25 405t Cu, 76.1kg Au, 61.8kg Ag (-1920)	Not calculated	Mount Erle Igneous Complex/ Mary Kathleen Domain	Shear-hosted veins in leucogranite, metadolerite and calc-silicate granofels. Held under Exploration Permit by Goldminco Resources Pty Ltd (joint venture with Ivanhoe Australia Ltd).
Dugald River		18.6km NW of Quamby	Active prospect	Not mined	Zn ore – 53Mt at 12.5 % Zn, 1.9% Pb and 36.4g/t Ag for 6 602 400t Zn, 983 000t Pb and 1 929 200kg Ag; Cu ore – 4.4Mt at 1.8% Cu and 0.2g/t Au for 79 200t Cu and 880kg Au (Minmetal Resources Limited, 2010).	Dugald River Shale Member/ Mary Kathleen Domain	Sediment-hosted Ag-Pb-Zn deposit in slate, shale, schist and limestone. Held under Mining Lease by MMG Australia Ltd (MMG Mining Ltd).
E1 Camp		34km NE of Cloncurry	Active prospect	Not mined	48.07Mt at 0.72% Cu and 0.21g/t Au for 346 029t Cu and 10 319kg Au (Exco Resources Limited, 2010)	Mount Fort Constantine Volcanics/ Cloncurry Subprovince	Iron oxide-Cu-Au deposit in breccia, metavolcanics and metasediments. Held under Mining Lease by Eliza Creek Mines Ltd (Exco Resources NL) but recently sold to Xstrata Copper.
Einasleigh Project	Chloe	16km SW of Einasleigh	Active prospect, feasibility study	Not mined	2.7Mt at 0.22% Cu, 5.1% Zn, 2% Pb and 37.7g/t Ag for 5900t Cu, 137 900t Zn, 54 500t Pb and 101 800kg Ag (Copper Strike Limited, 2009)	Einasleigh Metamorphics/ Etheridge Province	Broken Hill-style sulphide or skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd.
	Einasleigh	0.8km NE of Einasleigh	Abandoned mine, active prospect, feasibility study	8237t Cu, 71.2kg Au, 4083kg Ag (1898–1922)	1.1Mt at 2.85% Cu, 0.15g/t Au and 12.5g/t Ag for 31 400t Cu, 170kg Au and 13 800kg Ag (Copper Strike Limited, 2010)	Einasleigh Metamorphics/ Etheridge Province	Skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd.
	Jackson	41km E of Forsayth	Active prospect, feasibility study	Not mined	1.5Mt at 0.13% Cu, 4.6% Zn, 2.1% Pb and 74.3g/t Ag for 1900t Cu, 69 000t Zn, 32 000t Pb and 111 400kg Ag (Copper Strike Limited, 2009)	Einasleigh Metamorphics/ Etheridge Province	Broken Hill-style sulphide or skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd.
	Kaiser Bill	6.3km WSW of Einasleigh	Abandoned mine, active prospect, feasibility study	2.3t Cu, 0.83kg Ag (1909–1922)	15Mt at 0.84% Cu, 0.12g/t Au and 6.5g/t Ag for 126 150t Cu, 1875kg Au and 97 500kg Ag (Copper Strike Limited, 2010)	Einasleigh Metamorphics/ Etheridge Province	Skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Einasleigh Projec (continued)	Railway Flat	3.8km SW of Einasleigh	Active prospect, feasibility study	Not mined	0.9Mt at 0.2% Cu, 3.4% Zn, 0.9% Pb and 16g/t Ag for 1800t Cu, 30 600t Zn, 8100t Pb and 14 400kg Ag (Copper Strike Limited, 2010)	Einasleigh Metamorphics/ Etheridge Province	Broken Hill-style sulphide or skarn deposit in gneiss and calc-silicate rocks. Held under Exploration Permit by Copper Strike Ltd.
	Stella	41km E of Forsayth	Active prospect, feasibility study	Not mined	0.4Mt at 0.2% Cu, 3.9% Zn, 1.8% Pb and 51g/t Ag for 800t Cu, 15 600t Zn, 7200t Pb and 20 400kg Ag (Copper Strike Limited, 2009)	Einasleigh Metamorphics/ Etheridge Province	Broken Hill-style sulphide or skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd
Eloise		56.4km ESE of Cloncurry	Operating mine	157 923t Cu, 55 343.4t Cu conc., 29 383.2kg Ag, 3312.7kg Au, 266.3kg Au bullion (1996–2009)	3.5Mt at 3.1% Cu, 0.8g/t Au and 9.9g/t Ag for 108 100t Cu, 2880kg Au and 34 740kg Ag (Breakaway Resources Limited, 2008b)	Toole Creek Volcanics/ Soldiers Cap Domain	Iron oxide-Cu-Au deposit in schist, amphibolite and arkose. Held under Mining Leases by FMR Investments Pty Ltd. Mining recommenced in January 2011.
Ernest Henry		38km NE of Cloncurry	Operating mine	1 118 439t Cu, 42 748.2kg Au bullion (1997–2010)	105Mt at 1.23% Cu and 0.65g/t Au for 1 294 000t Cu and 68 100kg Au (Xstrata Plc, 2010)	Mount Fort Constantine Volcanics/ Canobie Domain	Iron oxide-copper-gold deposit in breccia, volcanics, siltstone and diorite. Ernest Henry is owned by Xstrata Copper and has been producing copper and gold since 1997. The mine is in the process of transitioning from open cut to underground operations. Magnetite will be produced from underground Cu-Au ore and potentially from tailings for steel making.
Federal		34.7km WNW of Cloncurry	Abandoned mine, active prospect	1035.3t Cu, 1.56kg Au, 92.66kg Ag (1906–1956, 1966–1974)	Not calculated	Milo beds/ Tommy Creek Domain	Shear-hosted veins in shale and schist. Held under Mining Lease by Forte Energy NL.
Fitzroy Project	Scorpion	47.6km N of Rookwood Homestead	Active prospect	Not mined	0.485Mt at 2% Cu, 1.9% Zn, 0.4g/t Au and 13.9g/t Ag for 9700t Cu, 9215t Zn, 194kg Au and 6741kg Ag (Icon Resources Ltd, 2007)	Rookwood Volcanics/ Grantleigh Subprovince	Volcanogenic massive sulphide deposit in basalt and andesite. Held under Exploration Permit by Fitzroy Copper Pty Ltd.
	Sulphide City	47.6km N of Rookwood Homestead	Active prospect	Not mined	1.175Mt at 1.63% Cu, 2.51% Zn, 0.19g/t Au and 7.15g/t Ag for 19 152t Cu, 29 516t Zn, 228kg Au and 8401kg Ag (Icon Resources Ltd, 2007)	Rookwood Volcanics/ Grantleigh Subprovince	Volcanogenic massive sulphide deposit in basalt and andesite. Held under Exploration Permit by Fitzroy Copper Pty Ltd.
	Window	47.2km N of Rookwood Homestead	Active prospect	Not mined	0.155Mt at 1.5% Cu, 0.002% Zn, 0.02g/t Au and 1g/t Ag for 2325t Cu, 4t Zn, 3kg Au and 155kg Ag (Icon Resources Ltd, 2008)	Rookwood Volcanics/ Grantleigh Subprovince	Volcanogenic massive sulphide deposit in basalt and andesite. Held under Exploration Permit by Fitzroy Copper Pty Ltd.

Table 12 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Flamingo	11km NE of Coolullah Homestead	Abandoned mine, active prospect	30.6t Cu, 0.6kg Au (–1958, 1966)	117 000t at 6% Cu and 1.74g/t Au for 7048t Cu and 204kg Au (Queensland Mining Corporation Limited, 2010e)	Boomarra Metamorphics/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in amphibolite. Held under Mining Lease by Flamingo Copper Mines Pty Ltd (Queensland Mining Corporation Ltd).
Flora Lode	38km SW of Nebo	Abandoned mine, inactive prospect	76.2t Cu, .005kg Au, 4.25kg Ag (-1880, 1972-1973)	30 481t at 2,74% Cu for 835t Cu (Woolf, 1975)	Back Creek Group/ Bowen Basin	Porphyry-related Cu-Mo-Au-quartz veins in phyllite. Under Exploration Permit application by Red Rock Australasia Pty Ltd.
Gem	12.6km N of Quamby	Abandoned mine, active prospect	1t Cu, 0.02kg Au (-1936)	491 936t at 0.51% Cu and 0.19g/t Au for 2508t Cu and 93kg Au (China Yunnan Copper Australia Limited, 2010b)	Dipvale Granodiorite/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in granite and amphibolite. Held under Exploration Permit by China Yunnan Copper Australia Ltd.
Girofla	1km SE of Mungana	Abandoned mine, active prospect	6018t Cu, 30 192t Pb, 54 425kg Ag (1902-1953)	Not calculated	Chillagoe Formation/ Hodgkinson Province	Skarn in limestone, chert and breccia. Held under Mining Lease by Mungana Pty Ltd.
Hampden Consol	15km N of Mount Tracey Homestead	Abandoned mine, active prospect	1931.6t Cu, 35.4kg Au (1911–1958)	Not calculated	Hampden Slate/ Kuridala-Selwyn Domain	Shear-hosted veins in slate and amphibolite. Held under Mining Lease by Matrix Metals Ltd.
Hampden No.1	15km N of Mount Tracey Homestead	Abandoned mine, active prospect	12 894t Cu, 340.6kg Au, 173.6kg Ag (–1958)	Not calculated	Hampden Slate/ Kuridala-Selwyn Domain	Shear-hosted veins in slate and amphibolite. Held under Mining Lease by Matrix Metals Ltd.
Handcuff	32km S of Charters Towers	Active prospect	Not mined	1Mt at 0.4% Cu, 7.4% Zn, 0.2% Pb, 0.2g/t Au and 8.8g/t Ag for 4000t Cu, 74 000t Zn, 2000t Pb, 200kg Au and 8800kg Ag (Dronseika, 1995)	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in chert and rhyolite. Held under Mining Lease by Thalanga Copper Mines Pty Ltd and BML Holdings Pty Ltd.
Hero	35km N of Mount Isa	Active prospect	Not mined	40Mt at 0.25% Cu for 100 000t Cu (Atkinson, 1959)	Warrina Park Quartzite/ Leichhardt River Domain	Breccia-hosted (possibly iron oxide-Cu-Au) Cu mineralisation in conglomerate and shale. Held under Exploration Permit by Summit Resources (Australia) Pty Ltd (in joint venture with MM Mining Ltd).
Highway-Reward	33km SSW of Charters Towers	Care and maintenance, active prospect	173 092t Cu, 7395.5kg Ag, 3302.3kg Au, 1137t Pb, 2866t Zn, 29.3kg Au bullion (1953–1989, 1998–2006)	Resources mined out	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolite, volcaniclastics and dacite. Held under Mining Lease by Thalanga Copper Mines Pty Ltd and BML Holdings Pty Ltd.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Isens		36.5km SSW of Nebo	Abandoned mine, inactive prospect	25.6t Cu, 0.33kg Au, 26.38kg Ag (1908–1909)	990 600t at 0.5% Cu for 4953t Cu (Lees, 1971)	Back Creek Group/ Bowen Basin	Porphyry-related Cu-Mo-Au-quartz veins in metasediments. Under Exploration Permit application by Red Rock Australasia Pty Ltd.
Ivanhoe		80km SSE of Mount Isa	Abandoned mine, active prospect	Not recorded	0.83Mt at 1.17% Cu and 0.18g/t Au for 9711t Cu and 149kg Au (Goldminco Corporation, 2008)	Mount Erle Igneous Complex/ Mary Kathleen Domain	Shear-hosted veins in microdiorite and leucogranite. Held under Exploration Permit by Goldminco Resources Pty Ltd.
Ivena		26km N of Gunpowder	Abandoned mine, active prospect	593t Cu, 0.068kg Au, 77.9kg Ag (1900–1960, 1968–1969)	2610t at 6.36% Cu for 166t Cu (Taylor, 1969)	Whitworth Quartzite/ Mount Oxide Domain	Brecciated sediment-hosted Cu in siltstone, sandstone and quartzite. Held under Exploration Permit by Mount Oxide Pty Ltd.
Julivon Creek Prospect		58.5km S of Bowen	Inactive prospect	Not mined	35Mt at 0.16% Cu and 0.01% Mo for 54 600t Cu and 3850t Mo (Leitch & Fletcher, 1972)	Hecate Granite/ Urannah Batholith	Porphyry Cu-Mo deposit in granodiorite. Held under Exploration Permit by Australia Oriental Minerals NL
Kagara North Queensland Operations	Mount Garnet Plant	1km SSW of Mount Garnet	Operating copper and polymetallic plants	67 333t Cu, 185 125t Zn, 33 525t Pb, 707.2kg Au, 80 720kg Ag (2005–2010)	Not applicable	Not applicable	Currently processes ore from Mount Garnet, Balcooma and Mungana; has treated Surveyor and Dry River South ore in past. Held under Mining Leases by Kagara Ltd.
	Thalanga Plant	12km ENE of Homestead	Operating polymetallic plant	43403t Cu (2006–2009)	Not applicable	Not applicable	Currently processes ore from Vomacka (Thalanga); has treated Balcooma ore in past. Held under Mining Leases by Kagara Ltd.
	Balcooma	33km NW of Greenvale	Operating mine	Production included in Mount Garnet Plant and Thalanga Plant figures	Balcooma Underground Copper – 1.63Mt at 2.83% Cu, 0.19% Zn, 0.1% Pb, 0.19g/t Au and 11.32g/t Ag for 46 152t Cu, 3077t Zn, 1557t Pb, 312kg Au and 18 430kg Ag. Balcooma Upper Lens Cu – 79 000t at 2.3% Cu, 1.1% Zn, 0.2% Pb, 0.2g/t Au and 7g/t Ag for 1817t Cu, 869t Zn, 158t Pb, 15kg Au and 553kg Ag Balcooma Lead Oxide – 58 600t at 11.9% Pb and 125g/t Ag for 6973t Pb and 7325kg Ag (Kagara Ltd, 2010)	Balcooma Metavolcanic Group/ Thalanga Province	Volcanogenic massive sulphide deposit in schist and meta-pelite. Held under Mining Leases by Kagara Ltd
	Dry River South	13.5km SSW of Conjuboy Homestead	Care and maintenance	Production included in Mount Garnet Plant figures	730 300t at 0.95% Cu, 6.9% Zn, 2.5% Pb, 0.64g/t Au and 62.1g/t Ag for 6445t Cu, 50 309t Zn, 18 347t Pb, 469kg Au and 45 356kg Ag (Kagara Ltd, 2010)	Balcooma Metavolcanic Group/ Thalanga Province	Volcanogenic massive sulphide deposit in greywacke and meta-volcanics. Held under Mining Leases by Kagara Ltd.
	Griffiths Hill	3km SE of Mungana	Abandoned mine, active prospect	213t Cu (1887–1919)	1.05Mt at 3.06% Cu, 0.62g/t Au and 64g/t Ag for 32130t Cu, 651kg Au and 67 200kg Ag (Kagara Ltd, 2011)	Chillagoe Formation/ Hodgkinson Province	Skarn in limestone, porphyry and breccia. Held under Mining Lease by Mungana Pty Ltd.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Kagara North Queensland Operation (continued)	King Vol	24km NW of Mungana	Abandoned mine, active prospect	0.3t Cu, 369t Pb, 257kg Ag (1922–1925)	3.286Mt at 0.76% Cu, 12.9% Zn, 1% Pb and 40.2g/t Ag for 24 971t Cu, 423 164t Zn, 32 195t Pb and 132 079kg Ag (Kagara Ltd, 2010)	Chillagoe Formation/ Hodgkinson Province	Skarn in limestone and siliceous rocks. Held under Exploration Permit and Mining Lease application by Kagara Ltd.
	Liontown	41.9km SSW of Charters Towers	Abandoned mine, active prospect	93kg Au, 1678kg Ag, 528t Pb (1951–1961)	1.845Mt at 0.57% Cu, 7.5% Zn, 2.5% Pb, 0.4g/t Au and 28.3g/t Ag for 10 455t Cu, 137 620t Zn, 45 535t Pb, 736kg Au and 52 275kg Ag (Kagara Ltd, 2010)	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in greywacke, meta-volcanics and volcaniclastics. Held under Mining Lease by Kagara Ltd.
	Maitland Copper Prospect	61km SE of Einasleigh	Abandoned mine, active prospect	293t Cu, 0.034kg Au, 18.01kg Ag (1909–1944)	1.49Mt at 1.48% Cu and 0.02% Mo for 22 041t Cu and 294t Mo (Glengarry Resources Limited, 2008)	Einasleigh Metamorphics/ Etheridge Province	Shear-hosted Cu-Mo veins in schist and gneiss. Held under Exploration Permit by Kagara Ltd.
	Mount Garnet	1km SSW of Mount Garnet	Operating mine	12 799t Cu, 13 624t Zn, 29 500kg Ag (1901–1903, 2003). Production since 2005 is included in Mount Garnet Plant figures	1.273Mt at 6.5% Zn, 0.35% Cu, 0.08% Pb and 19.9g/t Ag for 82 527t Zn, 4498t Cu, 1088t Pb and 25 348kg Ag (Kagara Ltd, 2010)	Chillagoe Formation/ Hodgkinson Province	Skarn in limestone and arkose. Held under Mining Leases by Kagara Ltd.
	Mungana	140km W of Cairns	Operating mine	Production included in Mount Garnet Plant figures	Mungana Copper Orebody – 90 000t at 6.4% Cu, 0.8% Zn, 8.7% Pb, 1.83g/t Au and 713g/t Ag for 5760t Cu, 720t Zn, 7830t Pb, 164kg Au and 64 170kg Ag. Mungana Base Metal Orebody – 1.33Mt at 1.9% Cu, 11.6% Zn, 1.4% Pb, 0.99g/t Au and 141g/t Ag for 25 370t Cu, 154 670t Zn, 18 170t Pb, 1314kg Au and 187 110kg Ag (Kagara Ltd, 2010) Mungana Gold Orebody – 48.7Mt at 0.19% Cu, 0.7g/t Au and 13.3g/t Ag for 93 510t Cu, 34 148kg Au and 646 150kg Ag (Mungana Goldmines Ltd, 2011)	Chillagoe Formation/ Hodgkinson Province; unnamed porphyry/ Kennedy Province	Porphyry Cu-Mo-Au and base metal skarn deposits. Held under Mining Leases by Mungana Pty Ltd (Mungana Goldmines Ltd)
	Red Dome	140km W of Cairns	Abandoned mine, active prospect	36 059t Cu, 105 855kg Ag, 22 716kg Au (1986–1998)	69.2Mt at 0.24% Cu, 0.63g/t Au and 5.16g/t Ag for 164 060t Cu, 43 687kg Au and 356 770kg Ag (Mungana Goldmines Ltd, 2011)	Chillagoe Formation/ Hodgkinson Province	Porphyry Cu-Mo-Au and base metal skarn deposits. Held under Mining Leases by Mungana Pty Ltd (Mungana Goldmines Ltd).

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Kagara North Queensland Operation (continued)	Shannon	5.5km W of Chillagoe	Abandoned mine, active prospect	Not recorded	1.01Mt at 0.07% cassiterite, 20.2g/t Ag, 1.23% Cu, 0.53% Zn, 0.96g/t Au and 0.08% Bi for 707t cassiterite, 20 402kg Ag, 12 423t Cu, 5353t Zn, 970kg Au and 808t Bi (Verwoerd & Sargeant, 1971)	Chillagoe Formation/ Hodgkinson Province; Ruddygore Granodiorite/ Kennedy Province	Cu-Zn-Ag-Au-Bi-cassiterite skarn in marble, chert, ironstone and granodiorite. Held under Mining Lease by Mungana Pty Ltd (Mungana Gold Mines Ltd).
	Surveyor	34km NW of Greenvale	Care and maintenance	2720t Cu, 63 289t Zn, 22 291t Pb, 239kg Au, 42 071kg Ag (2003–2005)	119 000t at 11.4% Pb, 2.41g/t Au and 158g/t Ag for 13 566t Pb, 286kg Au and 18 802kg Ag (Kagara Ltd, 2010)	Balcooma Metavolcanic Group/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolitic tuff. Held under Mining Lease by Kagara Ltd.
	Thalanga	11.9km ENE of Homestead	Operating mine	194 900t Cu conc., 158 100t Pb conc., 624 000t Zn conc., 20 277t Cu, 878t Pb, 1998t Zn, 66.8kg Au bullion, 1195.8kg Ag (1991–2000)	Vomacka – 885 823t at 1.7% Cu, 4.6% Zn, 1.35% Pb, 0.46g/t Au and 44.3g/t Ag for 15 134t Cu, 40 847t Zn, 12 034t Pb, 404kg Au and 39 282kg Ag Orient – 266 000t at 0.95% Cu, 10.5% Zn, 3% Pb, 0.25g/t Au and 58.5g/t Ag for 2516t Cu, 27 893t Zn, 8002t Pb, 67kg Au and 15 566kg Ag West 45 – 532 000t at 0.5% Cu, 7.2% Zn, 3% Pb, 0.26g/t Au and 48g/t Ag for 2660t Cu, 38 304t Zn, 15 960t Pb, 138kg Au and 25 536kg Ag (Kagara Ltd, 2010)	Mount Windsor Volcanics, Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolite and volcaniclastics. Held under Mining Lease by Kagara Copper Pty Ltd.
	Victoria (and Victoria South)	3.5km NE of Mungana	Abandoned mine, active prospect	34t Cu, 29t Pb, 25.5kg Ag (1922–1923)	3.44Mt at 0.96% Cu, 5.1% Zn, 0.14g/t Au and 22.2g/t Ag for 33 160t Cu, 175 020t Zn, 489kg Au and 76 490kg Ag (Kagara Ltd, 2010)	Chillagoe Formation/ Hodgkinson Province	Skarn in limestone and basalt. Held under Exploration Permit by Mungana Pty Ltd.
	Waterloo	36.9km SSW of Charters Towers	Active prospect	Not mined	476 000t at 2.5% Cu, 13.5% Zn, 2% Pb, 1.42g/t Au and 67.3g/t Ag for 11 844t Cu, 64 104t Zn, 9324t Pb, 677kg Au and 32 036kg Ag (Kagara Ltd, 2010)	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolite, andesite and volcaniclastics. Held under Exploration Permit by Kagara Copper Pty Ltd.
	Zillmanton	4.5km W of Chillagoe	Abandoned mine, active prospect	1767t Cu, 370kg Ag (1899–1930)	0.26Mt at 2.7% Cu for 7020t Cu (Verwoerd & Sargeant, 1971)	Chillagoe Formation/ Hodgkinson Province	Skarn in marble, chert, ironstone and granodiorite. Held under Mining Lease by Mungana Pty Ltd.
Kalman		61km SE of Mount Isa	Active prospect, scoping study in progress	Not mined	60.8Mt at 0.32% Cu, 0.05% Mo, 1.19g/t Re and 0.15g/t Au for 30 400t Mo, 194 700t Cu, 9120kg Au and 72 352kg Re (Kings Minerals NL, 2010)	Corella Formation/ Eastern Fold Belt Province	Shear zone-hosted Cu-Mo-Au-Re veins in calc-silicate rocks associated with the Pilgrim Fault Zone. Held under Exploration Permits by Cerro Resources NL (formerly Kings Minerals NL) and Syndicated Metals Ltd.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Lady Annie Copper Project	Lady Annie Copper Plant	115.4km NNW of Mount Isa	Operating plant	22 929t Cu (2007–2009)	Not applicable	Not applicable	Production from several deposits held under Mining Leases by CST Minerals Lady Annie Pty Ltd (CST Mining Group Ltd).
	Anthill	65.7km NW of Mount Isa	Active prospect	Not mined	5.61Mt at 0.76% Cu for 42 481t Cu (CST Mining Group Limited, 2010)	Paradise Creek Formation/ Sybella Domain	Brecciated sediment-hosted Cu in shale and dolomitic siltstone. Held under Exploration Permit by CST Minerals Lady Annie Pty Ltd (CST Mining Group Ltd).
	Flying Horse, Mount Kelly	99.3km NNW of Mount Isa	Operating mines	169.3t Cu (1930–1958, 1967–1968)	24.72Mt at 0.57% Cu for 140 874t Cu (CST Mining Group Limited, 2010)	Paradise Creek Formation/ Mount Oxide Domain	Brecciated sediment-hosted Cu in shale and dolomitic siltstone. Held under Mining Leases by CST Minerals Lady Annie Pty Ltd (CST Mining Group Ltd).
	Lady Annie, Lady Brenda	115.4km NNW of Mount Isa	Operating mines	1569.5t Cu (1937–1964)	24.76Mt at 0.91% Cu for 226 649t Cu (CST Mining Group Limited, 2010)	Paradise Creek Formation, Lady Loretta Formation/ Mount Oxide Domain	Brecciated sediment-hosted Cu in shale and dolomitic siltstone. Held under Mining Leases by CST Minerals Lady Annie Pty Ltd (CST Mining Group Ltd).
	McLeod Hill	94.2km NNW of Mount Isa	Abandoned mine, active prospect	58.2t Cu (1942–1957, 1969–1972)	1.42Mt at 0.49% Cu for 6999t Cu (CST Mining Group Limited, 2010)	Gunpowder Creek Formation/ Mount Oxide Domain	Brecciated sediment-hosted Cu in shale and dolomitic siltstone. Held under Mining Leases by CST Minerals Lady Annie Pty Ltd (CST Mining Group Ltd).
	Mount Clarke	99.3km NNW of Mount Isa	Operating mine	5.7t Cu (–1967)	8.29Mt at 0.48% Cu for 39 936t Cu (CST Mining Group Limited, 2010)	Paradise Creek Formation/ Mount Oxide Domain	Brecciated sediment-hosted Cu in shale and dolomitic siltstone. Held under Mining Leases by CST Minerals Lady Annie Pty Ltd (CST Mining Group Ltd).
	Swagman	97.9km NNW of Mount Isa	Active prospect	Not mined	0.33Mt at 0.6% Cu for 1965t Cu (CST Mining Group Limited, 2010)	Paradise Creek Formation/ Mount Oxide Domain	Brecciated sediment-hosted Cu in shale and dolomitic siltstone. Held under Mining Lease by CST Minerals Lady Annie Pty Ltd (CST Mining Group Ltd).
Lady Ella		48km NNE of Chatsworth	Abandoned mine, active prospect	Not recorded	0.74Mt at 1.51% Cu and 1.26g/t Au for 11 164t Cu and 929kg Au (Selwyn Mines Limited, 2002)	Hampden Slate/ Kuridala-Selwyn Domain	Breccia-hosted Cu deposit in breccia, schist and metadolerite. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
Lady Ethleen		54.1km ESE of Mount Isa	Abandoned mine, active prospect	60.5t Cu, 0.044kg Au, 493t silica (1906–1959, 1978, 1980)	123 546t at 1.52% Cu for 1878t Cu (Janecek, 1967)	Argylla Formation/ Mary Kathleen Domain	Shear-hosted veins in rhyolite, schist, siltstone and rhyodacite. Held under Mining Lease by Cape Lambert Leichhardt Pty Ltd.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Leichhardt (Mount Cuthbert) Copper Operation	Leichhardt Copper Plant	13km NW of Kajabbi	Care and maintenance	2759t Cu (1996–2001) Note: some production has been listed against individual mines.	Not applicable	Not applicable	Heap leach and SX-EW plant for satellite operation by Murchison United NL (1996–2000) and Matrix Metals Ltd (2000–2002, 2007–2008). Held under Mining Lease by Matrix Metals Ltd.
	Crusader	11.6km W of Coolullah Homestead	Abandoned mine	5041.8t Cu, 1.24kg Au (1915-1972, 1976–1977, 1997–1999)	Known resources mined out	Leichhardt Volcanics/ Mary Kathleen Domain	Shear-hosted veins in amphibolite, schist, rhyodacite and quartzite. Held under Mining Lease by Matrix Metals Ltd.
	Dobbyn	26.5km N of Kajabbi	Abandoned mine	7027t Cu, 10.6kg Au (1909–1933, 1999–2002)	Known resources mined out	Argylla Formation/ Mary Kathleen Domain	Shear-hosted veins in amphibolite, schist, rhyolite and quartzite. Held under Mining Lease by Matrix Metals Ltd.
	Hidden Treasure	36km NNW of Mount Cuthbert	Abandoned mine, active prospect	22.8t Cu (–1958, 1962–1968)	0.3Mt at 1.3% Cu for 4003t Cu (Matrix Metals Limited, 2008)	Surprise Creek Formation/ Kalkadoon-Leichhardt Domain	Brecciated sediment hosted Cu deposit in shale, tuff, siltstone and sandstone. Held under Mining Lease by Matrix Metals Ltd.
	Kalkadoon	0.8km N of Mount Cuthbert	Abandoned mine	3865.8t Cu, 1.2kg Au (–1936, 1971)	Not calculated	Leichhardt Volcanics/ Kalkadoon-Leichhardt Domain	Shear-hosted veins in amphibolite, schist, limestone and volcanics. Held under Mining Lease by Matrix Metals Ltd.
	Leichhardt	37.1km SSE of Gereta Homestead	Active prospect	Not mined	1.135Mt at 0.98% Cu for 11 109t Cu (Matrix Metals Limited, 2008)	Ballara Quartzite, Corella Formation/ Mary Kathleen Domain	Shear-hosted veins in amphibolite, quartzite, dolomite, shale and calc-silicate rocks. Held under Mining Lease by Matrix Metals Ltd.
	Little Wonder	10.2km NE of Mount Cuthbert	Abandoned mine, active prospect	214.5t Cu, 0.4kg Au (1903–1959, 1969)	0.126Mt at 1.5% Cu for 1890t Cu (Matrix Metals Limited, 2008)	Corella Formation/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in schist and quartzite. Held under Mining Lease by Matrix Metals Ltd.
	Mighty Atom	9.2km NE of Mount Cuthbert	Abandoned mine, active prospect	1184t Cu, 1kg Au (1913–1958, 1968–1972)	0.319Mt at 1.1% Cu for 3509t Cu (Matrix Metals Limited, 2008)	Argylla Formation, Corella Formation/ Mary Kathleen Domain	Shear-hosted veins in siltstone, schist, marble and dacite. Held under Mining Lease by Matrix Metals Ltd.
	Mount Cuthbert	90km NW of Cloncurry	Abandoned mine, active prospect	4393t Cu, 4.9kg Au (–1958)	64 000t at 1.9 % Cu for 1216t Cu (Matrix Metals Limited, 2008)	Leichhardt Volcanics/ Kalkadoon-Leichhardt Domain	Shear-hosted veins in shale, schist, phyllite and dacite. Held under Mining Lease by Matrix Metals Ltd.
	Mount Millicent	8.6km ENE of Mount Cuthbert	Abandoned mine, active prospect	2.4t Cu, 0.02kg Au (1936)	0.231Mt at 1% Cu for 2310t Cu (Matrix Metals Limited, 2008)	Argylla Formation / Mary Kathleen Domain	Shear-hosted veins in schist and quartzite. Held under Mining Lease by Matrix Metals Ltd.
	Mount Watson	24.3km N of Mount Cuthbert	Care and maintenance	4656.3t Cu (1966, 2007–2008)	8.086Mt at 0.9% Cu for 72 382t Cu (Matrix Metals Limited, 2008)	Surprise Creek Formation/ Kalkadoon-Leichhardt Domain	Brecciated sediment hosted Cu deposit in shale, dolomite, siltstone and quartzite. Held under Mining Lease by Matrix Metals Ltd.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Leichhardt (Mount Cuthbert) Copper Operation (continued)	Ned Kelly	14.6km E of Gereta Homestead	Abandoned mine, active prospect	Not recorded	95 000t at 1% Cu for 950t Cu (Matrix Metals Limited, 2008)	Argylla Formation / Mary Kathleen Domain	Brecciated sediment hosted Cu deposit in shale, siltstone and sandstone. Held under Mining Lease by Matrix Metals Ltd.
	Orphan	27km N of Kajabbi	Abandoned mine	4308.8t Cu, 18.7kg Au, 51.1kg Ag (1915–1945, 1974–1976, 2000–2002)	Known resources mined out	Leichhardt Volcanics/ Mary Kathleen Domain	Shear-hosted veins in schist, amphibolite and rhyodacite. Held under Mining Lease by Matrix Metals Ltd.
	Warwick Castle	9.3km NNW of Mount Cuthbert	Abandoned mine	2694t Cu, 0.35kg Au (–1958, 1974–1979, 1996–1999)	Known resources mined out	Leichhardt Volcanics, Kalkadoon Granodiorite/ Kalkadoon-Leichhardt Domain	Shear-hosted veins in schist and granite. Held under Mining Lease by Matrix Metals Ltd.
Lillimay		45.5km S of Gereta Homestead	Abandoned mine	524.4t Cu (1953–1957, 1967–1975)	Not calculated	Leichhardt Volcanics/ Kalkadoon-Leichhardt Domain	Shear-hosted veins in schist, dacite, amphibolite and rhyolite. Held under Exploration Permit by Syndicated Metals Ltd.
Limelight		23.6km ENE of Mount Isa	Abandoned mine	166.6t Cu, 659t limestone (1957, 1971)	178 000t at 2.25% Cu for 3998t Cu (Stuart, 1996)	Kalkadoon-Leichhardt Domain	Shear-hosted veins in dolomite, schist and metadolerite. Under Exploration Permit application by Syndicated Metals Ltd.
Magnet		13.8km NW of Quamby	Abandoned mine	735.9t Cu, 6.55kg Au (1906–1940)	Not calculated	Boomarra Metamorphics/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in schist and quartzite. Held under Exploration Permit by Roseby Copper Pty Ltd and Altona Mining Ltd.
Magpie		28.9km SSW of Ravenswood	Inactive prospect	Not mined	250 000t at 1.2% Cu, 8.3% Zn, 1.7% Pb, 0.2g/t Au and 37g/t Ag for 3000t Cu, 20 750t Zn, 4250t Pb, 50kg Au and 9250kg Ag (Dronseika, 1995)	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in volcaniclastics. Held under Mining Lease by Thalanga Copper Mines Pty Ltd and BML Holdings Pty Ltd.
Many Peaks		70km SW of Gladstone	Abandoned mine, active prospect	8648.2t Cu, 130.5kg Au (1909–1924)	Not calculated	Calliope beds/ Calliope Subprovince	Shear-hosted veins in sediments. Held under Mining Lease by Australian Geoscientists No2 Pty Ltd.
Merlin (including Little Wizard)		147km SE of Mount Isa	Active prospect, scoping study in progress	Not mined	Merlin – 6.7Mt at 1.32% Mo, 23.05g/t Re, 8.28g/t Ag, 0.33% Cu, 0.13% Zn, 0.02% Pb, 0.01% Co and 0.08g/t Au for 88 800t Mo, 154 470kg Re, 55 590kg Ag, 22 330t Cu, 9580t Zn, 1340t Pb, 544t Co and 546kg Au Little Wizard - 15 999t at 6.49% Mo, 83.9g/t Re, 25g/t Ag, 2.29% Cu, 0.63g/t Au and 0.01% Pb for 973t Mo, 1258kg Re, 375kg Ag, 343t Cu, 9kg Au and 1t Pb (Ivanhoe Australia Limited, 2010a)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted breccia in metasediments along Mount Dore Fault Zone. Held under mining leases by Ivanhoe Australia Ltd. Construction of an access decline commenced in the second half of 2010. Underground mine, molybdenum concentrator and roaster are planned, with production to commence in 2012

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Monakoff		20.8km ENE of Cloncurry	Abandoned mine, active prospect	466.6t Cu, 0.37kg Au (–1958, 1997–1998)	4Mt at 1.35% Cu and 0.42g/t Au for 53 800t Cu and 1680kg Au (Exco Resources Limited, 2010)	Mount Norna Quartzite/ Soldiers Cap Domain	Iron oxide-Cu-Au deposit in siltstone, amphibolite and shale. Held under Mining Lease by Great Australian Operations Pty Ltd (Exco Resources Ltd) but recently sold to Xstrata Copper.
Mount Cannindah	Monument	80km SW of Gladstone	Active prospect	Not mined	8.022Mt at 0.4% Cu and 0.02% Mo for 32 088t Cu and 1243t Mo (Queensland Ores Limited, 2005)	Rockhampton Group/ Yarrol Province	Cu skarn in sandstone and siltstone near a Permo-Triassic granodiorite intrusion. Held under Mining Lease by Mount Cannindah Mining Pty Ltd (Planet Metals Ltd). Farm-in by Drummond Gold Ltd.
	Mount Cannindah	80km SW of Gladstone	Abandoned mine, active prospect	1030t Cu, 933.1kg Au (1906–1907, 1916–1918, 1947–1965)	7.43Mt at 0.98% Cu, 0.38g/t Au and 15.5g/t Ag for 72 815t Cu, 2841kg Au and 115 160kg Ag (Queensland Ores Limited, 2008)	Rockhampton Group/ Rockhampton Subprovince; “The Monument intrusive”/ Permo-Triassic Igneous Provinces	Porphyry Cu–Mo–Au deposit in mudstone, granite, granodiorite and diorite. Held under Mining Lease by Mount Cannindah Mining Pty Ltd (Planet Metals Ltd). Farm-in by Drummond Gold Ltd.
	United Allies	80km SW of Gladstone	Abandoned mine, active prospect	2t Cu (1896)	1.974Mt at 0.5% Cu and 0.02% Mo for 9870t Cu and 388t Mo (Queensland Ores Limited, 2005)	Rockhampton Group/ Rockhampton Subprovince	Porphyry Cu–Mo–Au deposit in sandstone. Held under Mining Lease by Mount Cannindah Mining Pty Ltd (Planet Metals Ltd). Farm-in by Drummond Gold Ltd.
Mount Carlton	Mount Carlton – Main Hill	44.3km NW of Collinsville	Active prospect, mining development	Not mined	0.966Mt at 0.35% Cu, 1.35g/t Au and 38g/t Ag for 3332t Cu, 1304kg Au and 36 708kg Ag (Conquest Mining Limited, 2009)	Lizzie Creek Volcanics/ Bowen Basin	High sulphidation epithermal quartz vein stockwork in rhyodacite and volcaniclastics. Held under Exploration Permit and Mining Lease application by Conquest Mining Ltd.
	Silver Hill	44km NW of Collinsville	Active prospect, mining development	Not mined	25.8Mt at 0.28% Cu, 1.65g/t Au and 44g/t Ag for 71 520t Cu, 42 717kg Au and 1 152 000kg Ag (Conquest Mining Limited, 2010)	Lizzie Creek Volcanics/ Bowen Basin	High sulphidation epithermal quartz vein stockwork in rhyodacite, breccia and volcaniclastics. Held under Exploration Permit and Mining Lease application by Conquest Mining Ltd.
Mount Chalmers		80km NW of Gladstone	Abandoned mine, active prospect	22 624t Cu, 19 021t Pb, 7099t Zn, 3619.9kg Au, 21 751.3kg Ag (1860–1982)	3.55Mt at 1.26% Cu, 0.4% Zn, 0.16% Pb, 0.85g/t Au and 8.5g/t Ag for 44 610t Cu, 14 400t Zn, 5760t Pb, 3014kg Au and 30 140kg Ag (Echo Resources Limited, 2006)	Chalmers Formation/ Berserker Subprovince	Volcanogenic massive sulphide deposit in sandstone, dolomite and volcaniclastics. Held under Mining Lease by Affinis Pty Ltd (Echo Resource Ltd).
Mount Cobalt		33km NE of Chatsworth Homestead	Abandoned mine, active prospect	536t Cu concentrate, 291.5t Co (1919–1943, 1996–1997)	Not calculated	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted veins and breccia in schist and quartzite. Held under Mining Leases by Mount Cobalt Mining Pty Ltd and Ivanhoe Australia Ltd.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount Dore		147km SE of Mount Isa	Active prospect, scoping study in progress	6t Cu (1936)	Copper zone with 144.4Mt at 0.52% Cu, 0.01% Mo, 0.1g/t Re, 0.1g/t Au, 5.94g/t Ag, 0.30% Zn, 0.05% Pb and 0.01% Co for 747 880t Cu, 14 440t Mo, 14 440kg Re, 14 154kg Au, 857 960kg Ag, 433 410t Zn, 75 130t Pb and 11 497t Co (Ivanhoe Australia Limited, 2010a)	Kuridala Formation/ Quamby–Malbon Subprovince	Shear zone hosted breccia in metasediments along Mount Dore Fault Zone. Held under mining leases by Ivanhoe Australia Ltd. Heap-leach SX-EW processing planned for oxide ore.
Mount Elliott/Swan		16km N of Selwyn mine	Care and maintenance, active prospect	144 893.4t Cu, 6690.3kg Au bullion (1907–1920, 1993–2001)	570Mt at 0.44% Cu and 0.26g/t Au for 2 532 000t Cu and 146 400kg Au (Ivanhoe Australia Limited, 2010b)	Hampden Slate/ Kuridala-Selwyn Domain	Iron oxide-Cu-Au deposit in phyllite, schist, siltstone, quartzite, amphibolite, marble and calc-silicate granofels. Held under Mining Lease by Ivanhoe Australia Ltd.
Mount Gordon (Gunpowder)	Esperanza	115km N of Mount Isa	Abandoned mine, active prospect	243 889.4t Cu, 19 431t Cu conc., 2311.9kg Ag (1997–2005)	Known resources mined out	Esperanza Formation/ Leichhardt River Domain	Brecciated sediment hosted Cu deposit in shale, siltstone and chert. Held under Mining Lease by Birla Mt Gordon Pty Ltd (Aditya Birla Minerals Ltd).
	Esperanza South	115km N of Mount Isa	Abandoned mine, active prospect	0.9t Cu (1967)	Resources included with those for Mammoth.	Esperanza Formation/ Leichhardt River Domain	Brecciated sediment hosted Cu deposit in shale, siltstone and chert. Held under Mining Lease by Birla Mt Gordon Pty Ltd (Aditya Birla Minerals Ltd).
	Mammoth	115km N of Mount Isa	Operating mine	211 167t Cu, 2270t Cu conc., 5461.2kg Ag (1927–1959, 1969-1982, 1989–1998, 2003–2010)	22.1Mt at 2.49% Cu for 550 700t Cu (Aditya Birla Minerals Limited, 2010)	Whitworth Quartzite/ Leichhardt River Domain	Brecciated sediment hosted Cu deposit in quartzite, siltstone and sandstone. Held under Mining Lease by Birla Mt Gordon Pty Ltd (Aditya Birla Minerals Ltd).
Mount Hope		59km SE of Mount Isa	Abandoned mine	595t Cu, 0.11kg Au, 309 175t silica (1906–1958, 1963–1973)	Not calculated	Magna Lynn Metabasalt, Bushy Park Gneiss, Argylla Formation/ Mary Kathleen Domain	Shear-hosted Cu-quartz vein in amphibolite, gneiss, schist and rhyolite. Held under Mining Leases by I Foschi.
Mount Isa Copper		1.3km W of Mount Isa	Operating mine	7 267 665t Cu, 12 585t Co, 202 649kg Ag, 90t Sb (1942–2010)	483Mt at 1.48% Cu for 7 158 000t Cu (Xstrata Plc, 2010)	Urquhart Shale/ Leichhardt River Domain	Brecciated sediment hosted Cu deposit in shale and dolomite. Held under Mining Lease by Mount Isa Mines Ltd (Xstrata Plc).
Mount Isa Silver-lead-zinc		1.3km W of Mount Isa	Operating mine	8215t Cu, 18 654 240kg Ag, 7 757 899t Pb, 8 064 48t Zn, 2652t Sb, 5030t Cd, 318t Co, 730 769t S (1931–2010)	Copper resources not reported	Urquhart Shale/ Leichhardt River Domain	Mount Isa style sediment-hosted Ag-Pb-Zn deposit. Held under Mining Lease by Mount Isa Mines Ltd (Xstrata Plc).

Table 12 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount Kroombit	11km SE of Kroombit Dam	Abandoned mine, active prospect, scoping study	Not recorded	Copper ore – 0.857Mt at 1.04% Cu for 8891t Cu. Zinc ore – 5.159Mt at 0.15% Cu and 1.88% Zn for 7931t Cu and 96 849t Zn (Argonaut Resources NL, 2009)	Marble Waterhole beds/ Kroombit Subprovince	Skarn in limestone, mudstone and andesite. Held under Mining Lease by Kelaray Pty Ltd (Argonaut Resources NL).
Mount Mascotte	20km N of Duchess	Abandoned mine, active prospect	900t Cu, 7.72kg Au (1914–1928, 1967–1970)	Not calculated	Corella Formation/ Mary Kathleen Domain	Shear-hosted Cu-quartz vein in amphibolite, gneiss and aplite. Held under Mining Lease byMt Dockerell Mining Pty Ltd and Syndicated Metals Ltd.
Mount McNamara	25.8km SSW of Cloncurry	Abandoned mine, active prospect	625.6t Cu, 4.26kg Au (1915–1958, 1969, 1980)	Not calculated	Answer Slate/ Marimo-Staveley Domain	Shear-hosted Cu-quartz vein in shale, siltstone and slate. Held under Mining Lease by North Queensland Mines Pty Ltd (Conquest Mining Ltd).
Mount Molloy	3km S of Mount Molloy	Abandoned mine, active prospect	3863t Cu (1903–1941)	Not calculated	Hodgkinson Formation/ Hodgkinson Province	Volcanogenic massive sulphide deposit in shale, siltstone, greywacke, chert, basalt and breccia. Held under Mining Lease by Ozmin Resources Pty Ltd (Axiom Mining Ltd).
Mount Morgan	36km SW of Rockhampton	Abandoned mine, active prospect, feasibility study completed	360 616t Cu, 215 268kg Au bullion, 78 788kg Au, 36 842kg Ag, 568 000t pyrite (1884–1990)	Mullock – 0.345Mt at 1.85g/t Au for 638kg Au. Slag – 6Mt at 0.34% Cu and 1g/t Au for 20 400t Cu and 6000kg Au (Norton Gold Fields Limited 2007). Tailings – 8.348Mt at 1.23g/t Au for 0 237kg Au (Norton Gold Fields Limited, 2009).	Mount Warner Volcanics/ Mount Morgan Subprovince	Volcanogenic massive sulphide deposit in tuff, limestone and volcaniclastics. Held under Mining Lease by Norton Gold Fields Ltd.
Mount Moss	100km W of Townsville	Operating mine	90 741t magnetite (2008–2010)	20Mt at 41% Fe, 0.35% Cu and 0.35% Zn for 8.2Mt Fe, 70 000t Cu and 70 000t Zn (Geological Survey of Queensland, 2011)	Perry Creek Formation/ Camel Creek Subprovince	Magnetite-base metal skarn.Mt Moss Mining Pty Ltd produces magnetite for steel production and coal washing.
Mount Norma	30.7km SE of Cloncurry	Care and maintenance, active prospect	651.5t Cu, 1596t copper sulphate precipitate, 315.5kg Ag (1906–1907, 1932–1948, 1968–1979, 2004–2008)	1.6Mt at 4 % Cu for 64 000t Cu (sourced from CuDeco Limited website, 2006)	Mount Norna Quartzite/ Soldiers Cap Domain	Shear-hosted Cu-quartz vein in quartzite, siltstone, schist and slate. Held under Mining Lease byMt Norma Mining Company Pty Ltd. (Queensland Mining Corporation Ltd).
Mount Oxide	125km N of Mount Isa	Abandoned mine, active prospect, feasibility study	22 816t Cu, 4.5kg Au, 893.4kg Ag (1927–1960, 1967–1982)	15.9Mt at 1.42% Cu and 8.3g/t Ag for 225 600t Cu and 131 520kg Ag (Perilya Limited, 2011)	Gunpowder Creek Formation/ Lawn Hill Subprovince	Brecciated sediment hosted Cu deposit in shale and sandstone. Held under Exploration Permit by Mount Oxide Pty Ltd (Perilya Ltd).

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount Perry	Mount Perry Copper Lode	1km SW of Mount Perry	Abandoned mine	9213.5t Cu, 33.7kg Au, 4845.4kg Ag (1873–1884, 1902–1917)	Not calculated	Tenningering Granodiorite/ South East Queensland Volcanic and Plutonic Province	Porphyry intrusion related shear-hosted Cu-quartz veins in granodiorite and diorite. Held under Mining Lease by Belanda Pty Ltd.
	Normanby Copper Lode	1.1km WSW of Mount Perry	Abandoned mine	1560.3t Cu, 67.2kg Au, 2169.7kg Ag (1906–1909, 1917–1919)	Not calculated	Tenningering Granodiorite/ South East Queensland Volcanic and Plutonic Province	Porphyry intrusion related shear-hosted Cu-quartz veins in granodiorite and diorite. Held under Mineral Development Licence by Belanda Pty Ltd.
Osborne Operation	Inheritance	94km SSE of Mount Isa	Care and maintenance	39 142t Cu, 996.5kg Au (1900–1058, 2006–2010)	Confidential	Corella Formation/ Mary Kathleen Domain	Shear-hosted veins in schist and granofels. Held under Mining Lease by Barrick (Osborne) Pty Ltd (Ivanhoe Australia Ltd).
	Osborne	32km ESE of Chatsworth Homestead	Care and maintenance	536 570t Cu, 19 628.4kg Au, Bullion (1995–2010)	6.818Mt at 1.42% Cu and 0.84g/t Au for 96 578t Cu and 5755kg Au (Ivanhoe Australia Limited, 2010c)	Starcross Formation/ Kuridala-Selwyn Domain	Iron oxide-Cu-Au deposit in ironstone and schist. Held under Mining Lease by Ivanhoe (Osborne) Pty Ltd (Ivanhoe Australia Ltd).
Overlander		35km N of Duchess	Abandoned mine, active prospect	45t Cu (1966–1970)	80 000t at 2.27% Cu for 1816t Cu (Janecek & Goninon, 1967)	Corella Formation/ Mary Kathleen Domain	Shear-hosted veins in meta-rhyolite. Held under Exploration Permit byMt Dockerell Mining Pty Ltd (Cerro Resources NL).
Peak Downs		6km SW of Clermont	Abandoned mine, active prospect	17 000t Cu (1863–1877)	6.8Mt at 0.42% Cu for 28 840t Cu (Jerkovic, 1999)	Bathampton Metamorphics/ Anakie Orogen	Volcanogenic massive sulphide deposit in metasediments and metavolcanics. Held under Exploration Permit by Chalcophile Resources Pty Ltd (Diatreme Resources Ltd).
Phyllis May		25.7km E of Forest Home Homestead	Inactive prospect	Not mined	100Mt at 0.05% Cu for 5000t Cu (Lacy, 1980)	Forsayth Granite/ Etheridge Province	Porphyry Cu-Mo deposit in granite. Under Exploration Permit application by Queensland Uranium Pty Ltd.
Pinevale		15km S of Mirani	Abandoned mine, active prospect	250t Cu, 0.72kg Au, 263kg Ag (1889–1957)	26 695t at 6.8% Cu, 0.6g/t Au and 117g/t Ag for 1815t Cu, 16kg Au and 3123kg Ag (Axiom Mining Limited, 2006)	Ben Mohr Igneous Complex/ Jurassic-Cretaceous Igneous Provinces	Porphyry-related Cu-Mo-Au quartz vein stockwork in quartz monzonite. Held under Mining Lease by Ozmin Resources Pty Ltd (Axiom Mining Ltd).
Rebound		46km W of Cloncurry	Active prospect	Not mined	0.736Mt at 7.67% Cu and 1.02g/t Au for 56 451t Cu and 750kg Au (Seymour, 2001)	Corella Formation/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in quartzite. Held under Exploration Permit by Mosquito Resources (Australia) Pty Ltd.
Referee		59km NE of Mount Isa	Abandoned mine, active prospect	691.5t Cu, 16.1kg Au, 0.4kg Ag (1905–1972)	Not calculated	Kalkadoon Granodiorite/ Kalkadoon-Leichhardt Domain	Shear-hosted Cu-Au-quartz veins in schist and granite. Held under Exploration Permit by Syndicated Metals Ltd.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Roberts Creek Prospect		42.1km SE of Cloncurry	Active prospect	Not mined	82 000t at 1.06% Cu and 2.42g/t Au for 869t Cu and 198kg Au (sourced from Breakaway Resources Ltd website, 1997)	Mount Norna Quartzite/ Soldiers Cap Domain	Shear-hosted Cu-Au-quartz veins in schist, shale and quartzite. Held under Exploration Permit by Levuka Resources Pty Ltd (Breakaway Resources Ltd).
Rocklands Project (Las Minerale)		15km W of Cloncurry	Active prospect (feasibility study completed)	Not mined	41Mt at 0.76% Cu, 0.03% Co and 0.11g/t Au for 312 700t Cu, 13 580t Co and 4580kg Au (CuDeco Limited, 2010a)	Mitakoodi Quartzite/ Quamby-Malbon Subprovince	Shear zone hosted veins and breccia in siltstone, quartzite, dolerite and calc-silicate rocks. Held under Mining Lease and Exploration Permit by CuDeco Limited.
Rosebud		51.6km SSE of Mount Isa	Abandoned mine, active prospect	1889.4t Cu, 27.7kg Au (1915–1917, –1942, 1955–1957, 1966–1970)	Not calculated	Unnamed metadolerite/ Mary Kathleen Domain	Shear-hosted Cu-Au-calcite veins in amphibolite. Held under Mining Lease by Cape Lambert Leichhardt Pty Ltd.
Roseby Copper Project	Bedford North	22.7km NNW of Quamby	Abandoned mine, active prospect (feasibility study completed)	22.5t Cu (1938–1974)	1.07Mt at 1% Cu and 0.25g/t Au for 10 700t Cu and 267kg Au (Universal Resources Limited, 2010)	Boomarra Metamorphics/ Mary Kathleen Domain	Shear-hosted Cu-Au-quartz veins in schist, amphibolite and calc-silicate rocks. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Bedford South	21.3km NNW of Quamby	Abandoned mine, active prospect (feasibility study completed)	Not recorded	0.7Mt at 0.83% Cu and 0.24g/t Au for 5810t Cu and 168kg Au (Universal Resources Limited, 2010)	Boomarra Metamorphics/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in schist, amphibolite and calc-silicate rocks. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Blackard	22.5km NW of Quamby	Active prospect (feasibility study completed)	Not mined	46.25Mt at 0.63% Cu and 0.01g/t Au for 292 959t Cu and 460kg Au (Universal Resources Limited, 2010)	Mount Roseby Schist/ Mary Kathleen Domain	Disseminated native Cu and Cu-Au-quartz veining in deeply weathered schist and calc-silicate rocks; stratabound primary sulphide mineralisation. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Caroline	15.5km WNW of Quamby	Abandoned mine, active prospect (feasibility study completed)	7.11t Cu ore (unknown period)	3.6Mt at 0.53% Cu and 0.02g/t Au for 19 080t Cu and 72kg Au (Universal Resources Limited, 2010)	Mount Roseby Schist/ Mary Kathleen Domain	Disseminated native Cu and Cu-Au-quartz veining in deeply weathered schist and calc-silicate rocks; stratabound primary sulphide mineralisation. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Charlie Brown	20.6km NW of Quamby	Abandoned mine, active prospect (feasibility study completed)	Not recorded	0.7Mt at 0.4% Cu and 0.01g/t Au for 2800t Cu and 7kg Au (Universal Resources Limited, 2010)	Mount Roseby Schist/ Mary Kathleen Domain	Disseminated native Cu and Cu-Au-quartz veining in deeply weathered schist and calc-silicate rocks; stratabound primary sulphide mineralisation. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Roseby Copper Project (continued)	Great Southern	19.3km NW of Quamby	Abandoned mine, active prospect (feasibility study completed)	Not recorded	6.0Mt at 0.61% Cu and 0.01g/t Au for 36 600t Cu and 60kg Au (Universal Resources Limited, 2010)	Mount Roseby Schist/ Mary Kathleen Domain	Disseminated native Cu in deeply weathered schist and metasediments; stratabound primary sulphide mineralisation. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Ivy Ann	5.6km S of Quamby	Abandoned mine, active prospect (feasibility study completed)	Not recorded	4.0Mt at 0.72% Cu and 0.12g/t Au for 28 800t Cu and 480kg Au (Universal Resources Limited, 2010)	Corella Formation/ Canobie Domain	Iron oxide-Cu-Au deposit in metasediments and calc-silicate rocks. Held under Exploration Permit by Altona Mining Ltd.
	Ken Brown	15.2km NW of Quamby	Active prospect	Not mined	4.0Mt at 0.8% Cu for 32 000t Cu (Universal Resources Limited, 2004)	Mount Roseby Schist/ Mary Kathleen Domain	Disseminated native Cu in deeply weathered schist and limestone; stratabound primary sulphide mineralisation. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Lady Clayre	16.4km WNW of Quamby	Abandoned mine, active prospect (feasibility study completed)	25.7t Cu, 1.49kg Ag (–1908, 1969)	3.7Mt at 0.88% Cu and 0.5g/t Au for 32 712t Cu and 1858kg Au (Universal Resources Limited, 2010)	Coocerina Formation/ Mary Kathleen Domain	Shear-hosted Cu-Au-quartz veins and stratabound lenses in shale, dolomite and quartzite. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Legend	25.4km NW of Quamby	Active prospect (feasibility study completed)	Not mined	6.13Mt at 0.6% Cu and 0.01g/t Au for 36 780t Cu and 61kg Au (Universal Resources Limited, 2010)	Mount Roseby Schist/ Mary Kathleen Domain	Disseminated native Cu in deeply weathered schist and metasediments; stratabound primary sulphide mineralisation. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Little Eva	28.9km NNW of Quamby	Abandoned mine, active prospect (feasibility study completed)	28.5t Cu, 0.22kg Au (–1958, 1961)	26.53Mt at 0.75% Cu and 0.13g/t Au for 198 231t Cu and 3523kg Au (Universal Resources Limited, 2010)	Corella Formation/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in schist and calc-silicate rocks. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Longamundi	17.2km NW of Quamby	Abandoned mine, active prospect (feasibility study completed)	6.1t Cu (1906)	10.4Mt at 0.66% Cu and 0.01g/t Au for 68 640t Cu and 104kg Au (Universal Resources Limited, 2010)	Mount Roseby Schist/ Mary Kathleen Domain	Disseminated native Cu in deeply weathered schist, metasediments and calc-silicate rocks; stratabound primary sulphide mineralisation. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Scanlan	15.7km WNW of Quamby	Active prospect (feasibility study completed)	Not mined	19.61Mt at 0.68% Cu and 0.01g/t Au for 133 825t Cu and 195kg Au (Universal Resources Limited, 2010)	Mount Roseby Schist/ Mary Kathleen Domain	Disseminated native Cu in deeply weathered schist; stratabound primary sulphide mineralisation. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Ruddygore		3km NE of Chillagoe	Abandoned mine, active prospect	1450t Cu (1896–1930)	10Mt at 0.4% Cu for 40 000t Cu (Lacy, 1980)	Ruddygore Granodiorite/ Kennedy Province	Porphyry Cu-Sn deposit in monzonite and granodiorite. Held under Exploration Permit by MFG Pty Ltd (Australian Gold Corporation).
Saint Mungo		35km E of Dajarra	Abandoned mine	1561t Cu (1910–1918)	Not calculated	Saint Mungo Granite/ Mary Kathleen Domain	Shear-hosted Cu-Au-quartz veins in granite, amphibolite and schist. No current tenure.
Selwyn (Starra) line	Selwyn Plant	37km NNE of Chatsworth Homestead	Care and maintenance	25 500.4t Cu, 946.1kg Au (1999-2003) — production not attributable to individual deposits.	Not applicable	Not applicable	Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
	Starra 222	34km NNE of Chatsworth Homestead	Abandoned mine, active prospect	21 000t Cu, 8646kg Au (1988–1998)	12.6Mt at 0.62% Cu and 0.83g/t Au for 78 300t Cu and 10 410kg Au (Ivanhoe Australia Limited, 2009)	Staveley Formation/ Marimo-Staveley Domain	Iron oxide-Cu-Au deposit in ironstone, arenite, schist and calc-silicate rocks. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
	Starra 244	37km NNE of Chatsworth Homestead	Abandoned mine, active prospect	4000t Cu, 2613kg Au (1988–1998)	Mined out	Staveley Formation/ Marimo-Staveley Domain	Iron oxide-Cu-Au deposit in ironstone, arenite, schist and calc-silicate rocks. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
Selwyn (Starra) line (continued)	Starra 251	37km NNE of Chatsworth Homestead	Abandoned mine, active prospect	104 000t Cu, 13 499kg Au (1987–1994)	Mined out	Staveley Formation/ Marimo-Staveley Domain	Iron oxide-Cu-Au deposit in ironstone, arenite, schist and calc-silicate rocks. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
	Starra 257	38km NNE of Chatsworth Homestead	Abandoned mine, active prospect	7000t Cu, 5195kg Au (1987–1998)	Mined out	Staveley Formation/ Marimo-Staveley Domain	Iron oxide-Cu-Au deposit in ironstone, arenite, schist and calc-silicate rocks. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
	Starra 276	39km NNE of Chatsworth Homestead	Abandoned mine, active prospect	7000t Cu, 1244kg Au (1997–1999)	17.7Mt at 1.13%Cu and 0.83g/t Au for 200 400t Cu and 14 740kg Au (Ivanhoe Australia Limited, 2009)	Staveley Formation/ Marimo-Staveley Domain	Iron oxide-Cu-Au deposit in ironstone, arenite, schist and calc-silicate rocks. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
Silver Spur		10.2km E of Texas	Abandoned mine, active prospect	990t Cu, 1050t Pb, 690t Zn, 140kg Au, 68 000kg Ag (1892–1976)	Ore – 0.808Mt at 0.17% Cu, 3.56% Zn, 1.25% Pb, 0.9g/t Au and 70g/t Ag for 1373t Cu, 28 764t Zn, 10 100t Pb, 727kg Au and 56 560kg Ag (Macmin Silver Ltd, 2008a). Slag – 90 000t at 0.34% Cu, 15.8% Zn, 3.17% Pb, 0.5g/t Au and 158g/t Ag for 306t Cu, 14 220t Zn, 2853t Pb, 45kg Au and 14 220kg Ag (Macmin Silver Ltd, 2004).	Silver Spur beds/ Texas Subprovince	Volcanogenic massive sulphide deposit in shale, siltstone and greywacke. Held under Mining Lease by Texas Silver Mines Pty Ltd (Alcyone Resources Ltd)

Table 12 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Silver Star (Munholme)	34km WNW of Many Peaks	Abandoned mine, active prospect	Not recorded	Barite lode – 0.167Mt at 0.6% Cu, 3.4% Zn, 1.3% Pb and 180g/t Ag for 1002t Cu, 5678t Zn, 2171t Pb and 30 060kg Ag. Amoeba – 0.105Mt at 2.8g/t Au for 294kg Au (Hall, 2001)	Munholme Quartz Diorite/ Permo-Triassic Igneous Provinces	Porphyry-related polymetallic veins in diorite. Held under Exploration Permit by Echo Resources Ltd.
Slate Ridge	36km N of Chatsworth Homestead	Active prospect	Not mined	0.5Mt at 2.53% Cu and 0.15g/t Au for 12 660t Cu and 744kg Au (Selwyn Mines Limited, 2002)	Answer Slate/ Marimo-Staveley Domain	Shear-hosted Cu-Au-quartz veins in siltstone and schist. Held under Exploration Permit by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
Split Rock	30km W of Mungana	Abandoned mine, active prospect	Not recorded	2Mt at 0.5% Cu for 10 000t Cu (Cyprus Mines Corporation, 1973)	Nundah Granodiorite	Porphyry Cu deposit in granite. Held under Exploration Permit by Ozmin Resources Pty Ltd (Axiom Mining Ltd).
Strathfield	63km NNE of Cannington mine	Active prospect	Not mined	0.49Mt at 1.3% Cu and 0.2g/t Au for 6370t Cu and 98kg Au (Exco Resources NL, 2000)	Soldiers Cap Group/ Cloncurry Subprovince	Shear-hosted Cu-Au veins in metasediments. Held under Exploration Permit by BHP Billiton Minerals Pty Ltd.
Surprise	22.9km SE of Gereta Homestead	Abandoned mine, active prospect	567t Cu, 8.23kg Au (1920–1992)	Not calculated	Corella Formation/ Mary Kathleen Domain	Shear-hosted Cu-Au veins in schist and granofels. Held under Exploration Permit by Gateway Mining Ltd.
Tally Ho	30km S of Mirani	Abandoned mine, active prospect	23t Pb (1908–1940)	0.733Mt at 0.1% Cu, 0.83% Zn, 0.09% Pb, 0.06g/t Au and 49g/t Ag for 733t Cu, 6083t Zn, 659t Pb, 43kg Au and 35 917kg Ag (Macmin Silver Ltd, 2008b)	Tally-Ho Igneous Complex/ Connors Subprovince	Porphyry-related polymetallic quartz vein stockwork in granite and granodiorite. Held under Mining Lease by Alcyone Resources Ltd.
Tartana	40km NW of Chillagoe	Operating mine	2958t copper sulphate pentahydrate (2004–2008)	1.7Mt at 1.1% Cu for 18 700t Cu (Martinson, 2006)	Chillagoe Formation/ Hodgkinson Province	Shear-hosted Cu veins in arenite and mudstone. Held under Mining Lease bym.E. Meyer (Solomons Copper).
Titree	4km SE of Chillagoe	Abandoned mine	400t Cu, 52.8kg Au, 564kg Ag (1901–1942)	Resources are confidential	Chillagoe Formation/ Hodgkinson Province; Almaden Granodiorite/ Kennedy Province	Skarn in marble and granite. Held under Mining Lease by R. de Lacey and S.V. Foster.
TPM	5.4km SSW of Mount Coolon	Active prospect	Not mined	0.319Mt at 1.17% Cu and 0.28g/t Au for 3732t Cu and 89kg Au (Weeks, 1992)	Anakie Metamorphic Group/ Anakie Orogen	Skarn in schist, quartzite and hornfels. Held under Exploration Permit byMt Coolon Gold Mines Pty Ltd (Drummond Gold Ltd).
Trekelano	14.3km S of Duchess	Abandoned mine, active prospect	20468t Cu, 368.9kg Au, 461.9t Ag (1913–1943, 1971)	Resources are confidential	Corella Formation/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in ironstone, amphibolite, schist and granofels. Held under Mining Lease by Ivanhoe (Osborne) Pty Ltd (Ivanhoe Australia Ltd).

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Victoria mine		28km NE of Chatsworth Homestead	Abandoned mine, active prospect	4938.5t Cu, 60.6kg Au (1994–1995)	2.92Mt at 1.21% Cu and 0.18g/t Au for 35 360t Cu and 532kg Au (Selwyn Mines Limited, 2002)	Hampden Slate/ Kuridala-Selwyn Domain	Shear-hosted Cu-Au veins in schist, phyllite and shale. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
Walford Creek		315km NNW of Mount Isa	Active prospect	Not mined	6.5Mt at 0.67% Cu, 0.07% Co, 25g/t Ag, 2.1% Zn and 1.6% Pb for 39 000t Cu, 4550t Co, 162 500kg Ag, 136 500t Zn and 104 000t Pb (Copper Strike Limited, 2006)	Mount Les Siltstone/ Camooweal-Murphy Domain	Sediment-hosted Ag-Pb-Zn and breccia-hosted Cu-Co in shale and siltstone. Held under Exploration Permit by Copper Strike Ltd.
Wee MacGregor		51.4km ESE of Mount Isa	Abandoned mine, active prospect	2820.5t Cu, 56.7t Cu precipitate, 43.5kg Au (1911–1920, 1962–1971, 1974–1975, 1979–1981)	0.52Mt at 1.8% Cu for 9360t Cu (Resource Information Unit Ltd, 1998)	Argylla Formation/ Mary Kathleen Domain	Shear-hosted Cu-Au veins in amphibolite, schist, rhyolite and quartzite. Held under Mining Lease by Cape Lambert Leichhardt Pty Ltd.
Wellington Springs		17.1km WSW of Ravenswood	Abandoned mine, active prospect	3.8t Cu, 15.7kg Au, 92.9kg Ag (1895-1909, 1936–1937)	Ore – 0.112Mt at 0.6% Cu, 3.01g/t Au and 58g/t Ag for 672t Cu, 337kg Au and 6496kg Ag. Tailings – 18 500t at 1.25g/t Au and 22.8g/t Ag for 23kg Au and 421kg Ag (Haoma Mining NL, 2000)	Wellington Springs Tonalite/ Pama Province	Porphyry-related Cu-Au-quartz veins in diorite and granodiorite. Held under Mining Lease by Kitchener Mining NL.
White Range Project	Greenmount	110km ESE of Mount Isa	Abandoned mine, active prospect	Not recorded	12.29Mt at 0.79% Cu, 0.06% Co and 0.32g/t Au for 96 716t Cu, 7263t Co and 3883kg Au (Queensland Mining Corporation Limited, 2010a)	Staveley Formation, Marimo Slate/ Marimo-Staveley Domain	Shear zone hosted veins and breccia in siltstone, slate and schist. Held under Mining Lease and Mineral Development Licence by Queensland Mining Corporation Ltd.
	Kuridala	115km SE of Mount Isa	Active prospect	Not mined	7.2Mt at 0.84% Cu and 0.02% Co and 0.21g/t Au for 60 110t Cu, 1610t Co and 1494kg Au (Queensland Mining Corporation Limited, 2010a)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted veins and breccia in slate and metadolerite. Held under Mining Lease by Queensland Mining Corporation Ltd.
	McCabe	110km ESE of Mount Isa	Abandoned mine, active prospect	1.22t Cu (–1958)	7.7Mt at 0.57% Cu and 0.02% Co for 43 890t Cu and 1694t Co (Queensland Mining Corporation Limited, 2010c)	Marimo Slate/ Marimo-Staveley Domain	Shear zone hosted veins and breccia in siltstone and sandstone. Held under Mining Lease by Queensland Mining Corporation Ltd.
	Sierra	100km SE of Mount Isa	Abandoned mine, active prospect	1.54 r Cu (1968)	240 700t at 1% Cu for 2407t Cu (Matrix Metals Limited, 2003)	Staveley Formation/ Marimo-Staveley Domain	Shear-hosted Cu-Au-quartz veins in shale, siltstone and sandstone. Held under Exploration Permit by matrix Metals Ltd (Queensland Mining Corporation Ltd).

Table 12 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
White Range Project (continued)	Stuart	155km SE of Mount Isa	Abandoned mine, active prospect	21t Cu (1968-1979)	5.58Mt at 0.55% Cu, 0.002% Co and 0.14g/t Au for 30 690t Cu, 122t Co and 781kg Au (Queensland Mining Corporation Limited, 2010b)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted veins and breccia in siltstone, slate and shale. Held under Mining Lease by Queensland Mining Corporation Ltd.
	Vulcan	116km ESE of Mount Isa	Abandoned mine, active prospect	11.95t Cu and 0.019kg Au (1905-1931)	1.42Mt at 0.65% Cu and 0.02% Co for 9230t Cu and 241t Co (Queensland Mining Corporation Limited, 2010d)	Marimo Slate/ Marimo-Staveley Domain	Shear zone hosted veins and breccia in siltstone and sandstone. Held under Mining Lease and Mineral Development Licence by Queensland Mining Corporation Ltd.
Whitewash/ Gordons		26.5km WNW of Monto	Active prospect	Not mined	71.5Mt at 0.034% Mo, 0.1% Cu and 1.2g/t Ag for 24 135t Mo, 85 200kg Ag and 70 600t Cu (Aussie Q Resources Limited, 2008; Aussie Q Resources Limited, 2009)	Wingfield Granite/ Rawbelle Batholith	Porphyry Mo-Cu deposit in granodiorite. Held under Exploration Permit by Aussie Q Resources Ltd.
Winston Churchill		53.6km NE of Mount Isa	Abandoned mine, active prospect	935.3t Cu (1969–1973)	Not calculated	Argylla Formation, Ballara Quartzite/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in schist, rhyodacite, metadolerite and quartzite. Held under Mining Lease by CuDeco Ltd.
Wyandotte		19km NW of Greenvale	Abandoned mine, inactive prospect	Not recorded	0.175Mt at 2.3% Cu for 4025t Cu (resource from Lachlan Resources NL information for MDL renewal application, 1994)	Lugano Metamorphics	Volcanogenic massive sulphide deposit in schist. Held under Exploration Permit by Nornico Pty Ltd.
Young Australia		117km SE of Mount Isa	Abandoned mine, active prospect	4724.4t Cu (1959–1967, 1994–2003)	Young Australian – 1.519t at 1.07% Cu, 0.01% Co and 2g/t Ag for 16 327t Cu, 164t Co and 3026kg Ag. East Drift – 0.61Mt at 0.8% Cu for 4880t Cu (Queensland Mining Corporation Limited, 2011a)	Answer Slate/ Marimo-Staveley Domain	Shear zone hosted veins and breccia in siltstone, schist and quartzite. Held under Mining Lease by North Queensland Mines Pty Ltd (Queensland Mining Corporation Ltd)

GOLD

Gold is a soft malleable yellow metal that melts at about 1060°C. It is known as 'the precious metal' and has been used in jewellery since ancient times. Although gold is seldom used in coinage these days, it remains a valuable standard against which various currencies can be measured and an investment medium. Gold's properties as a heat and electrical conductor and its resistance to corrosion underpin its use advanced technological industries, particularly in inaccessible or harsh environments.

Queensland is the third largest gold producer in Australia. Since the early gold rushes of the late 19th century, total documented gold production in Queensland has been >7000t. Queensland's significant current gold producers are Pajingo, Ernest Henry, Mount Rawdon, Cracow and Ravenswood. Queensland's gold production in 2009–10 totalled 13 191kg, comprising 11 509kg from 24 414kg of gold bullion, 48kg from 56kg of alluvial gold, 1615kg from copper concentrates, and 19kg from lead concentrates. The majority of Queensland's gold production is from hard-rock mining operations, with about 28 per cent from copper-gold operations where gold is a by-product.

Gold mineralisation occurs in a diverse range of deposit styles and geological provinces in Queensland, ranging from the large, historically important, alluvial goldfields of north Queensland to the Proterozoic iron oxide–copper–gold deposits of the Mount Isa Inlier. The significant gold mineralisation styles recognised in Queensland include:

- alluvial deposits
- mesothermal and shear-hosted hydrothermal Au-quartz veins
- skarns
- volcanogenic massive sulphide deposits
- porphyry-related subvolcanic breccias
- epithermal veins
- Proterozoic iron oxide-Cu-Au deposits
- porphyry Cu±Au±Mo deposits (Figure 19, Table 13).

Queensland's gold deposits and resources have been described by Denmead (1932), Ishaq (1985), Bruvel (1993, 1994, 1996a, 1996b, 1997, 1998, 2001c) and Geological Survey of Queensland (2011).

Alluvial deposits

Significant alluvial gold production has accompanied hard rock gold mining, particularly in north Queensland goldfields. In many regions, it was the alluvial gold potential that led to the large 'gold rushes' that established the goldfields. The main alluvial gold mining area in Queensland is the Palmer River drainage system (Palmer River Goldfield). The Palmer River drains areas of mesothermal, metamorphic-

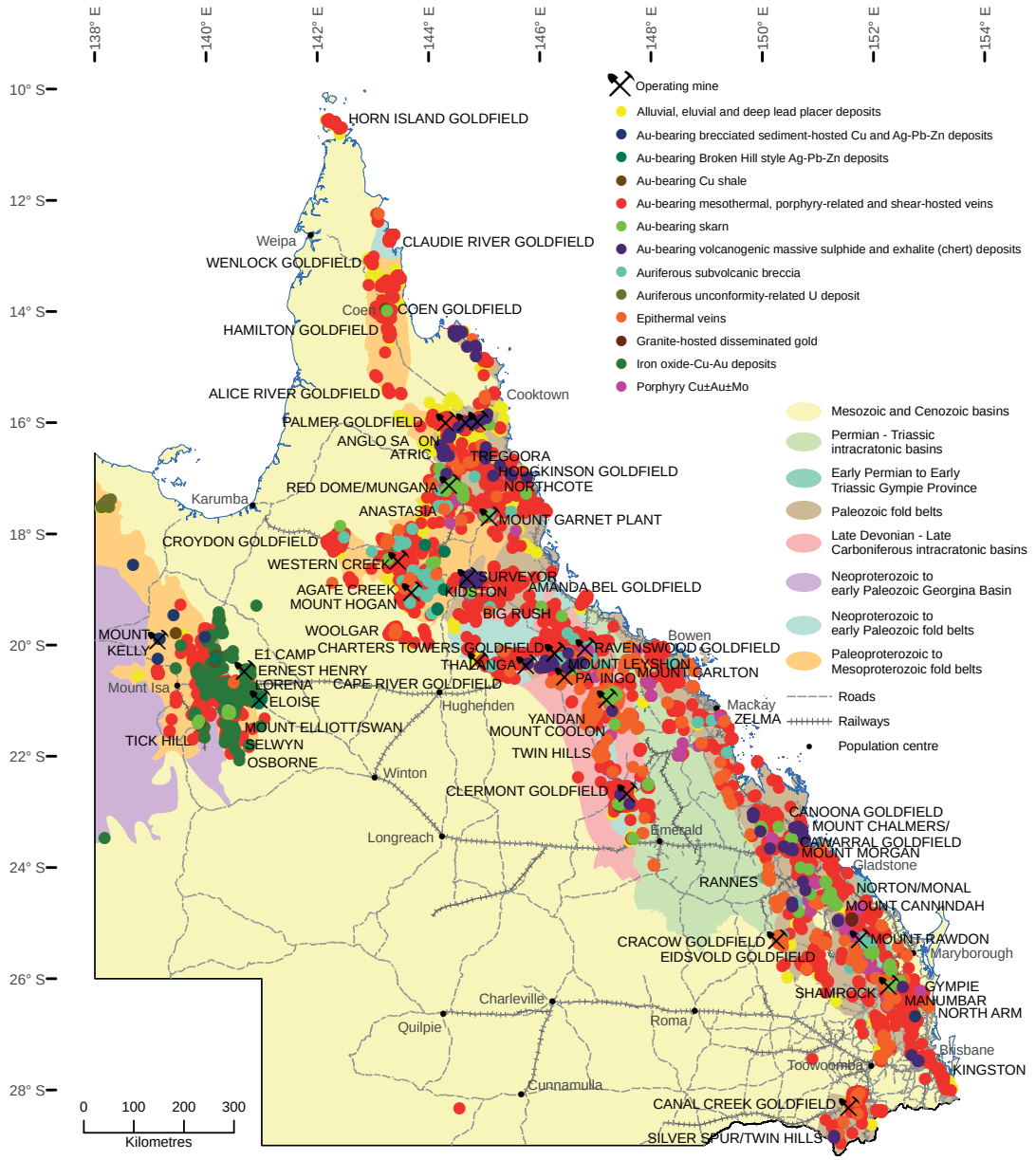

Figure 19: Gold occurrences and deposits

related gold mineralisation of the slate belt type in the Hodgkinson Province, and has produced >33t of alluvial gold. The Etheridge Goldfield, incorporating the Gilbert River, Percy River and drainage systems around the Kidston deposit, has also been a significant producer, with >5.5t of alluvial gold. The most significant alluvial gold producer in southern Queensland was the Gympie Goldfield, with >9t.

Mesothermal Au-quartz veins

Mesothermal deposits are generally high-grade, gold-bearing quartz veins that formed from hydrothermal solutions at high temperatures (200–300°C) and at substantial depths (1200–4500m). The important historical goldfields in Queensland characterised by mesothermal quartz veins include the Gympie, Hodgkinson, Palmer, Charters Towers-Ravenswood, Croydon and Etheridge fields.

Four main styles of quartz-gold lodes are recognised in the Gympie Goldfield: Gympie veins, break style, Inglewood Lode style and stockworks. In a modern exploration context, stockwork and Inglewood Lode styles are the most significant exploration targets. The Inglewood quartz lodes are associated with structural control along the north-west-trending Inglewood Structure, which may have been a significant fluid pathway. The north-trending, steeply west dipping 'Gympie veins' are linked to the Inglewood Structure and occur along joints. These veins form stockworks where they intersect carbonaceous shale 'breaks'. A genetic link between the gold mineralisation and a heat source (the Woondum Granite of the South East Queensland Volcanic and Plutonic Province located to the south-east of Gympie) forms the basis of a current mineralisation model for the goldfield. Operations at Monkland and the Lewis Decline ceased at the end of 2009.

In the Hodgkinson and Palmer Goldfields, slate-belt gold-quartz veins are thought to have formed from metamorphic fluids produced during devolatilisation of the sediment pile. Fluids were channelled to dilational sites in fault/shear zones within metasediments of the Hodgkinson Formation (Hodgkinson Province). Republic Gold Ltd has proved significant gold and antimony resources at its Northcote project.

Fault-controlled mesothermal gold-bearing quartz veins also occur at Charters Towers. Mineralisation at Charters Towers is of Devonian age and is related to Pama Province intrusive activity.

At the Sarsfield deposit near Ravenswood, multiphase gold mineralisation is associated with veining and brecciation of the Silurian to Devonian Jessop Creek Tonalite of the Ravenswood Batholith (Pama Province). Mineralising fluids are interpreted to be derived from an early Carboniferous intrusive of the Kennedy Province that was emplaced into a mesothermal to deep epithermal environment.

In the Etheridge Goldfield, structurally-controlled quartz lodes are hosted by rocks of the Proterozoic Etheridge Province and are possibly genetically related to Silurian–Devonian I-type granitoids of the Pama Province. Similar vein mineralisation in the Croydon Goldfield is hosted by Proterozoic granite and volcanics but may be related to late Palaeozoic igneous activity.

Shear zone hosted hydrothermal deposits

The Tick Hill deposit, south of Mount Isa in the Mount Isa Inlier forms a unique, but potentially important style of mineralisation. Mineralisation comprised high-grade gold in quartz-feldspar laminite bands within a broader strongly strained zone in the Corella Formation in the Mary Kathleen Domain (Eastern Fold Belt Province). The deposit was mined between 1992 and 1995 producing 15.9t of gold at an average gold grade of 22.5g/t.

Skarns

Gold-copper skarn mineralisation in the Red Dome–Mungana corridor, north of Chillagoe, also contributes to gold resources and reserves in Queensland. Mining of the Red Dome deposit occurred from 1988–1998 and new resources have been delineated. The Red Dome and Mungana deposits are currently being assessed by Mungana Goldmines Ltd. An exploration decline excavated to access polymetallic orebodies will be used to access the Au-Cu ore and carry out further exploration.

Volcanogenic massive sulphide deposits

Mount Morgan is one of the more significant historical mines in Australia in terms of total gold and copper production. It is hosted by a belt of Middle Devonian volcanic and sedimentary rocks of the Yarrol Province that forms a roof pendant in a Late Devonian tonalite intrusion. The genesis of the Mount Morgan mineralisation has long been controversial, but the deposit is now widely regarded as being a volcanic-hosted massive sulphide type.

Porphyry-related subvolcanic breccias

Porphyry-related, subvolcanic breccia style mineralisation is associated with Carboniferous to Permian rhyolitic porphyries of the Kennedy Province in north Queensland, for example, Mount Leyshon, Kidston and Mount Wright. These deposits are commonly associated with subvolcanic intrusion, breccia development and multiphase hydrothermal activity.

Mount Leyshon, south of Charters Towers, was the largest porphyry-related deposit in Queensland. Mineralisation occurred within the Mount Leyshon diatreme (a volcanic intrusive breccia complex) and was generally coincident with a zone of later breccia development where cavities were infilled with sulphide minerals to form a massive porphyry style disseminated orebody. Higher grade veinlet style gold mineralisation also extended into adjacent rocks. Both the Mount Leyshon and Kidston mines have closed due to depletion of resources. Mount Wright, near Ravenswood, commenced operations in 2007.

The Mount Rawdon gold deposit in south-east Queensland is hosted by a sequence of interbedded subaerial pyroclastic flow, surge and ashfall deposits that are intruded by coeval dacite of the Aranbanga Volcanic Group (South East Queensland Volcanic and Plutonic Province). The bulk of the host rock sequence consists of massive lapillistone. Gold occurs as microscopic grains in pyrite and sphalerite veins and disseminations in the lapillistone and dacite.

Epithermal deposits

Early Carboniferous epithermal gold (-silver) mineralisation of the low sulphidation (quartz-adularia) style occurs within Cycle 1 volcanics of the northern Drummond Basin in north Queensland. The Pajingo (Vera-Nancy and Scott Lode), Wirralie,

Twin Hills (309 and Lone Sister), Yandan and Mount Coolon deposits are significant examples.

Pajingo is the largest epithermal gold deposit in Queensland and consists of several oreshoots along the south-east-trending Vera-Nancy trend. Drilling over a strike length of ~3km has intersected high-grade gold mineralisation to depths of >400m along the structure. Mining has been carried out at the Nancy North, Nancy, Vera North, Vera, Vera South, Venue and Jandan orebodies. Newmont Mining Corporation sold the mine to North Queensland Metals Ltd (now part of Conquest Mining Ltd) in late 2007 and production has continued on a smaller scale.

The Vera-Nancy structure is considered to be a predominantly strike-slip fault, with mineralisation occurring on dilational jogs or flexures. Mineralisation is hosted by porphyritic andesitic lithic tuff previously assigned to the Star of Hope Formation, but now considered to be part of the Cycle 1 volcanics of the Drummond Basin.

The Pajingo epithermal field, which covers an area of ~150km^2, contains an array of south-east-trending gold-silver veins that are disrupted by east-trending faults. The veins dip steeply, range in thickness from centimetres to 20m and are usually enclosed by zones of silicic alteration up to 50m thick.

The Twin Hills gold project comprises the 309 and Lone Sister deposits. BMA Gold Ltd commenced underground mining operations at 309 in 2005, but a downgrading of resource figures led to a decision to close the mine in February 2007. Conquest Mining Ltd is refurbishing the underground workings and plans to commence trial mining to provide satellite feed for the Pajingo processing plant in 2011.

Epithermal mineralisation also occurs near Cracow in central Queensland, where the Golden Plateau and satellite deposits such as the Klondyke, Klondyke North and Crown Shoot are associated with quartz veining and zones of silicification. Andesitic lavas, tuffs and coarse breccias of the Camboon Andesite (Connors–Auburn Province) host these deposits. Newcrest has developed an underground mine on the Klondyke group of veins. Exploration continues to define additional mineralisation in this region.

In the Sandy Creek area of the Woolgar Inlier, Mesoproterozoic rocks of the Etheridge Province host several epithermal deposits of probable Carboniferous to Permian age. The largest of these deposits are the Lost World, Explorer and Soapspar prospects. Strategic Minerals Corporation NL is actively exploring the area to define sufficient resources for mining operations. Defined gold resources at Woolgar at the beginning of 2007 exceed 12.5t in seven vein systems. Strategic Minerals is investigating the feasibility of a stand-alone, small-scale, pilot mine development at the Soapspar prospect.

Renison Consolidated Mines NL has delineated significant epithermal gold resources at its Agate Creek Project in north Queensland. Mineralisation occurs along reactivated faults between the Silurian Robin Good Granodiorite (Pama Province) and

rhyolitic intrusives of the Carboniferous to Permian Agate Creek Volcanic Complex (Kennedy Province). Swarms of chalcedonic veins grade into breccias and zones of stockworking.

Conquest Mining Ltd has discovered significant high sulphidation epithermal gold–silver mineralisation at the Silver Hill and Mount Carlton prospects, near Collinsville in northern central Queensland. The vein systems are hosted by the Early Permian Lizzie Creek Volcanics (Bowen Basin).

Proterozoic iron oxide–Cu–Au deposits

Gold is an important by-product of processing copper ores from structurally-controlled Proterozoic copper–gold deposits in the Eastern Fold Belt Province of the Mount Isa Inlier. Deposits tend to be associated with magnetite-rich iron oxide bodies (for example, Ernest Henry, Osborne, Selwyn, Mount Elliott, E1 Camp, Rocklands) within spatially extensive sodic-calcic alteration zones and local K-silicate alteration. Gold is generally concentrated in the chalcopyrite lattice within the ore.

Ernest Henry differs from other deposits because it is developed within variably brecciated and altered felsic to intermediate volcanic rocks, with primary mineralisation forming within a magnetite-carbonate gangue. Magnetite makes up 20–25% of the primary ore. Refer to the Copper section for more detail.

Porphyry Cu±Au±Mo deposits

Significant gold resources are known to occur with porphyry Cu-Mo-Au systems at Boggy Creek near Monto, Mungana and Red Dome near Chillagoe, Mount Cannindah near Gladstone, Nymbool near Mount Garnet, and the Yarrol Gold Prospect near Monto.

Other deposit styles

At the Miclere Diggings, near Clermont in central Queensland, gold mineralisation is concentrated within basal conglomerates of the Permian Miclere Basin, which lies unconformably on rocks of the Anakie Province. The genesis of this mineralisation remains controversial, with opposing models of deep lead gold, structurally-controlled epigenetic mineralisation and unconformity-related fluid mixing.

Gold mineralisation is also known to occur within sediment-hosted Cu and Ag-Pb-Zn deposits, Broken Hill Style Ag-Pb-Zn deposits, Cu shales, unconformity-related U deposits and granite-hosted disseminated Au deposits.

Table 13: Significant gold deposits of Queensland

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Alice River and Potallah Creek Goldfields		35km S of New Dixie Homestead	Abandoned mines, active prospects	122.9kg Au bullion (1903–1947), 2.8kg Au bullion (2004–2005)	Alice Queen – 183 133t at 3.81g/t Au for 697kg Au (North Queensland Mining and Exploration Limited, 2005)	Kintore Granite/Pama Province; rhyolite dykes/ Kennedy Province	Shear-hosted intrusive-related mesothermal quartz veins and stockworks in granite. Held under Mining Leases and Exploration Permits by Tinpitch Pty Ltd.
Amanda Bel Goldfield	Amanda Bel Goldfield	68km ENE of Greenvale	Abandoned mines, inactive prospects	2962.7kg Au (1989–1994). Significant lode mines included the Camel Creek mine (1.78t) and Golden Cup (0.53t)	See below	Kangaroo Hills Formation/ Camel Creek Subprovince	Slate-belt style and intrusive-related mesothermal quartz veins in metasediments. Held under Mining Leases by Golden Ant Mining Pty Ltd.
	Camel Creek Mine (Golden Ant)	67km ENE of Greenvale	Abandoned mine, active prospect	Included in figures for Amanda Bel Goldfield	0.57Mt at 1.6g/t Au for 912kg Au (Resource Information Unit Ltd, 1993)	Kangaroo Hills Formation/ Camel Creek Subprovince	Slate-belt style and intrusive-related mesothermal quartz veins in metasediments. Held under Mining Leases by Golden Ant Mining Pty Ltd.
	Golden Cup	77.5km E of Greenvale	Abandoned mine, active prospect	Included in figures for Amanda Bel Goldfield	44 475t at 9.42g/t Au for 419kg Au (Robertson & Fielding, 1998)	Kangaroo Hills Formation/ Camel Creek Subprovince	Slate-belt style and intrusive-related mesothermal quartz veins in metasediments. Held under Mining Lease by Golden Ant Mining Pty Ltd.
Anastasia		36km NNW of Lyndbrook Siding	Inactive prospect	Not mined	0.39Mt at 2.5g/t Au for 975kg Au (Nethery, 1998)	McDevitt Metamorphics/ Etheridge Province, Scardons Volcanic Group/ Kennedy Province	Epithermal quartz veins and breccia associated with rhyolite doming. Held under Exploration Permit by Queensland Epithermal Minerals Ltd (Queensland Minerals Ltd).
Atric		83km W of Mount Carbine	Active prospect	Not mined	1.04Mt at 1.89g/t Au for 1965kg Au (Republic Gold Limited, 2006)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Au-Sb-quartz veins in metasediments. Held under Exploration Permit by Republic Gold Ltd and N.F. Stuart.
Barbara South Lode		51km NE of Mount Isa	Abandoned mine, active prospect	Not recorded	3.34Mt at 1.57% Cu, 2.67g/t Ag, 0.03% Co and 0.19g/t Au for 52 338t Cu, 8905kg Ag, 910t Co and 631kg Au (Syndicated Metals Limited, 2010)	Leichhardt Volcanics/ Mary Kathleen Domain	Shear zone hosted veins and breccia in schist and volcanics. Held under Exploration Permit by Syndicated Metals Ltd and Mt Isa Metals Ltd.
Belyando		68km NW of Clermont	Abandoned mine, active prospect	2.283kg Au (1990–1995)	1.8Mt at 0.32g/t Au for 576kg Au (Ashburton Minerals Ltd, 2005)	Anakie Metamorphic Group/ Anakie Orogen	Low sulphidation epithermal quartz veins and breccia in schist and siltstone. Held under Mining Lease by Wirralie Mines Pty Ltd.
Big Rush		53km SSW of Greenvale	Abandoned mine, active prospect	1008.8kg Au (1995–1997)	Mined out	Mytton Formation/ Graveyard Creek Subprovince	Slate-belt style mesothermal quartz veins in shale, siltstone and greywacke. Held under Mining Lease by Alphadale Pty Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Bimurra		34km N of Mount Coolon	Active prospect	Not mined	1.6Mt at 1.4g/t Au for 2240kg Au (Gemmell & AMIRA P588 Research Team, 2006)	Bimurra Volcanics/ Drummond Basin	Low sulphidation epithermal quartz veins, stockwork and breccia in tuff, rhyolite, ignimbrite and volcaniclastics. Held under Mineral Development Licence by Wirralie Mines Pty Ltd.
Boggy Creek		34km NE of Monto	Active prospect	Not mined	4Mt at 0.33g/t Au for 990kg Au (Magner & Mackee, 1994)	Lawyer Granite/ Permo-Triassic Igneous Provinces	Porphyry Cu-Au-Mo breccia in quartz monzodiorite. Held under Exploration Permit by Norton Gold Mine Pty Ltd.
Canal Creek Goldfield		47km W of Warwick	Abandoned mines	570kg Au (1863–1887)	Not calculated	alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer Au. Held under Exploration Permits by Mingoola Gold Pty Ltd and N.C. Schwerin.
Canoona Goldfield		40km NW of Rockhampton	Abandoned mines, active prospects	1242.4kg alluvial Au, 16.3kg lode Au (1858–1860)	Not calculated	Princhester Serpentinite/ Marlborough Block; alluvium/ Cainozoic Alluvial and Colluvial Deposits	Shear-hosted Au in serpentinite, alluvial placer Au. Held under Exploration Permits by Accord Mining Pty Ltd, Marlborough Nickel Pty Ltd and D.J. Sims
Cape River Goldfield	Cape River Goldfield (including Pentland, Lolworth and Mount Emu)	210km SW of Townsville	Abandoned mines, active prospects	>2462kg Au (1867–1994)	See below	Cape River Metamorphics/ Cape River Province; Fat Hen Complex/ Macrossan Province; Amarra Granite, Big Bore Granite, Bomnarri Granodiorite, Mount Elvan Granite, Upland Granodiorite, Weaner Vale Granite/ Pama Province; Elimeek Volcanics, unnamed quartz-feldspar porphyries/ Kennedy Province; Campaspe beds/ Cainozoic Sedimentary Cover; alluvium/ Cainozoic Alluvial and Colluvial Deposits	Shear-hosted, intrusive-related quartz veins and stockworks in metamorphics, granite, diorite; subvolcanic breccia pipes; alluvial and deep lead placer Au. Held under Exploration Permits by Activex Ltd, Circle Resources Pty Ltd, Mantle Mining Corporation Ltd, Maritime Academy Australasia Pty Ltd and Zulu Gold Mining Pty Ltd.
	Granite Castle	88km NW of Pentland	Abandoned mine, active prospect	Included with production figures for Cape River Goldfield	764 704t at 3.14g/t Au and 61.08g/t Ag for 2401kg Au and 46 705kg Ag (Mantle Mining Corporation Limited, 2008)	Upland Granodiorite/ Pama Province	Shear-hosted polymetallic quartz veins in granodiorite. Held under Exploration Permit by Zulu Gold Mining Pty Ltd.
Cawarral Goldfield		23km NE of Rockhampton	Abandoned mines, active prospects	847.5kg Au (1881–1922)	Not calculated	Chalmers Formation/ Berserker Subprovince; unnamed serpentinite/ Coastal Subprovince; alluvium/ Cainozoic Alluvial and Colluvial Deposits	Mesothermal quartz veins in serpentinite, schist, siltstone, ignimbrite and dacite; alluvial placer Au. Held under Exploration Permits by Echo Resources Ltd, Quadrio Resources Pty Ltd, Redflame Holdings Pty Ltd and Victorian Ferries Pty Ltd.

Table 13 (continued)

	Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Charters Towers Goldfield	Charters Towers Goldfield (includes the current CitiGold Corporation Ltd operations)	Centred on city of Charters Towers	Operating mine, abandoned mines, active and inactive prospects	>250t Au bullion (1872–1991) Significant producers included the Brilliant lode (51.48t), Day Dawn lode (38.67t), New Queen Cross lode (5.75t), Queen lode (5.26t), Victory lode (3.45t), Rainbow-Wyndham lode (2.18t), St Patrick lode (2.4t), Stockhold (2.36t), Lady Maria lode (1.82t), Caledonia reef (1.73t), Identity lode (1.67t), North Australian lode (1.65t), Wellington lode (1.43t), Old Queen Cross lode (1.28t), Victoria and Queen lode (1.05t), Golden Alexandra (0.98t), Mexican (0.9t), Ruby lode (0.75t), Sunburst Joint Venture (0.72t), Sunburst lode (0.63t), Moonstone lode (0.61t)	See below	Charters Towers Metamorphics/ Cape River Province; Towers Hill Granite, Hogsflesh Granodiorite/ Macrossan Province; Millchester Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins in metamorphics, granodiorite, granite and tonalite. Held under Exploration Permits, Mineral Development Licences and Mining Leases by Citigold Corporation Ltd, Kagara Copper Pty Ltd, Mantle Mining Corporation Ltd.
	Black Jack Lode	8.9km SSW of Charters Towers	Abandoned mine, inactive prospect	49.4kg Au (1951–1959), 323.3kg Au, 122.3kg Ag (1987–1991)	0.972Mt at 13.5g/t Au for 13 122kg Au (Citigold Corporation Limited, 2005a)	Towers Hill Granite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granodiorite. Held under Mining Lease by Citigold Corporation Ltd.
	Brilliant Lode	1.1km ESE of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	1.56Mt at 14.27g/t Au for 22 262kg Au (Citigold Corporation Limited, 2005a, 2005b)	Hogsflesh Granodiorite/Macrossan Province; Millchester Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins in granodiorite and tonalite. Held under Mining Lease by Citigold Corporation Ltd.
	Caledonia Reef	1.9km ESE of Charters Towers	Abandoned mine, inactive prospect	Included in figures for Charters Towers Goldfield	14 969 at 15g/t Au for 224kg Au (Citigold Corporation Limited, 2005b)	Millchester Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins in tonalite. Held under Mining Lease by Citigold Corporation Ltd.
	Central Decline	0.9km ESE of Charters Towers	Care and maintenance, active prospect	559.8kg Au, 434.3kg Ag (1997–1998)	0.58Mt at 13.5g/t Au for 7873kg Au (Citigold Corporation Limited, 2005a)	Millchester Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins in tonalite. Held under Mining Lease by Citigold Corporation Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Charters Towers Goldfield (continued)	Clark's Moonstone Lode	1.9km SW of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	0.583Mt at 13.5g/t Au for 7873kg Au (Citigold Corporation Limited, 2005a)	Towers Hill Granite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granodiorite. Held under Mineral Development Licence by Citigold Corporation Ltd.
	Day Dawn Lode	0.7km W of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	0.386Mt at 13.5g/t Au for 5209kg Au (Citigold Corporation Limited, 2005b)	Towers Hill Granite, Hogsflesh Creek Granodiorite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granodiorite. Held under Mining Lease by Citigold Corporation Ltd.
	Day Dawn West Prospect	3.7km W of Charters Towers	Abandoned mine, active prospect	Not recorded	47 000t at 11.4g/t Au for 536kg Au (Charters Towers Gold NL, 1995)	Hogsflesh Creek Granodiorite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granodiorite. Held under Exploration Permit by Mantle Mining Corporation Ltd.
	Hidden Secret	6.8km S of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	1.458Mt at 13.5g/t Au for 19 683kg Au (Citigold Corporation Limited, 2005a)	Hogsflesh Creek Granodiorite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granodiorite. Held under Mineral Development Licence by Citigold Corporation Ltd.
	Identity Lode	3.8km ESE of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	0.973Mt at 13.5g/t Au for 13 122kg Au (Citigold Corporation Limited, 2005a)	Millchester Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins in tonalite. Held under Mineral Development Licence by Citigold Corporation Ltd.
	John Bull Lode	8.8km SSW of Charters Towers	Abandoned mine, inactive prospect	1281.2kg Au (1951)	75 600t at 8g/t Au for 604kg Au (Charters Towers Gold Mines NL, 2000)	Towers Hill Granite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granodiorite and granite. Held under Mining Lease by Citigold Corporation Ltd.
	Lady Florence Lode	4.4km ESE of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	0.972Mt at 13.5g/t Au for 13 122kg Au (Citigold Corporation Limited, 2005a)	Millchester Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins in tonalite. Held under Mineral Development Licence by Citigold Corporation Ltd.
	Merrie Monarch	7km S of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	0.972Mt at 13.5g/t Au for 13 122kg Au (Citigold Corporation Limited, 2005a)	Charters Towers Metamorphics/ Cape River Province; Hogsflesh Creek Granodiorite/ Macrossan Province	Intrusive-related mesothermal quartz veins in metamorphics and granodiorite. Held under Mineral Development Licence by Citigold Corporation Ltd.
	Mount Cenis	7km S of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	0.486Mt at 13.5g/t Au for 6561kg Au (Citigold Corporation Limited, 2005a)	Charters Towers Metamorphics/ Cape River Province; Towers Hill Granite/ Macrossan Province	Intrusive-related mesothermal quartz veins in metamorphics and granodiorite. Held under Mineral Development Licence by Citigold Corporation Ltd.

Table 13 (continued)

	Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Charters Towers Goldfield (continued)	Queen Lode	1.6km E of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	1.85Mt at 14.57g/t Au for 26 949kg Au (Citigold Corporation Limited, 2005a, 2005b)	Millchester Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins in granodiorite. Held under Mining Lease by Citigold Corporation Ltd.
	Ruby	2.8km SSE of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	0.972Mt at 13.5g/t Au for 13 122kg Au (Citigold Corporation Limited, 2005a)	Millchester Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins in granodiorite. Held under Mineral Development Licence by Citigold Corporation Ltd.
	Silent Friend	7km S of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	0.972Mt at 13.5g/t Au for 13 122kg Au (Citigold Corporation Limited, 2005a)	Hogsflesh Creek Granodiorite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granodiorite and diorite. Held under Mineral Development Licence by Citigold Corporation Ltd.
	St Patrick Lode	1.2km N of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	3.6Mt at 13.5g/t Au for 48 628kg Au (Citigold Corporation Limited, 2005a)	Millchester Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins in granodiorite. Held under Mining Lease by Citigold Corporation Ltd.
	Stockholm	6.7km SW of Charters Towers	Abandoned mine, active prospect	Pre-1991 included in figures for Charters Towers Goldfield, 972.4kg Au (1996–1998)	14 968t at 12.3g/t Au for 184kg Au (Citigold Corporation Limited, 2005b)	Towers Hill Granite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granite. Held under Mining Lease by Citigold Corporation Ltd.
	Sunburst Lode	2.9km NNE of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	0.213Mt at 11.16g/t Au for 2382kg Au (Citigold Corporation Limited, 2005b)	Charters Towers Metamorphics/ Cape River Province; Sunburst Granodiorite/ Macrossan Province	Intrusive-related mesothermal quartz veins in metamorphics and quartz diorite. Held under Mining Lease by Citigold Corporation Ltd.
	Towers Hill	1.5km SSW of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	2.33Mt at 13.5g/t Au for 31 492kg Au (Citigold Corporation Limited, 2005a)	Towers Hill Granite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granodiorite and diorite. Held under Mineral Development Licence by Citigold Corporation Ltd.
	Warrior	5.7km SSE of Charters Towers	Operating mine	Pre-1915 included in figures for Charters Towers Goldfield, 973.4kg Au, 381.4kg Ag (2006–2010)	1.94Mt at 13.5g/t Au for 26 244kg Au (Citigold Corporation Limited, 2005a)	Towers Hill Granite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granite. Held under Mining Lease by Citigold Corporation Ltd.
	Washington	5.4km SE of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	1.46Mt at 13.5g/t Au for 19 683kg Au (Citigold Corporation Limited, 2005a)	Millchester Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins in granite. Held under Mining Lease by Citigold Corporation Ltd.
	Wellington Lode	2.6km SSW of Charters Towers	Abandoned mine, active prospect	Included in figures for Charters Towers Goldfield	0.97Mt at 13.5g/t Au for 13 122kg Au (Citigold Corporation Limited, 2005a)	Towers Hill Granite/ Macrossan Province	Intrusive-related mesothermal quartz veins in granodiorite. Held under Mineral Development Licence by Citigold Corporation Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Claudie River Goldfield		N of Lockhart River township	Abandoned mines	256.5kg Au bullion (1934–1942)	Gordons – 36 000t at 28g/t Au for 1008kg Au, Johnsons – 0.25Mt at 2.03g/t Au for 507kg Au (Switzer, 1995)	Sefton Metamorphics/ Iron Range Province, Weymouth Granite/ Kennedy Province	Sulphide breccias and sulphide-quartz veins and breccias in quartzite and banded iron formation; shear-hosted quartz veins in granite.
Clermont Goldfield		Centred on town of Clermont	Operating mines, abandoned mines, active prospects	~14 000kg Au (1861–1993)	Miclere – 1.1Mt at 7.7g/t Au for 8470kg Au (Sedimentary Holdings Limited, 1997)	Anakie Metamorphic Group/ Anakie Orogen; Blair Athol Coal Measures/ Bowen Basin; alluvium and eluvium/ Cainozoic Alluvial and Colluvial Deposits	Structurally-controlled quartz-sulphide veins, deep lead placer Au (?quartz-pebble conglomerate Au), alluvial and eluvial Au. Held under Exploration Permits and Mining Leases by Central Minerals Pty Ltd, Chalcophile Resources Pty Ltd, CNW Pty Ltd, Echo Resources Ltd, Tasman Goldfields Miclere Pty Ltd, and a number of individuals.
Cloncurry Copper Project	Great Australia	1.8km S of Cloncurry	Abandoned mine, active prospect	12 953t Cu, 283.8kg Au (1868–1946, 1953–1968, 1996–2002)	2.2Mt at 1.54% Cu and 0.13g/t Au for 33 980t Cu and 294kg Au (Exco Resources Limited, 2010)	Corella Formation/ Canobie Domain; Staveley Formation/ Soldiers Cap Domain	Iron oxide-Cu-Au deposit in sandstone, dolerite and calc-silicate rocks. Held under Mining Lease by Great Australian Operations Pty Ltd (Exco Resources Ltd).
	Kangaroo Rat	29.6km ESE of Cloncurry	Abandoned mine, active prospect	31.8t Cu, 2.1kg Au (1927–1930, 1962, 1980)	0.875Mt at 1.65% Cu and 1g/t Au for 14 437t Cu and 875kg Au (Exco Resources Limited, 2010)	Toole Creek Volcanics/ Soldiers Cap Domain	Shear zone hosted veins in shale, amphibolite and quartzite. Held under Mining Lease by Exco Resources Ltd.
	Wallace South	30.6km ESE of Cloncurry	Active prospect	Not mined	1Mt at 1.6g/t Au for 1600kg Au (Exco Resources Limited, 2010)	Toole Creek Volcanics/ Soldiers Cap Domain	Shear zone hosted quartz breccia veins in shale, metabasalt, phyllite and quartzite. Held under Exploration Permit by Exco Resources Ltd.
Coen Goldfield		Coen area	Abandoned mines, active prospects	>2788kg Au bullion (1893–1916) The main producing reef was the Great Northern (2.17t)	Louis Tunnel – 0.5Mt at 4g/t Au for 2000kg Au (Fielding, 1993)	Coen Metamorphic Group/ Savannah Province; Lankelly Granite/ Pama Province; rhyolite dykes and plugs/ Kennedy Province	Shear-hosted quartz veins and breccias in granite and metamorphics; alluvial placer gold. Held under Exploration Permit by Seco Resource Finance Pty Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Cracow Goldfield	Cracow Goldfield	Centred on town of Cracow	Operating mine, active prospects	27.3t Au, 21.1t Ag (1932–1993)	See below	Camboon Volcanics/ Auburn Subprovince	Low sulphidation epithermal quartz veins in andesitic volcaniclastics. Held under Mining Leases and Exploration Permits by Newcrest Operations Ltd, Lion Mining Ltd, Sedgold Pty Ltd and Fernyside Pty Ltd.
	Cracow Gold Mine (Royal, Royal Standard, Crown, Klondyke, Kilkenny, Tipperary, Roses Pride, Phoenix, Empire and Sovereign shoots)	3.2km W of Cracow	Operating mine	16 553.4kg Au, 10 633.6kg Ag (2004–2010)	4.8Mt at 6.58g/t Au and 4.17g/t Ag for 31 650kg Au and 20 058kg Ag (Catalpa Resources Limited, 2010)	Camboon Volcanics/ Auburn Subprovince	Low sulphidation epithermal quartz veins in andesitic volcaniclastics. Held under Mining Leases by Newcrest Operations Ltd, Lion Mining Ltd, Sedgold Pty Ltd and Fernyside Pty Ltd.
	Golden Plateau	1.6km NNW of Cracow	Abandoned mine, active prospect	Included in production figures for Cracow Goldfield	Low grade stockpiles with 1.18Mt at 1.06g/t Au for 1251kg Au (Sedimentary Holdings Limited, 2003)	Camboon Volcanics/ Auburn Subprovince	Low sulphidation epithermal quartz veins in andesitic volcaniclastics. Held under Mining Leases by Newcrest Operations Ltd, Lion Mining Ltd, Sedgold Pty Ltd and Fernyside Pty Ltd.
Croydon Goldfield		Centred on town of Croydon	Abandoned mines	>52 039kg Au bullion (1886–1958), 7596kg Au bullion (1981–1990) Significant reefs included: Golden Gate (16t), Highland Mary (3.21t), True Blue (2.95t), Iguana (2.88t), Content (2.03t), Croydon Queen (1.27t), Richmond (0.78t), Mountain Maid (0.74t), Homeward Bound (0.74t), Croydon King (0.54t) and Lady Mary (0.52t).	Not calculated	Esmeralda Granite, Croydon Volcanic Group/ Croydon Province	Shear-hosted, intrusive-related mesothermal quartz veins in graphitic granite and acid volcanics. Held under Mining Leases by Barrick (Kalgoorlie) Ltd and D.J. O'Rourke and Exploration Permits by Gold Anomaly Ltd.

Table 13 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Crush Creek Prospect	10km N of Collinsville	Active prospect	Not mined	0.828Mt at 2.16g/t Au and 4.89g/t Ag for 1788kg Au and 4048kg Ag (Conquest Mining Limited, 2006)	Lizzie Creek Volcanics, unnamed intrusives/ Bowen Basin	Low sulphidation epithermal quartz veins and stockwork in andesite, trachyte and rhyolite. Held under Exploration Permit by Basin Gold Pty Ltd.
Denny Gully	85km S of Gladstone	Abandoned mine, active prospect	Not recorded	1.427Mm^3 at 0.6g/m^3 Au for 856kg Au (Pyper & Gillies, 2001)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer and deep lead placer Au. Held under Exploration Permit by D'Aguilar Gold Ltd.
Disraeli	36.6km W of Ravenswood	Abandoned mine	1832.7kg Au (1881–1942, 1987–1994)	Mined out	Boatswain Granodiorite/ Pama Province	Intrusive-related mesothermal quartz veins in granodiorite.
Duffer (Dittmer)	26km W of Proserpine	Abandoned mine, active prospect	1715.3kg Au, 729.6kg Ag, 300.3t Cu (1935–1954, 1968–1971)	Mined out	Camila beds/ Connors Subprovince	Intrusive-related quartz veins in andesite and pyroclastics. Held under Exploration Permit by D.J. Wilson, L.J. Wilson and R.B. Spruce.
Dugald River	18.6km NW of Quamby	Active prospect	Not mined	Zn ore – 53Mt at 12.5 % Zn, 1.9% Pb and 36.4g/t Ag for 6 602 400t Zn, 983 00t Pb and 1 929 200kg Ag; Cu ore – 4.4Mt at 1.8% Cu and 0.2g/t Au for 79 200t Cu and 880kg Au (Minmetal Resources Limited, 2010).	Dugald River Shale Member/ Mary Kathleen Domain	Sediment-hosted Ag-Pb-Zn deposit in slate, shale, schist and limestone. Held under Mining Lease by MMG Australia Ltd (MMG Mining Ltd).
E1 Camp	34km NE of Cloncurry	Active prospect	Not mined	48.07Mt at 0.72% Cu and 0.21g/t Au for 346 029t Cu and 10 319kg Au (Exco Resources Limited, 2010)	Mount Fort Constantine Volcanics/ Cloncurry Subprovince	Iron oxide-Cu-Au deposit in breccia, metavolcanics and metasediments. Held under Mining Lease by Eliza Creek Mines Ltd (Exco Resources NL) but recently sold to Xstrata Copper.
Eidsvold Goldfield	Immediately W of Eidsvold	Abandoned mines	2.9t Au (1862–1990)	Not calculated	Ceratodus Granite/ Permo-Triassic Igneous Provinces	Low sulphidation epithermal quartz veins in granite. Held under Exploration Permit application by Roar Resources Pty Ltd.
Eloise	56.4km ESE of Cloncurry	Operating mine	157 923t Cu, 55 343.4t Cu conc., 29 383.2kg Ag, 3312.7kg Au, 266.3kg Au bullion (1996–2009)	3.5Mt at 3.1% Cu, 0.8g/t Au and 9.9g/t Ag for 108 100t Cu, 2880kg Au and 34 740kg Ag (Breakaway Resources Limited, 2008b)	Toole Creek Volcanics/ Soldiers Cap Domain	Iron oxide-Cu-Au deposit in schist, amphibolite and arkose. Held under Mining Leases by Ernest Henry Mining Pty Ltd (Xstrata Plc).

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Ernest Henry		38km NE of Cloncurry	Operating mine	1 118 439t Cu, 42 748.2kg Au bullion (1997–2010)	105Mt at 1.23% Cu and 0.65g/t Au for 1 294 000t Cu and 68 100kg Au (Xstrata Plc, 2010)	Mount Fort Constantine Volcanics/ Canobie Domain	Iron oxide-Cu-Au deposit in breccia, volcanics, siltstone and diorite. Held under Mining Leases by FMR Investments Pty Ltd. Mining recommenced in January 2011.
Etheridge Goldfield	Etheridge Goldfield	Georgetown-Forsayth region	Abandoned mines, active prospects	>19 525kg Au bullion, 3 432kg Au, 5 538kg Ag (1869–1952). Significant reefs included: Cumberland (2.07t), Queenslander (1.01t), Havelock (0.88t), Durham (0.87t), Big Reef (0.86t), International (0.75t), Nil Desperandum (0.63t).	See below	Forsayth Batholith, Einasleigh Metamorphics/ Etheridge Province; Permo-Carboniferous intrusions/ Kennedy Province	Intrusive-related mesothermal to epithermal quartz veins, stockworks and subvolcanic breccias in granite, metasediments and porphyry intrusions; alluvial placer gold. Held under Mining Leases and Exploration Permits by Altius Mining Ltd, Atherton Minerals Exploration Pty Ltd, Aurogen Mining Pty Ltd, Centaurus Metals Ltd, Chalcophile Resources Pty Ltd, Consolidated Exploration NQ Pty Ltd, Copper Strike Ltd, Deutsche Rohstoff Australia Pty Ltd, Eastern Prospector Pty Ltd, Ero Georgetown Gold Operations Pty Ltd, Far West Mining Pty Ltd, Gascoyne Metals Pty Ltd, Georgetown Mining Ltd, Hama Investments Pty Ltd, KS Mining Pty Ltd, Lexamont Pty Ltd, Mega Georgetown Pty Ltd, Mineral Development Australia Pty Ltd, NQ Ex Pty Ltd, Pepinnini Minerals Ltd, Regalpoint Exploration Ltd, Renison Consolidated Mines NL.
	Agate Creek Epithermal Project	24km SW of Robinhood Homestead	Active prospect, feasibility study	Not mined	14.9Mt at 0.97g/t Au for 14 440kg Au (Renison Consolidated Mines NL, 2008)	Corbett Formation/ Etheridge Province. Robin Hood Granodiorite/ Pama Province, Unnamed Carboniferous-Permian volcanics/ Kennedy Province	Epithermal quartz vein stockworks and breccias in granite, schist and volcanics. Held under Exploration Permit and Mineral Development Licence applications by Renison Consolidated Mines NL.
	Electric Light	13.7km NNE of Georgetown	Abandoned mine, active prospect	Included with figures for Etheridge Goldfield	183 800t at 8.2g/t Au for 1508kg Au (Plentex Limited, 2006)	Delaney Granite/ Etheridge Province	Low sulphidation epithermal quartz veins and subvolcanic breccia in granite. Held under Mining Lease by Deutsche Rohstoff Australia Pty Ltd.
	Flying Cow	14.7km SE of Forsayth	Operating mine	Not reported	16 300t at 31g/t Au for 505kg Au (Altius Mining Limited, 2011)	Lane Creek Formation/ Etheridge Province	Intrusive-related mesothermal quartz veins in metasediments. Small scale open cut mining by Altius Mining Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Etheridge Goldfield (continued)	Gilbert River Alluvials	80km S of Forsayth	Inactive prospect	Included with figures for Etheridge Goldfield	2.3Mt at 0.27g/t Au for 621kg Au (Resource Information Unit Ltd, 1990)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer Au.
	Havelock	2.3km S of Forsayth	Abandoned mine, active prospect	Production pre-1950 included in Etheridge Goldfield figures. 240.2kg Au, 282kg Ag (1996–1997)	Not calculated	Goldsmiths Granite/ Etheridge Province	Intrusive-related mesothermal quartz veins in granite. Held under Mining Lease by R.C. Terry.
	Mount Hogan	16.5km ENE of Gilberton	Abandoned mine	1743.9kg Au, 2141.6kg Ag (1992–1994)	Mined out	Mount Hogan Granite/ Etheridge Province	Porphyry intrusion-related quartz veins and stockworks.
Far Fanning		100km SW of Townsville	Abandoned mine, active prospect	1850kg Au bullion, 180kg fine Au, 68kg Ag (1865–1908, 1986–1987, 1999–2006)	47 704t at 7.59g/t Au for 362kg Au (SMC Gold Limited, 2004a)	Julia Formation/ Burdekin Basin	Intrusive-related mesothermal quartz veins in sandstone and siltstone. Held under Mining Lease by Bush Oasis Pty Ltd.
Fitzroy Prospect		35.3km SSE of Mount Perry	Abandoned mine, active prospect	Not recorded	1.2Mt at 0.9g/t Au for 1080kg Au (Diatreme Resources Ltd, 2006)	Chowey Granite/ South East Queensland Volcanic and Plutonic Province	Porphyry intrusive-related quartz vein stockworks in granite, microgranite and dolerite. Held under Exploration Permit by Xtreme Resources Ltd.
Gilded Rose		14.2km SE of Cloncurry	Abandoned mine, active prospect	226kg Au (1872–1883, 1905–1947)	143 500t at 4.17g/t Au for 598kg Au (Queensland Mining Corporation Limited, 2011c)	Mount Norna Quartzite/ Soldiers Cap Domain	Shear-hosted quartz veins in schist, quartzite, siltstone and metabasalt. Held under Mining Lease by Spinifex Mines Pty Ltd (Queensland Mining Corporation Ltd).
Gympie Goldfield		Centred on city of Gympie	Abandoned mines	>111 756kg Au bullion, 1316kg Au, 363kg Ag, 168.7kg jewellery Au (1867–1971, 1994–2008). The most productive reef mines were the Monkland/Scottish Gympie (41.9t), Phoenix No.1 North (6.1t), Glanmire and Monkland South (5.3t), Phoenix PC (4.7t), Glanmire No.1 North Western (3.9t), Phoenix No.4 North (3.8t), Smithfield North (3.3t), Great Eastern (3t), Glanmire North (2.7t), Monkland Nos 7 and 8 South (2.2t), Smithfield Nos 2 and 3 South (2.2t),	Monkland Gold Mine – 0.348Mt at 9.51g/t Au for 3313kg Au (Buka Gold Ltd, 2006)	Ramutt Formation/ Kin Kin Subprovince; alluvium/ Cainozoic Alluvial and Colluvial Deposits	Mesothermal quartz veins in metasediments; alluvial placer Au. Held under Mining Leases and Exploration Permits by Centius Mines Pty Ltd, China Australia Mining Pty Ltd and Gympie Eldorado Mining Pty Ltd).

Table 13 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Gympie Goldfield (continued)			Glanmire Nos 3 and 4 North (2.1t), Wilmot Extended (1.6t), Columbia Smithfield (1.5t), Smithfield No.1 North (1.5t), Glanmire PC (1.4t), Ellen Harkins (1.3t), Golden Crown (1.3t), Glanmire No.1 North Eastern (1.2t), New Zealand PC (1.2t), Nicholls (1.2t), Phoenix Golden Pile (1.2t), Great Eastern No.2 (1.1t), Oriental and Glanmire No.1 North (1.1t), Great Eastern No.1 South (1t), Oriental and Glanmire East (1t), Smithfield United (1t), Smithfield No.1 South (1t), Columbia Smithfield No.1 North (0.9t), Columbia Smithfield No.2 North (0.9t), Monkland West (0.9t), Crown and Phoenix (0.8t), Glanmire and Monkland (0.8t), Monkland Nos 2 and 3 (0.8t), Smithfield Phoenix Golden Pile (0.8t), Columbia Extended (0.7t), Columbia No.3 North (0.7t), Great Eastern No.2 North (0.7t), Phoenix No.3 North (0.7t), Phoenix No.5 North (0.7t), Oriental and Glanmire Western (0.6t), Oriental and Glanmire No.1 South (0.5t) and Phoenix No.1 South (0.5t).			
Hadleigh Castle	36km E of Charters Towers	Abandoned mine	10 639kg Au (1874–1915, 1988–2005)	0.472Mt at 6.62g/t Au for 3123kg Au (SMC Gold Limited, 2004a, 2004b)	Boatswain Granodiorite/ Pama Province	Intrusive-related mesothermal quartz veins in granodiorite and granite.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Hamilton (Ebagoola and Yarraden) Goldfield		SSE of Ebagoola Homestead	Abandoned mines, active prospects	2291.6kg Au bullion (1900–1951)	Queenslander – 0.368Mt at 2.03g/t Au for 747kg Au (Stirton, 1997)	Coen Metamorphic Group/ Coen Inlier; Kintore Granite, Flyspeck Granodiorite/ Pama Province; rhyolite dykes and plugs/ Kennedy Province	Shear-hosted quartz veins in metamorphics, granite and rhyolite; alluvial placer gold. Held under Mining Lease by Ebagoola Gold Mines Pty Ltd and Exploration Permits by Ebagoola Gold Mines Pty Ltd and Gulf Mines Ltd.
Highway-Reward		33km SSW of Charters Towers	Care and maintenance, active prospect	173 092t Cu, 7395.5kg Ag, 3302.3kg Au, 1137t Pb, 2866t Zn, 29.3kg Au bullion (1953–1989, 1998–2006)	Resources mined out	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolite, volcaniclastics and dacite. Held under Mining Lease by Thalanga Copper Mines Pty Ltd and BML Holdings Pty Ltd.
Joe's Delight		35.2km W of Ravenswood	Abandoned mine	525kg Au (1881–1936, 1987–1993, 2003–2004)	Mined out	Boatswain Granodiorite/ Pama Province	Intrusive-related mesothermal quartz veins in quartz monzonite.
Hodgkinson Goldfield	Hodgkinson Goldfield	45km WNW of Mareeba	Abandoned mines, active prospects	HGF– ~8610kg lode Au, ~1210kg alluvial Au (1876–1990). Significant lode mines included the Tyrconnel (1.82t), General Grant (0.81t), Minnie Moxham (0.81t), Union (0.64t) and Monarch (0.3t).	See below	Hodgkinson Formation/ Hodgkinson Province; alluvium/ Cainozoic Alluvial and Colluvial Deposits	Slate-belt style mesothermal quartz veins in metasediments; alluvial placer Au. Held under Exploration Permits and Mining Leases by BHP Billiton Minerals Pty Ltd, Delfos Minerals Pty Ltd, International Metals (Qld) Pty Ltd, John Sainsbury Consultants Pty Ltd, Monax Mining Ltd, NQ Mining and Exploration Pty Ltd, Paterson Mining Ltd, Plethora Pty Ltd, Queensland Ore Holdings Pty Ltd, Republic Gold Ltd, Wolfram Camp Mining Pty Ltd, and numerous individuals.
	General Grant	3.3km NE of Thornborough	Abandoned mine, inactive prospect	Included in figures for Hodgkinson Goldfield	7260t at 12.4g/t Au for 90kg Au (Peters, 1987)	Hodgkinson Formation/ Hodgkinson Province	Slate-belt style mesothermal quartz veins in metasediments.
	Minnie Moxham	21.9km E of Thornborough	Abandoned mine, active prospect	Included in figures for Hodgkinson Goldfield	73 000t at 2.95g/t Au for 215kg Au (unreferenced data from Intierra website).	Hodgkinson Formation/ Hodgkinson Province	Slate-belt style mesothermal quartz veins in metasediments. Held under Exploration Permit by Republic Gold Ltd, Jackson Minerals Ltd and Cape Lambert Iron Ore Ltd.
	Monarch	12.8km E of Thornborough	Abandoned mine, inactive prospect	Included in figures for Hodgkinson Goldfield	0.386Mt at 5g/t Au for 1935kg Au (Purcell, 1988)	Hodgkinson Formation/ Hodgkinson Province	Slate-belt style mesothermal quartz veins in metasediments.
	Pinnacle Creek	10.3km ESE of Thornborough	Abandoned mine, active prospect	Included in figures for Hodgkinson Goldfield	0.42Mt at 1.87g/t Au for 785kg Au (Blackwattle Gold Limited, 1994)	Hodgkinson Formation/ Hodgkinson Province	Slate-belt style mesothermal quartz vein stockwork in metasediments. Held under Exploration Permit by Republic Gold Ltd and Jackson Minerals Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Horn Island Goldfield		32.4km NNW of Bamaga	Abandoned mines	1659kg Au bullion (1894–1919, 1941, 1988–1989)	Not calculated	Torres Strait Volcanics, Horn Island Granite/ Kennedy Province	Porphyry-related mesothermal quartz veins and stockworks in volcanics and granite. Within the Horn Island Rehabilitation Restricted Area.
Kagara North Queensland Operations	Mount Garnet Plant	1km SSW of Mount Garnet	Operating copper and polymetallic plants	67 333t Cu, 185 125t Zn, 33 525t Pb, 707.2kg Au, 80 720kg Ag (2005–2010)	Not applicable	Not applicable	Currently processes ore from Mount Garnet, Balcooma and Mungana; has treated Surveyor and Dry River South ore in past. Held under Mining Leases by Kagara Ltd.
	Dry River South	13.5km SSW of Conjuboy Homestead	Care and maintenance	Production included in Mount Garnet Plant figures	730 300t at 0.95% Cu, 6.9% Zn, 2.5% Pb, 0.64g/t Au and 62.1g/t Ag for 6445t Cu, 50 309t Zn, 18 347t Pb, 469kg Au and 45 356kg Ag (Kagara Ltd, 2010)	Balcooma Metavolcanic Group/ Thalanga Province	Volcanogenic massive sulphide deposit in greywacke and meta-volcanics. Held under Mining Leases by Kagara Ltd.
	Griffiths Hill	3km SE of Mungana	Abandoned mine, active prospects	213t Cu (1887–1919)	1.05Mt at 3.06% Cu, 0.62g/t Au and 64g/t Ag for 32130t Cu, 651kg Au and 67 200kg Ag (Kagara Ltd, 2011)	Chillagoe Formation/ Hodgkinson Province	Skarn in limestone, porphyry and breccia. Held under Mining Lease by Mungana Pty Ltd.
	Harpers	9km SE of Chillagoe	Abandoned mine, active prospect	Not recorded	0.84Mt at 1.9g/t Au for 1577kg Au (Elders Resources Limited, 1987)	Chillagoe Formation/ Hodgkinson Province; Almaden Granodiorite/ Kennedy Province	Au-Cu-Sn skarn in metasediments and granite. Held under Exploration Permit by Mungana Pty Ltd.
	Liontown	41.9km SSW of Charters Towers	Abandoned mine, active prospect	93kg Au, 1678kg Ag, 528t Pb (1951–1961)	1.845Mt at 0.57% Cu, 7.5% Zn, 2.5% Pb, 0.4g/t Au and 28.3g/t Ag for 10 455t Cu, 137 620t Zn, 45 535t Pb, 736kg Au and 52 275kg Ag (Kagara Ltd, 2010)	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in greywacke, meta-volcanics and volcaniclastics. Held under Mining Lease by Kagara Ltd.

Table 13 (continued)

	Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Kagara North Queensland Operations (continued)	Mungana	140km W of Cairns	Operating mine	Production included in Mount Garnet Plant figures	Mungana Copper Orebody – 90 000t at 6.4% Cu, 0.8% Zn, 8.7% Pb, 1.83g/t Au and 713g/t Ag for 5760t Cu, 720t Zn, 7830t Pb, 164kg Au and 64 170kg Ag. Mungana Base Metal Orebody – 1.33Mt at 1.9% Cu, 11.6% Zn, 1.4% Pb, 0.99g/t Au and 141g/t Ag for 25 370t Cu, 154 670t Zn, 18 170t Pb, 1314kg Au and 187 110kg Ag (Kagara Ltd 2010) Mungana Gold Orebody – 48.7Mt at 0.19% Cu, 0.7g/t Au and 13.3g/t Ag for 93 510t Cu, 34 148kg Au and 646 150kg Ag (Mungana Goldmines Ltd, 2011)	Chillagoe Formation/ Hodgkinson Province; unnamed porphyry/ Kennedy Province	Porphyry Cu-Mo-Au and base metal skarn deposits. Held under Mining Leases by Mungana Pty Ltd (Mungana Goldmines Ltd).
	Red Dome	140km W of Cairns	Abandoned mine, active prospect	36 059t Cu, 105 855kg Ag, 22 716kg Au (1986–1998)	69.2Mt at 0.24% Cu, 0.63g/t Au and 5.16g/t Ag for 164 060t Cu, 43 687kg Au and 356 770kg Ag (Mungana Goldmines Ltd, 2011)	Chillagoe Formation/ Hodgkinson Province	Porphyry Cu-Mo-Au and base metal skarn deposits. Held under Mining Leases by Mungana Pty Ltd (Mungana Goldmines Ltd).
	Shannon	5.5km W of Chillagoe	Abandoned mine, active prospect	Not recorded	1.01Mt at 0.07% cassiterite, 20.2g/t Ag, 1.23% Cu, 0.53% Zn, 0.96g/t Au and 0.08% Bi for 707t cassiterite, 20 402kg Ag, 12 423t Cu, 5353t Zn, 970kg Au and 808t Bi (Verwoerd & Sargeant, 1971)	Chillagoe Formation/ Hodgkinson Province; Ruddygore Granodiorite/ Kennedy Province	Cu-Zn-Ag-Au-Bi-cassiterite skarn in marble, chert, ironstone and granodiorite. Held under Mining Lease by Mungana Pty Ltd (Mungana Gold Mines Ltd).

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Kagara North Queensland Operations (continued)	Surveyor	34km NW of Greenvale	Care and maintenance	2720t Cu, 63 289t Zn, 22 291t Pb, 239kg Au, 42 071kg Ag (2003–2005)	119 000t at 11.4% Pb, 2.41g/t Au and 158g/t Ag for 13 566t Pb, 286kg Au and 18 802kg Ag (Kagara Ltd, 2010)	Balcooma Metavolcanic Group/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolitic tuff. Held under Mining Lease by Kagara Ltd.
	Thalanga	11.9km ENE of Homestead	Operating mine	194 900t Cu conc., 158 100t Pb conc., 624 000t Zn conc., 20 277t Cu, 878t Pb, 1998t Zn, 66.8kg Au bullion, 1195.8kg Ag (1991–2000)	Vomacka – 885 823t at 1.7% Cu, 4.6% Zn, 1.35% Pb, 0.46g/t Au and 44.3g/t Ag for 15 134t Cu, 40 847t Zn, 12 034t Pb, 404kg Au and 39 282kg Ag Orient – 266 000t at 0.95% Cu, 10.5% Zn, 3% Pb, 0.25g/t Au and 58.5g/t Ag for 2516t Cu, 27 893t Zn, 8002t Pb, 67kg Au and 15 566kg Ag West 45 – 532 000t at 0.5% Cu, 7.2% Zn, 3% Pb, 0.26g/t Au and 48g/t Ag for 2660t Cu, 38 304t Zn, 15 960t Pb, 138kg Au and 25 536kg Ag (Kagara Ltd, 2010)	Mount Windsor Volcanics, Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolite and volcaniclastics. Held under Mining Lease by Kagara Copper Pty Ltd.
	Waterloo	36.9km SSW of Charters Towers	Active prospect	Not mined	476 000t at 2.5% Cu, 13.5% Zn, 2% Pb, 1.42g/t Au and 67.3g/t Ag for 11 844t Cu, 64 104t Zn, 9324t Pb, 677kg Au and 32 036kg Ag (Kagara Ltd, 2010)	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolite, andesite and volcaniclastics. Held under Exploration Permit by Kagara Copper Pty Ltd.
Kaiser Bill		6.3km WSW of Einasleigh	Abandoned mine, active prospect, feasibility study	2.3t Cu, 0.83kg Ag (1909–1922)	15Mt at 0.84% Cu, 0.12g/t Au and 6.5g/t Ag for 126 150t Cu, 1875kg Au and 97 500kg Ag (Copper Strike Limited, 2010)	Einasleigh Metamorphics/ Etheridge Province	Skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd.

Table 13 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Kalman	61km SE of Mount Isa	Active prospect, scoping study in progress	Not mined	60.8Mt at 0.32% Cu, 0.05% Mo, 1.19g/t Re and 0.15g/t Au for 30 400t Mo, 194 700t Cu, 9120kg Au and 72 352kg Re (Kings Minerals NL, 2010)	Corella Formation/ Eastern Fold Belt Province	Shear zone-hosted Cu-Mo-Au-Re veins in calc-silicate rocks associated with the Pilgrim Fault Zone. Held under Exploration Permits by Cerro Resources NL (formerly Kings Minerals NL) and Syndicated Metals Ltd.
Kidston	40.7km S of Einasleigh	Abandoned mine	1309kg Au bullion, 112 495kg Au, 60 887kg Ag (1915–1924, 1985–2002)	Mined out	Einsaleigh Metamorphics/ Etheridge Province, Oak River Granodiorite/ Pama Province, Kidston breccia/ Kennedy Province	Porphyry-related subvolcanic breccia pipe in metamorphics, granodiorite, rhyolite and quartz-feldspar porphyry. Held under Mining Lease by Kidston Gold Mines Ltd.
Kingston Gold Mine	Logan City	Abandoned mine	613.2kg Au (1898, 1932–1954)	Mined out	Neranleigh-Fernvale beds/ Beenleigh Subprovince	Slate-belt style mesothermal quartz veins in schist, phyllite and quartzite.
Kitty O'Shea	60km SSW of Townsville	Abandoned mine, inactive prospect	0.4kg Au (1898)	1Mt at 1.5g/t Au for 1500kg Au (Close, 1983)	Julia Formation/ Burdekin Basin	Intrusive-related mesothermal quartz veins in sandstone and siltstone.
Lady Ella	48km NNE of Chatsworth	Abandoned mine, active prospect	Not recorded	0.74Mt at 1.51% Cu and 1.26g/t Au for 11 164t Cu and 929kg Au (Selwyn Mines Limited, 2002)	Hampden Slate/ Kuridala-Selwyn Domain	Breccia-hosted Cu deposit in breccia, schist and metadolerite. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
Lorena	14.8km E of Cloncurry	Care and maintenance, active prospect	245.4kg Au bullion (1990, 1996–2000)	272 800t at 9g/t Au for 2426kg Au (Malachite Resources Limited, 2010)	Toole Creek Volcanics/ Soldiers Cap Domain	Quartz-calcite veins stockwork and breccia in shale and metabasalt. Held under Mining Lease by Volga Elderberry Pty Ltd (Malachite Resources Ltd)
Lost Mine	115km W of Cairns	Abandoned mine, active prospect	Not recorded	0.5Mt at 3g/t Au for 1500kg Au (Chapple & Gibbes, 1989)	Hodgkinson Formation/ Hodgkinson Province	Slate-belt style mesothermal quartz veins in meta-arenite. Held under Mining Lease by Dudeneye Pty Ltd.
Lucky Creek Goldfield	21km WSW of Greenvale	Abandoned mines, active prospect	54kg Au (1903–1940)	Steam Engine – 0.28Mt at 2.5g/t Au for 700kg Au (Rea, 1990)	Lucky Creek Metamorphic Group/ Thalanga Province	Intrusive-related mesothermal quartz veins in schist. Held under Mineral Development Licence and Exploration Permit by Traditional Securities Group Pty Ltd.
Manumbar	36km SE of Goomeri	Abandoned mine, active prospect	1047.8kg Au, 1133.7kg Ag (1996–2000)	Not calculated	Neara Volcanics/ Esk Basin	Low sulphidation epithermal quartz veins and breccia in andesite and agglomerate. Held under Mining Lease by D'Aguilar Gold Ltd.

Table 13 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Merlin (including Little Wizard)	147km SE of Mount Isa	Active prospect, scoping study in progress	Not mined	Merlin – 6.7Mt at 1.32% Mo, 23.05g/t Re, 8.28g/t Ag, 0.33% Cu, 0.13% Zn, 0.02% Pb, 0.01% Co and 0.08g/t Au for 88 800t Mo, 154 470kg Re, 55 590kg Ag, 22 330t Cu, 9580t Zn, 1340t Pb, 544t Co and 546kg Au Little Wizard – 15 999t at 6.49% Mo, 83.9g/t Re, 25g/t Ag, 2.29% Cu, 0.63g/t Au and 0.01% Pb for 973t Mo, 1258kg Re, 375kg Ag, 343t Cu, 9kg Au and 1t Pb (Ivanhoe Australia Limited, 2010a)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted breccia in metasediments along Mount Dore Fault Zone. Held under mining leases by Ivanhoe Australia Ltd. Construction of an access decline commenced in the second half of 2010. Underground mine, molybdenum concentrator and roaster are planned, with production to commence in 2012.
Monakoff	20.8km ENE of Cloncurry	Abandoned mine, active prospect	466.6t Cu, 0.37kg Au (–1958, 1997–1998)	4Mt at 1.35% Cu and 0.42g/t Au for 53 800t Cu and 1680kg Au (Exco Resources Limited, 2010)	Mount Norna Quartzite/ Soldiers Cap Domain	Iron oxide-Cu-Au deposit in siltstone, amphibolite and shale. Held under Mining Lease by Great Australian Operations Pty Ltd (Exco Resources Ltd) but recently sold to Xstrata Copper.
Monal Goldfield	42km N of Monto	Abandoned mines, active prospects	589kg Au (1891–1904)	Not calculated	Rockhampton Group/ Rockhampton Subprovince; Littlemore Granodiorite/ Permo-Triassic Igneous Provinces	Porphyry intrusion-related quartz veins and skarns in sandstone, siltstone and granodiorite. Held under Exploration Permits and Mineral Development Licence by Energy Minerals Pty Ltd, Horton Geoscience Consultants Pty Ltd and Laguna Resources NL.
Monsildale	8.5km WSW of Jimna	Abandoned mine, active prospect	Not recorded	0.35Mt at 2g/t Au for 700kg Au (Young, 1986)	Marumba beds/ Marumba Subprovince	Intrusive-related mesothermal quartz veins in conglomerate, greywacke, argillite and andesite. Held under Exploration Permit by China Australia Mining Pty Ltd.
Mountain Maid	45km W of Chillagoe	Abandoned mine, active prospect	Not recorded	72Mt at 0.23g/t Au for 16 560kg Au (Axiom Mining Limited, 2010)	Nundah Granodiorite/ Pama Province	Porphyry intrusion-related quartz veins and stockwork in granodiorite and porphyry. Held under Exploration Permit by Ozmin Resources Pty Ltd (Axiom Mining Ltd).

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount Biggenden		38.4km ENE of Gayndah	Operating mine producing crushed aggregate and road base material	1612.5t bismuthinite, 1511.3kg Au, 5.9t Cu, 203.2t limestone, 740 462.3t magnetite (1890–1895, 1901–1912, 1931–1938, 1942–1954, 1967–1999)	Essentially mined out	Gympie Group/ Gympie Province	Magnetite skarn deposit. Originally mined for gold, copper and bismuth. Mined by Commercial Minerals Pty Ltd to produce magnetite for coal washing. Currently operated to produce crushed aggregate from the waste dumps.
Mount Cannindah	East Cannindah	80km SW of Gladstone	Abandoned mine, active prospect	Not reported	0.25Mt at 2.82g/t Au for 705kg Au (Coolgardie Gold NL, 1998)	Rockhampton Group/ Rockhampton Subprovince	Porphyry Cu–Mo–Au deposit in mudstone. Held under Mining Leases by Mount Cannindah Mining Pty Ltd (Planet Metals Ltd). Farm-in by Drummond Gold Ltd.
	Mount Cannindah	80km SW of Gladstone	Abandoned mine, active prospect	1030t Cu, 933.1kg Au (1906–1907, 1916–1918, 1947–1965)	7.43Mt at 0.98% Cu, 0.38g/t Au and 15.5g/t Ag for 72 815t Cu, 2841kg Au and 115 160kg Ag (Queensland Ores Limited, 2008)	Rockhampton Group/ Rockhampton Subprovince; “The Monument intrusive”/ Permo-Triassic Igneous Provinces	Porphyry Cu–Mo–Au deposit in mudstone, granite, granodiorite and diorite. Held under Mining Leases by Mount Cannindah Mining Pty Ltd (Planet Metals Ltd). Farm-in by Drummond Gold Ltd.
Mount Carlton	Herbert Creek East	41.7km NW of Collinsville	Active prospect	Not mined	0.351Mt at 2.17g/t Au and 4.2g/t Ag for 761kg Au and 1474kg Ag (Conquest Mining Limited, 2009)	Lizzie Creek Volcanics/ Bowen Basin	High sulphidation epithermal quartz vein stockwork in rhyodacite and volcaniclastics. Held under Exploration Permit and Mining Lease application by Conquest Mining Ltd.
	Mount Carlton	44.3km NW of Collinsville	Active prospect, mining development	Not mined	Main Hill - 0.966Mt at 0.35% Cu, 1.35g/t Au and 38g/t Ag for 3332t Cu, 1304kg Au and 36 708kg Ag. Western Lodes – 0.558Mt at 1.49g/t Au and 120g/t Ag for 831kg Au and 66 960kg Ag (Conquest Mining Limited, 2009)	Lizzie Creek Volcanics/ Bowen Basin	High sulphidation epithermal quartz vein stockwork in rhyodacite and volcaniclastics. Held under Exploration Permit and Mining Lease application by Conquest Mining Ltd.
	Silver Hill	44km NW of Collinsville	Active prospect, mining development	Not mined	25.8Mt at 0.28% Cu, 1.66g/t Au and 44.65g/t Ag for 71 520t Cu, 42 717kg Au and 1 152 000kg Ag (Conquest Mining Limited, 2010)	Lizzie Creek Volcanics/ Bowen Basin	High sulphidation epithermal quartz vein stockwork in rhyodacite, breccia and volcaniclastics. Held under Exploration Permit and Mining Lease application by Conquest Mining Ltd.

Table 13 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount Chalmers	80km NW of Gladstone	Abandoned mine, active prospect	22 624t Cu, 19 021t Pb, 7099t Zn, 3619.9kg Au, 21 751.3kg Ag (1860–1982)	3.55Mt at 1.26% Cu, 0.4% Zn, 0.16% Pb, 0.85g/t Au and 8.5g/t Ag for 44 610t Cu, 14 400t Zn, 5760t Pb, 3014kg Au and 30 140kg Ag (Echo Resources Limited, 2006)	Chalmers Formation/ Berserker Subprovince	Volcanogenic massive sulphide deposit in sandstone, dolomite and volcaniclastics. Held under Mining Lease by Affinis Pty Ltd (Echo Resources Ltd).
Mount Dore	147km SE of Mount Isa	Active prospect, scoping study in progress	6t Cu (1936)	Copper zone with 144.4Mt at 0.52% Cu, 0.01% Mo, 0.1g/t Re, 0.1g/t Au, 5.94g/t Ag, 0.30% Zn, 0.05% Pb and 0.01% Co for 747 880t Cu, 14 440t Mo, 14 440kg Re, 14 154kg Au, 857 960kg Ag, 433 410t Zn, 75 130t Pb and 11 497t Co (Ivanhoe Australia Limited, 2010a)	Kuridala Formation/ Quamby–Malbon Subprovince	Shear zone hosted breccia in metasediments along Mount Dore Fault Zone. Held under mining leases by Ivanhoe Australia Ltd. Heap-leach SX-EW processing planned for oxide ore.
Mount Elliott/Swan	16km N of Selwyn mine	Care and maintenance, active prospect	144 893.4t Cu, 6690.3kg Au bullion (1907–1920, 1993–2001)	570Mt at 0.44% Cu and 0.26g/t Au for 2 532 000t Cu and 146 400kg Au (Ivanhoe Australia Limited, 2010b)	Hampden Slate/ Kuridala-Selwyn Domain	Iron oxide-Cu-Au deposit in phyllite, schist, siltstone, quartzite, amphibolite, marble and calc-silicate granofels. Held under Mining Lease by Ivanhoe Australia Ltd.
Mount Freda	38.7km SE of Cloncurry	Abandoned mine, active prospect	317.1kg Au (1880–1945, 1975–1989)	1.6Mt at 1.7g/t Au and 0.03% Co for 2720kg Au and 464t Co (Queensland Mining Corporation Limited, 2011b)	Toole Creek Volcanics/ Soldiers Cap Domain	Shear zone hosted veins and breccia in metabasalt, quartzite, slate and schist. Held under mining lease by Spinifex Mines Pty Ltd (Queensland Mining Corporation Ltd).
Mount Leyshon	23.8km S of Charters Towers	Abandoned mine	107 670kg Au, 68 900kg Ag (1986–2002)	Mined out	Mount Leyshon Complex/ Kennedy Province	Porphyry-related subvolcanic breccia in rhyolite and trachyte. Held under Mining Lease by Leyshon Resources Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount MacKenzie		60km SSW of St Lawrence	Active prospect	Not mined	2.95Mt at 1.1g/t Au for 3188kg Au (Marlborough Gold Mines Ltd, 1995)	Mount Benmore Volcanics/ Connors Subprovince	High sulphidation epithermal quartz veins and porphyry-related quartz veins in andesite, volcaniclastics and quartz diorite. Held under Exploration Permit by SmartTrans Holdings Ltd and Australia Oriental Minerals NL.
Mount Morgan		36km SW of Rockhampton	Abandoned mine, active prospect, feasibility study completed	360 616t Cu, 215 268kg Au bullion, 78 788kg Au, 36 842kg Ag, 568 000t pyrite (1884–1990)	Mullock — 0.345Mt at 1.85g/t Au for 638kg Au. Slag — 6Mt at 0.34% Cu and 1g/t Au for 20 400t Cu and 6000kg Au (Norton Gold Fields Limited 2007). Tailings — 8.348Mt at 1.23g/t Au for 10 237kg Au (Norton Gold Fields Limited, 2009).	Mount Warner Volcanics/ Mount Morgan Subprovince	Volcanogenic massive sulphide deposit in tuff, limestone and volcaniclastics. Held under Mining Lease by Norton Gold Fields Ltd.
Mount Rawdon		16.5km SE of Mount Perry	Operating mine	868kg Au bullion, 27 023kg Au, 53 067kg Ag (1949–1953, 2000–2010)	57.8Mt at 0.8g/t Au and 2.29g/t Ag for 46 440kg Au and 132 588kg Ag (Lihir Gold Limited, 2009)	Aranbanga Volcanic Group/ South-East Queensland Volcanic and Plutonic Province	Porphyry-related subvolcanic breccia in volcaniclastics, dacite and trachyandesite. Held under Mining Leases by LGL Mount Rawdon Operations Pty Ltd (Newcrest Mining Ltd).
Mount Shamrock		40.7km SE of Mount Perry	Abandoned mine, active prospect	916kg Au bullion, 3.73kg Au, 0.47kg Ag, 4.06t Bi (1886–1903, 1916–1917, 1923–1925, 1933–1934, 1947)	Not calculated	Good Night beds/ Wandilla Province; Aranbanga Volcanic Group, unnamed intrusive/ South-East Queensland Volcanic and Plutonic Province	Porphyry-related subvolcanic breccia in metasediments, volcanics, diorite and microdiorite. Held under Mining Lease by E.J. Vella.
North Arm		12.5km N of Nambour	Abandoned mines	605.2kg Au, 325kg Ag (1931–1939, 1997–1998)	Not calculated	North Arm Volcanic Group/ South-East Queensland Volcanic and Plutonic Province	Low sulphidation epithermal quartz veins in dacite, andesite, epiclastics, siltstone and breccia.
Northcote	Belfast Hill	18.4km NE of Dimbulah	Abandoned mine, active prospect	Not recorded	269 000t at 0.38% Sb and 1.27g/t Au for 1031t Sb and 341kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in arenite. Under mining lease application by Republic Gold Ltd.
	Black Bess	17.6km NNE of Dimbulah	Abandoned mine, active prospect	8.4t Sb and 127.4kg Au (1926–1944, 1992)	787 000t at 0.45% Sb and 2.38g/t Au for 3591t Sb and 1875kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in pelite. Under Mining Lease application by Republic Gold Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Northcote (continued)	East Leadingham	19.4km NE of Dimbulah	Abandoned mine, active prospect	156.8kg Au (1991–1992)	557 000t at 0.16% Sb and 2.29g/t Au for 885t Sb and 1275kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in greywacke and siltstone. Under Mining Lease application by Republic Gold Ltd.
	Emily	19.8km NE of Dimbulah	Abandoned mine, active prospect	3t Sb and 57.67kg Au (1878–1992)	764 000t at 0.08% Sb and 2.04g/t Au for 598t Sb and 1558kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in greywacke, slate, phyllite and schist. Under Mining Lease application by Republic Gold Ltd.
	Emily South	19.3km NE of Dimbulah	Abandoned mine, active prospect	44.32kg Au (1991–1992)	222 000t at 0.04% Sb and 2.26g/t Au for 86t Sb and 501kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in arenite and argillite. Under Mining Lease application by Republic Gold Ltd.
	Ethel	18.1km NNE of Dimbulah	Abandoned mine, active prospect	67.6t Sb and 25.02kg Au (1892–1950, 1991–1992)	843 000t at 0.24% Sb and 1.89g/t Au for 2035t Sb and 1596kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in arenite. Under Mining Lease application by Republic Gold Ltd.
	Tunnel Hill	20km NNE of Dimbulah	Abandoned mine, active prospect	Not reported	450 000t at 0.27% Sb and 1.77g/t Au for 1236t Sb and 797kg Au (Republic Gold Limited, 2005)	Hodgkinson Formation/ Hodgkinson Province	Mesothermal Sb-Au-quartz veins in greywacke and siltstone. Under Mining Lease application by Republic Gold Ltd.
Norton (Milton) Goldfield		8.6km NE of Nagoorin	Abandoned mines, care and maintenance, active prospects	>560kg Au (1878–1905, 1980), 52.9kg Au, 32kg Ag (1996–1997, 2005–2006)	0.453Mt at 7.53g/t Au for 3412kg Au (Norton Gold Fields Limited, 2005)	Norton Tonalite/ Permo-Triassic Igneous Provinces	Intrusive-related quartz veins in tonalite. Held under Mining Lease and Exploration Permit by Norton Gold Holdings Pty Ltd and Roar Resources Pty Ltd.
Nymbool Porphyry		110km SW of Cairns	Inactive prospect	Not mined	2.433Mt at 0.73g/t Au for 1782kg Au (Strike Mining NL, 1996)	Sandy Tate Granite/ Kennedy Province	Porphyry Au deposit in quartz-feldspar porphyry. Held under Exploration Permits by International Metals (Qld) Pty Ltd and Bookall Mining Company Pty Ltd.
Osborne Operation	Inheritance	94km SSE of Mount Isa	Care and maintenance	39 142t Cu, 996.5kg Au (1900–1058, 2006–2010)	Confidential	Corella Formation/ Mary Kathleen Domain	Shear-hosted veins in schist and granofels. Held under Mining Lease by Barrick (Osborne) Pty Ltd (Ivanhoe Australia Ltd).
	Osborne	32km ESE of Chatsworth Homestead	Care and maintenance	536 570t Cu, 19 628.4kg Au Bullion (1995–2010)	6.818Mt at 1.42% Cu and 0.84g/t Au for 96 578t Cu and 5755kg Au (Ivanhoe Australia Limited, 2010c)	Starcross Formation/ Kuridala-Selwyn Domain	Iron oxide-Cu-Au deposit in ironstone and schist. Held under Mining Lease by Ivanhoe (Osborne) Pty Ltd (Ivanhoe Australia Ltd).

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Pajingo	Cindy	39km NE of Pajingo Homestead	Abandoned mine, active prospect	1445.3kg Au, 779.6kg Ag (1994–1996)	Mined out	Vera-Nancy Volcanics/ Drummond Basin	Low sulphidation epithermal quartz veins and stockworks in andesite and tuff. Held under Mining Lease by NWM Gold No 2 Pty Ltd and HSK Gold Australia Pty Ltd (Conquest Mining Ltd).
	Scott Lode	39.2km NE of Pajingo Homestead	Abandoned mine, active prospect	11 399.4kg Au, 31 806.4kg Ag (1987–1993)	Mined out	Vera-Nancy Volcanics, Pallamana Sandstone/ Drummond Basin	Low sulphidation epithermal quartz veins and stockworks in andesite, tuff, volcaniclastics and sandstone. Held under Mining Lease by NWM Gold No 2 Pty Ltd and HSK Gold Australia Pty Ltd (Conquest Mining Ltd).
	Vera-Nancy	38.6km NE of Pajingo Homestead	Operating mine	67 010.5kg Au, 60 958.6kg Ag (1996–2010)	2.013Mt at 7.5g/t Au for 15 105kg Au (North Queensland Metals Limited, 2008)	Vera-Nancy Volcanics/ Drummond Basin	Low sulphidation epithermal quartz veins and stockworks in andesite, tuff, volcaniclastics and sandstone. Held under Mining Lease by NWM Gold No 2 Pty Ltd and HSK Gold Australia Pty Ltd (Conquest Mining Ltd).
Palmer Goldfield	Palmer Goldfield	185km NW of Cairns	Abandoned mines	>39 200kg alluvial gold, 4340.5kg lode gold (1873–1990). The most productive reef mines were the Anglo Saxon (0.96t) and Queen of the North (0.51t).	See below	Hodgkinson Formation/ Hodgkinson Province; alluvium/ Cainozoic Alluvial and Colluvial Deposits	Slate-belt style mesothermal quartz veins in metasediments; alluvial placer Au. Held under Mining Leases and Exploration Permits by BHP Billiton Minerals Pty Ltd, Dianne Mining Corporation Pty Ltd, Imode Pty Ltd, Lodestone Energy Ltd, MFG Pty Ltd, Nickmere Pty Ltd, Palmer River Pty Ltd, Prospect Hill Mining and Exploration Pty Ltd, Republic Gold Ltd, and numerous individuals.
	Fine Gold Creek	145km WNW of Cairns	Abandoned mine, inactive prospect	Not recorded	3.7Mm^3 at 0.62g/m^3 Au for 2306kg Au (Hamilton, 1988)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer Au.
	Reedy	140km WNW of Cairns	Active prospect	Not mined	0.886Mt at 1.3g/t Au for 1151kg Au (Republic Gold Limited, 2006)	Hodgkinson Formation/ Hodgkinson Province	Slate-belt style mesothermal quartz veins in metasediments. Held under Exploration Permit by Republic Gold Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Rannes Project	Crunchy Granola	13km SW of Rannes	Active prospect	Not mined	4.6Mt at 0.51g/t Au and 50g/t Ag for 2346kg Au and 230 000kg Ag (Solomon Gold Plc, 2011)	Camboon Volcanics/ Auburn Subprovince	Epithermal quartz veins in andesite and metasediments. Held under Exploration Permit by Central Mines Pty Ltd. (D'Aguilar Gold Ltd).
	Kauffmans	9.4km SSW of Rannes	Abandoned mine, active prospect	Not recorded	7.7Mt at 0.68g/t Au and 9g/t Ag for 5236kg Au and 69 300kg Ag (Solomon Gold Plc, 2011)	Camboon Volcanics/ Auburn Subprovince	Epithermal quartz veins in andesite, limestone and tuff. Held under Exploration Permit by Central Mines Pty Ltd. (D'Aguilar Gold Ltd).
	Porcupine Pie	10.5km S of Rannes	Abandoned mine, active prospect	Not recorded	0.745Mt at 1.86g/t Au for 1385kg Au (Milburn, 1997)	Camboon Volcanics/ Auburn Subprovince	Epithermal quartz veins in schist. Held under Exploration Permit by Central Mines Pty Ltd. (D'Aguilar Gold Ltd).
Ravenswood Goldfield	Ravenswood Goldfield	Centred on town of Ravenswood	Operating mine, abandoned mines, active prospects	>28t Au (1868–1962) Significant producing mines included: Sunset (6.5t), General Grant (1.49t), Donnybrook (0.74t), Black Jack (0.53t), Buck Reef West (0.45t)	See below	Millaroo Granite/ Macrossan Province; Ravenswood Granodiorite Complex, Jessop Creek Tonalite/ Pama Province; unnamed rhyolitic intrusives/ Kennedy Province; alluvium/ Cainozoic Alluvial and Colluvial Deposits	Intrusive-related mesothermal and porphyry-related quartz veins and stockworks in tonalite, granodiorite and diorite; auriferous subvolcanic breccias in granite and rhyolite; alluvial placer gold. Held under Exploration Permits and Mining Leases by Carpentaria Gold Pty Ltd, Conquest Mining Ltd, Kitchener Mining NL, .
	Area 2	0.8km SSW of Ravenswood	Abandoned mine, active prospect	1757.4kg Au (1992–1993)	Mined out	Jessop Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins and stockworks in tonalite. Held under Mining Leases by Carpentaria Gold Pty Ltd.
	Area 5	1.0km SE of Ravenswood	Abandoned mine	624kg Au (1988–1991)	Mined out	Jessop Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins and stockworks in tonalite. Held under Mining Leases by Carpentaria Gold Pty Ltd.
	Copper Knob	1.3km N of Ravenswood	Abandoned mine, active prospect	Included in figures for Ravenswood Goldfield	2.16Mt at 0,11% Cu, 0.82g/t Au, 0.2% Zn and 4.3g/t Ag for 2468t Cu, 1783kg Au, 4340t Zn and 9312kg Ag (Haoma Mining NL, 1999)	Jessop Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins and stockworks in tonalite. Held under Mining Lease by Kitchener Mining NL.
	Mount Wright	9.0km NW of Ravenswood	Operating mine	2066.6kg Au, 662.4kg Ag (1992–1993, 2009–2010)	7.31Mt at 2.72g/t Au for 19 911kg Au (Resolute Mining Limited, 2010)	Millaroo Granite/ Macrossan Province; unnamed rhyolitic intrusives/ Kennedy Province	Auriferous subvolcanic breccia in granite and rhyolite. Held under Mining Lease by Carpentaria Gold Pty Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Ravenswood Goldfield (continued)	Nolans	1.6km SE of Ravenswood	Abandoned mine	11 308.9kg Au bullion, 7205.9kg fine Au, 1816.1kg Ag (1996–2002)	Mined out	Jessop Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins and stockworks in tonalite. Held under Mining Leases by Carpentaria Gold Pty Ltd.
	OCA	0.9km E of Ravenswood	Abandoned mine	1596.9kg Au (1987–1991)	Mined out	Jessop Creek Tonalite/ Pama Province	Porphyry-related quartz veins and stockworks in tonalite. Held under Mining Leases by Carpentaria Gold Pty Ltd.
	Sarsfield	0.9km ESE of Ravenswood	Operating mine	1787.9kg Au bullion, 33 959.6kg fine Au, 9058.9kg Ag (2000–2010)	80.34Mt at 0.73g/t Au for 58 624kg Au (Resolute Mining Limited, 2010, 2011)	Jessop Creek Tonalite/ Pama Province	Intrusive-related mesothermal quartz veins and stockworks in tonalite and diorite. Held under Mining Leases by Carpentaria Gold Pty Ltd.
	Slaughter-yard Creek	0.5km ESE of Ravenswood	Abandoned mine	1420.6kg Au (1987–1997)	Mined out	Jessop Creek Tonalite/ Pama Province	Intrusive-related mesothermal and porphyry-related quartz veins and stockworks in tonalite and diorite. Held under Mining Leases by Carpentaria Gold Pty Ltd.
Rebound		46km W of Cloncurry	Active prospect	Not mined	0.736Mt at 7.67% Cu and 1.02g/t Au for 56 451t Cu and 750kg Au (Seymour, 2001)	Corella Formation/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in quartzite. Held under Exploration Permit by Mosquito Resources (Australia) Pty Ltd.
Red Dam		11.7km E of Dagworth Homestead	Abandoned mine, active prospect	Not recorded	151 200t at 19.8g/t Au and 33.1g/t Ag for 3001kg Au and 5010kg Ag (Plentex Limited, 2006)	Lane Creek Formation, Cobbold Metadolerite/ Etheridge Province	Shear-hosted hydrothermal quartz veins in metamorphics. Held under Mining lease and Exploration Permit by Deutsche Rohstoff Australia Pty Ltd.
Rocklands Project (Las Minerale)		15km W of Cloncurry	Active prospect (feasibility study completed)	Not mined	41Mt at 0.76% Cu, 0.03% Co and 0.11g/t Au for 312 700t Cu, 13 580t Co and 4580kg Au (CuDeco Limited, 2010a)	Mitakoodi Quartzite/ Quamby-Malbon Subprovince	Shear zone hosted veins and breccia in siltstone, quartzite, dolerite and calc-silicate rocks. Held under Mining Lease and Exploration Permit by CuDeco Limited.
Roseby Copper Project	Lady Clayre	16.4km WNW of Quamby	Abandoned mine, active prospect (feasibility study completed)	25.7t Cu, 1.49kg Ag (–1908, 1969)	3.7Mt at 0.88% Cu and 0.5g/t Au for 32 712t Cu and 1858kg Au (Universal Resources Limited, 2010)	Coocerina Formation/ Mary Kathleen Domain	Shear-hosted Cu-Au-quartz veins and stratabound lenses in shale, dolomite and quartzite. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.
	Little Eva	28.9km NNW of Quamby	Abandoned mine, active prospect (feasibility study completed)	28.5t Cu, 0.22kg Au (–1958, 1961)	26.53Mt at 0.75% Cu and 0.13g/t Au for 198 231t Cu and 3523kg Au (Universal Resources Limited, 2010)	Corella Formation/ Mary Kathleen Domain	Iron oxide-Cu-Au deposit in schist and calc-silicate rocks. Held under Mining Lease by Roseby Copper Pty Ltd and Altona Mining Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Rosehall Prospect		19.8km NE of Auburn	Active prospect	Not mined	0.595Mt at 1.7g/t Au for 1011kg Au (Cardia Technologies Limited, 1999)	Mount Saul Quartz Monzonite/ Rawbelle Batholith	Epithermal quartz veins in monzonite. Held under Exploration Permit by Rugby Mining Pty Ltd.
Selwyn (Starra) Line	Selwyn Plant	37km NNE of Chatsworth Homestead	Care and maintenance	25 500.4t Cu, 946.1kg Au (1999–2003) — production not attributable to individual deposits.	Not applicable	Not applicable	Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
	Starra 222	34km NNE of Chatsworth Homestead	Abandoned mine, active prospect	21 000t Cu, 8646kg Au (1988–1998)	12.6Mt at 0.62% Cu and 0.83g/t Au for 78 300t Cu and 10 410kg Au (Ivanhoe Australia Limited, 2009)	Staveley Formation/ Marimo-Staveley Domain	Iron oxide-Cu-Au deposit in ironstone, arenite, schist and calc-silicate rocks. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
	Starra 244	37km NNE of Chatsworth Homestead	Abandoned mine, active prospect	4000t Cu, 2613kg Au (1988–1998)	Mined out	Staveley Formation/ Marimo-Staveley Domain	Iron oxide-Cu-Au deposit in ironstone, arenite, schist and calc-silicate rocks. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
	Starra 251	37km NNE of Chatsworth Homestead	Abandoned mine, active prospect	104 000t Cu, 13 499kg Au (1987–1994)	Mined out	Staveley Formation/ Marimo-Staveley Domain	Iron oxide-Cu-Au deposit in ironstone, arenite, schist and calc-silicate rocks. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
	Starra 257	38km NNE of Chatsworth Homestead	Abandoned mine, active prospect	7000t Cu, 5195kg Au (1987–1998)	Mined out	Staveley Formation/ Marimo-Staveley Domain	Iron oxide-Cu-Au deposit in ironstone, arenite, schist and calc-silicate rocks. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
	Starra 276	39km NNE of Chatsworth Homestead	Abandoned mine, active prospect	7000t Cu, 1244kg Au (1997–1999)	17.7Mt at 1.13%Cu and 0.83g/t Au for 200 400t Cu and 14 740kg Au (Ivanhoe Australia Limited, 2009)	Staveley Formation/ Marimo-Staveley Domain	Iron oxide-Cu-Au deposit in ironstone, arenite, schist and calc-silicate rocks. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
Shamrock		20.5km ESE of Goomeri	Abandoned mine, active prospect	292.6kg Au bullion, 403.9kg fine Au, 90.1kg Ag, 56.6t Cu (1860–1907, 1990-1993)	Not calculated	Black Snake Porphyry/ South East Queensland Volcanic and Plutonic Province	Porphyry intrusion-related quartz veins in feldspar porphyry. Held under Mining Leases by D'Aguilar Gold Ltd.

Table 13 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Silver Spur	10.2km E of Texas	Abandoned mine, active prospect	990t Cu, 1050t Pb, 690t Zn, 140kg Au, 68 000kg Ag (1892–1976)	Ore – 0.808Mt at 0.17% Cu, 3.56% Zn, 1.25% Pb, 0.9g/t Au and 70g/t Ag for 1373t Cu, 28 764t Zn, 10 100t Pb, 727kg Au and 56 560kg Ag (Macmin Silver Ltd, 2008a). Slag – 90 000t at 0.34% Cu, 15.8% Zn, 3.17% Pb, 0.5g/t Au and 158g/t Ag for 306t Cu, 14 220t Zn, 2853t Pb, 45kg Au and 14 220kg Ag (Macmin Silver Ltd, 2004).	Silver Spur beds/ Texas Subprovince	Volcanogenic massive sulphide deposit in shale, siltstone and greywacke. Held under Mining Lease by Texas Silver Mines Pty Ltd (Alcyone Resources Ltd)
Slate Ridge	36km N of Chatsworth Homestead	Active prospect	Not mined	0.5Mt at 2.53% Cu and 0.15g/t Au for 12 660t Cu and 744kg Au (Selwyn Mines Limited, 2002)	Answer Slate/ Marimo-Staveley Domain	Shear-hosted Cu-Au-quartz veins in siltstone and schist. Held under Exploration Permit by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
Tick Hill	43km E of Dajarra	Abandoned mine	15 900kg Au bullion (1991–1995)	Mined out	Corella Formation/ Mary Kathleen Domain	Shear zone hosted hydrothermal vein system in granofels, quartzite, schist and calc-silicate rocks. Held under Mining Lease by Mount Isa Mines Ltd (Xstrata Plc).
Tregoora Gold Project (Sleeping Giant, Retina and Terrace Creek)	63km W of Mount carbine	Abandoned mine, active prospect	17 515t limestone (2003–2004)	4.472Mt at 1.6g/t Au for 7122kg Au (Republic Gold Limited, 2010)	Hodgkinson Formation/ Hodgkinson Province	Slate-belt style mesothermal Sb-Au-quartz veins in schist. Held under Mining Lease by Republic Gold Ltd.
Triple Crown	4km WNW of Mount Garnet	Active prospect	Not mined	0.467Mt at 1.5g/t Au for 700kg Au (Queensland Ores Limited, 2005)	Chillagoe Formation/ Hodgkinson Province; unnamed granite/ Kennedy Province	Breccia pipes in granite and metasediments. Held under Mining Lease by Snowmist Pty Ltd.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Twin Hills		9.3km E of Texas	Care and maintenance	5.6kg Au, 11 669.5kg Au (2006–2008)	Leach dumps – 14.41Mt at 0.07g/t Au and 34.5g/t Ag for 1008kg Au and 497 230kg Ag (Macmin Silver Ltd, 2008a) *In situ* – 3.842Mt at 79.3g/t Ag for 304 746kg Ag (Alcyone Resources Limited, 2010)	Silver Spur beds/ Texas Subprovince	Low sulphidation epithermal quartz veins in volcaniclastics. Held under Mining Lease by Texas Silver Mines Pty Ltd (Alcyone Resources Ltd).
Twin Hills	309	21.4km WSW of Avon Downs Homestead	Care and maintenance, active prospect	266.9kg Au, 808.6kg Ag (2005–2007)	3.685Mt at 2.59g/t Au and 3.2g/t Ag for 9533kg Au and 11 808kg Ag (North Queensland Metals Limited, 2009)	Saint Anns Formation, Silver Hills Volcanics/ Drummond Basin	Low sulphidation epithermal quartz veins and breccia in mudstone, sandstone, tuff and volcaniclastics. Held under Mining Lease by HSK Gold Australia Pty Ltd and NWM Gold 2 Pty Ltd (Conquest Mining Ltd).
	Lone Sister	22.7km SW of Avon Downs Homestead	Active prospect	Not mined	1.016Mt at4.09g/t Au and 4.86g/t Ag for 4155kg Au and 4938kg Ag (North Queensland Metals Limited, 2010)	Silver Hills Volcanics/ Drummond Basin	Low sulphidation epithermal quartz veins and breccia in mudstone, rhyodacite and tuff. Held under Mining Lease by HSK Gold Australia Pty Ltd and NWM Gold 2 Pty Ltd (Conquest Mining Ltd).
Victoria		12.5km NW of Chillagoe	Abandoned mine, active prospect	29t Pb, 25.5kg Ag and 34t Cu (1922–1923)	3.44Mt at 5.09% Zn, 22.23g/t Ag, 0.96% Cu, 0.14g/t Au and 14.8ppm Mo for 175 020t Zn, 76 490kg Ag, 33 160t Cu, 489kg Au and 51t Mo (Kagara Ltd, 2010)	Chillagoe Formation/ Hodgkinson Province	Cu skarn. Held under Exploration Permit by Mungana Pty Ltd.
Victoria mine		28km NE of Chatsworth Homestead	Abandoned mine, active prospect	4938.5t Cu, 60.6kg Au (1994–1995)	2.92Mt at 1.21% Cu and 0.18g/t Au for 35 360t Cu and 532kg Au (Selwyn Mines Limited, 2002)	Hampden Slate/ Kuridala-Selwyn Domain	Shear-hosted Cu-Au veins in schist, phyllite and shale. Held under Mining Lease by Ivanhoe Cloncurry Mines Pty Ltd (Ivanhoe Australia Ltd).
Wenlock Goldfield		40km N of the Archer River Roadhouse	Abandoned mines	1521.1kg Au bullion (1892–1894, 1905–1965)	Not calculated	Kintore Granite/ Pama Province	Shear-hosted quartz veins in granite; alluvial and deep lead placer gold.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
White Range Project	Greenmount	110km ESE of Mount Isa	Abandoned mine, active prospect	Not recorded	12.29Mt at 0.79% Cu, 0.06% Co and 0.32g/t Au for 96 716t Cu, 7263t Co and 3883kg Au (Queensland Mining Corporation Limited, 2010a)	Staveley Formation, Marimo Slate/ Marimo-Staveley Domain	Shear zone hosted veins and breccia in siltstone, slate and schist. Held under Mining Lease and Mineral Development Licence by Queensland Mining Corporation Ltd.
	Kuridala	115km SE of Mount Isa	Active prospect	Not mined	7.2Mt at 0.84% Cu and 0.02% Co and 0.21g/t Au for 60 110t Cu, 1610t Co and 1494kg Au (Queensland Mining Corporation Limited, 2010a)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted veins and breccia in slate and metadolerite. Held under Mining Lease by Queensland Mining Corporation Ltd.
	Stuart	155km SE of Mount Isa	Abandoned mine, active prospect	21t Cu (1968-1979)	5.58Mt at 0.55% Cu, 0.002% Co and 0.14g/t Au for 30 690t Cu, 122t Co and 781kg Au (Queensland Mining Corporation Limited, 2010b)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted veins and breccia in siltstone, slate and shale. Held under Mining Lease by Queensland Mining Corporation Ltd.
Wirralie		31.3km NNW of Mount Coolon	Care and maintenance, active prospect	17 281.6kg Au (1988–1993, 1999–2001, 2006–2007)	9.734Mt at 1.75g/t Au for 17 060kg Au (Ashburton Minerals Ltd, 2004)	Mount Wyatt Formation/ Drummond Basin	Low sulphidation epithermal quartz veins, stockwork and breccia in conglomerate, sandstone, mudstone, tuff and volcaniclastics. Held under Mining Lease by Wirralie Mines Pty Ltd
Woolgar Gold Project	Explorer and Explorer South	109km NNE of Richmond	Active prospect	Not mined	0.895Mt at 2.53g/t Au for 2262kg Au (Strategic Minerals Corporation NL, 2006)	Einasleigh Metamorphics/ Etheridge Province	Low sulphidation epithermal quartz veins and stockworks in dolerite and metamorphics. Held under Mining Lease by Strategic Minerals Corporation NL.
	Grand Central	109km NNE of Richmond	Active prospect	Not mined	0.436Mt at 1.16g/t Au for 506kg Au (Strategic Minerals Corporation NL, 2006)	Einasleigh Metamorphics/ Etheridge Province	Low sulphidation epithermal quartz veins and stockworks in dolerite and metamorphics. Held under Mining Lease by Strategic Minerals Corporation NL.

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Woolgar Gold Project (continued)	Lost World	109km NNE of Richmond	Active prospect	Not mined	5.58Mt at 1.42g/t Au for 8051kg Au (Strategic Minerals Corporation NL, 2006)	Einasleigh Metamorphics/ Etheridge Province	Low sulphidation epithermal quartz veins and stockworks in dolerite and metamorphics. Held under Mining Lease by Strategic Minerals Corporation NL.
	Soapspar	110km N of Richmond	Abandoned mine, active prospect	Included with Woolgar Goldfield	3.314Mt at 0.89g/t Au for 2960kg Au (Strategic Minerals Corporation N,L 2007)	Einasleigh Metamorphics/ Etheridge Province	Low sulphidation epithermal quartz veins and stockworks in dolerite and metamorphics. Held under Mining Lease by Strategic Minerals Corporation NL.
	Woolgar Goldfield	110km N of Richmond	Abandoned mines, active prospects	>979kg Au bullion (1880–1980)	Not calculated	Einasleigh Metamorphics/ Etheridge Province	Mesothermal and low sulphidation epithermal quartz veins and stockworks in dolerite and metamorphics; minor alluvial gold. Held under Exploration Permit and Mining Leases by Strategic Minerals Corporation NL.
Wynberg		25.4km ESE of Cloncurry	Active prospect	Not mined	329 000t at 2g/t Au for 658kg Au (Kingsgate Consolidated Limited, 2007)	Toole Creek Volcanics/ Soldiers Cap Domain	Shear-hosted quartz veins in siltstone and shale. Held under Exploration Permit by Kingsgate Consolidated Ltd.
Yarrol Gold Prospect		28km SE of Monto	Active prospect	Not mined	1.151Mt at 1.51g/t Au for 1738kg Au (Strike Mining NL, 1997)	Unnamed intrusive/ Permo-Triassic Igneous Provinces	Porphyry Cu-Mo-Au deposit in diorite. Held under Exploration Permit by Xtreme Resources Ltd.
Yandan Project	Eugenia (Police Creek)	6.5km NE of Mount Coolon	Active prospect	Not mined	4.416Mt at 1.23g/t Au for 5427kg Au (Drummond Gold Limited, 2009)	Silver Hills Volcanics/ Drummond Basin	Low sulphidation epithermal quartz veins, stockwork and breccia in andesite and ignimbrite. Held under Exploration Permit by Mt Coolon Gold Mines Pty Ltd (Drummond Gold Ltd).
	Glen Eva	12.5km SE of Mount Coolon	Abandoned mine, active prospect	752.5kg Au, 694.3kg Ag (1996–1998)	153 598t at 7.53g/t Au for 1156kg Au (Drummond Gold Limited, 2009)	Silver Hills Volcanics/ Drummond Basin	Low sulphidation epithermal quartz veins, stockwork and breccia in volcaniclastics and tuff. Held under Mining Lease by Mt Coolon Gold Mines Pty Ltd (Drummond Gold Ltd).
	Mount Coolon	2.7km SE of Mount Coolon	Abandoned mine, active prospect	7060.8kg Au, 756.3kg Ag (1914–1942, 1996)	0.6Mt at 3.45g/t Au for 2086kg Au (Drummond Gold Limited, 2009)	Mount Coolon Andesite/ Drummond Basin	Low sulphidation epithermal quartz veins, stockwork and breccia in andesitic ignimbrite. Held under Mining Lease by Mt Coolon Gold Mines Pty Ltd (Drummond Gold Ltd).

Table 13 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Yandan Project (continued	Yandan	38km WNW of Mount Coolon	Care and maintenance, active prospect	7046kg Au bullion, 4641kg Au, 683kg Ag (1993–2003)	4.1Mt at 2.4g/t Au for 9840kg Au (Drummond Gold Limited, 2009)	Saint Anns Formation/ Drummond Basin	Low sulphidation epithermal quartz veins stockwork in sandstone, siltstone, agglomerate and tuff. Held under Mining Lease by Straits Gold Pty Ltd (in joint venture with Drummond Gold Ltd).
Yellow Jack		43km SSW of Greenvale	Abandoned mine, active prospect	Not recorded	804 000t at 1.39g/t Au for 1121kg Au (Hewitt, 1998)	Quinton Formation/ Graveyard Creek Subprovince	Slate–belt style mesothermal quartz veins in sandstone, siltstone and shale. Held under Exploration Permit by Bluekebble Pty Ltd.
Zelma (Mount Haden)		28km SE of Mackay	Abandoned mine, inactive prospect	125.2kg Au (1892–1901, 1936–1939, 1977)	51 000t at 7.5g/t Au for 382kg Au (Burdekin Pacific Ltd, 2005)	Campwyn Volcanics, unnamed intrusives/ Campwyn Subprovince	High sulphidation epithermal quartz veins and subvolcanic breccia in volcaniclastics, siltstone, diorite, dacite and quartz-feldspar porphyry. Held under Mining Lease by Gold Dredging Pty Ltd.

IRON

Iron (as steel) is the most widely used metal and has numerous applications, including automotive and marine manufacture, building and infrastructure construction, and manufacture of tools, machinery and household items.

Queensland's only current iron ore producer is Mount Moss, 100km west of Townsville, which produces magnetite for domestic consumption as a coal washing medium and for export to China for steel making.

Queensland's magnetite and titanomagnetite deposits and resources have already been discussed under "Magnetite" in Section 8.4.2.3 and are included in Table 14 for completeness. Many of the deposits in eastern Queensland have potential as small producers of magnetite and titanomagnetite for steel making. Significant magnetite resources are associated with many of the iron oxide-copper-gold deposits (for example, Ernest Henry, Osborne) and hematite-magnetite ironstone lenses and bodies (for example, Mount Philp, Mount Leviathan) in the Eastern Fold Belt Province of the Mount Isa Inlier (Figure 20). Significant but as yet unquantified resources of magnetite (and hematite) occur within the Selwyn Ironstones south of Cloncurry. Queensland magnetite and ironstone deposits have been described by Cameron (1903), Ball (1904b), Reid (1919), Dunstan (1920a), Brooks (1956), Brooks (1957a), Brooks (1970), Bruvel & others (1995) and Wallis (2008).

Moderate resources of more traditional iron ore types have also been delineated in Queensland (Table 14). The main area of sedimentary iron formation mineralisation in Queensland is in the Constance Range area, in north-west Queensland, where up to ten lenticular beds of oolitic iron formation, with interbedded shale, siltstone and sandstone, form the Train Range Ironstone Member of the South Nicholson Group in the South Nicholson Basin. Ironstones crop out around the rims of two major and several minor structural basins that are complicated by folding and faulting. They consist of a variable mixture of ochrous red hematite, finely crystalline blue-black hematite, limonite, quartz grains and cement, clay and relict siderite, and vary in appearance from oolitic forms to a quartz sandstone with hematite matrix. Below the zone of oxidation, the ironstones comprise oolites of hematite, siderite and/or chamosite and silica grains in a matrix of siderite, hematite, quartz and carbon. Grades range from 20 to 62% Fe, depending on the silica content of the parent rock.

Exploration by the Broken Hill Proprietary Company Ltd in the early 1960s outlined three main resources (Deposits A, I and P), with a total resource of 368Mt at 45.4% Fe and 9.1% SiO_2, including 40Mt of oxidised ore at 57% Fe and 10.0% SiO_2 (Harms, 1965).

Oolitic ironstone occurs in two distinct subunits in flat-lying sandstone of the Jurassic Evergreen Formation (Surat Basin) at Dawsonvale in the Mundubbera region. Prominent plateaux and scarps with residual mesas extend from Gebe Mountain in the north-west to Mount Misery in the south-east. The mesas comprise flat-topped ironstone formation ranging from 5–30m in height, and have a reddish soil cover.

The basal subunit consists of thick-bedded oolitic ironstone and large spheroidal concretionary hematitic structures. The upper subunit is interlayered hematitic oolitic ironstone and limonitic sandstone. A scarp marks the basal contact of the ironstone unit. The oolitic ironstone at Dawsonvale is a type of sandy, clayey and oolitic sediment deposited in a shallow inland sea. The deposits are generally a few metres thick and chert-poor, but are rich in phosphorous and aluminium. These deposits are being explored by Ridge Exploration Pty Ltd and AARD Metals Ltd.

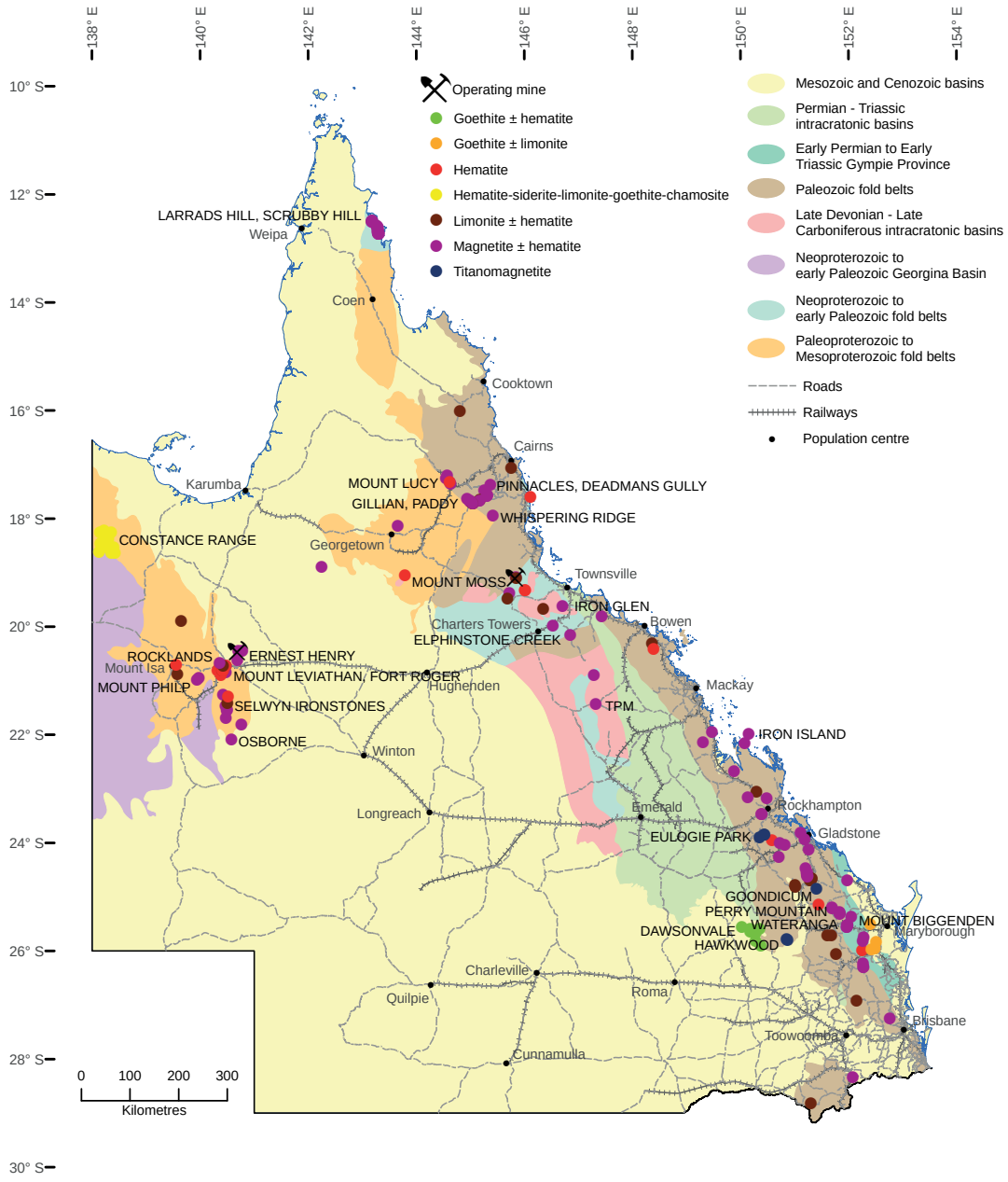

Figure 20: Iron occurrences and deposits

Table 14: Significant iron deposits in Queensland

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Constance Range — Deposit A	250km NNW of Mount Isa	Active prospect	Not mined	236.4Mt at 53.2% Fe and 10.33% SiO2 for 125.749Mt Fe (Kimberley Metals Limited, 2010)	Train Range Ironstone Member/ South Nicholson Basin	Sedimentary iron formation (mainly hematite and siderite). Within the Lawn Hill (Little Range) Resources Reserve. Held under Exploration Permit by Constance Range Pty Ltd in joint venture with Kimberley Metals Pty Ltd.
Constance Range — Deposit I	270km NNW of Mount Isa	Active prospect	Not mined	21Mt at 42.2% Fe and 7.4% SiO2 for 8.862Mt Fe (Harms, 1965)	Train Range Ironstone Member/ South Nicholson Basin	Sedimentary iron formation (mainly hematite and siderite). Within the Lawn Hill (Little Range) Resources Reserve. Held under Exploration Permit by Cast Resources Pty Ltd.
Constance Range — Deposit P	255km NNW of Mount Isa	Active prospect	Not mined	44Mt at 46.3% Fe and 7.8% SiO2 for 20.372Mt Fe (Harms, 1965)	Train Range Ironstone Member/ South Nicholson Basin	Sedimentary iron formation (mainly hematite and siderite). Within the Lawn Hill (Little Range) Resources Reserve. Held under Exploration Permit by Constance Range Pty Ltd in joint venture with Kimberley Metals Pty Ltd.
Dawsonvale	26km E of Taroom	Active prospect	Not mined	199Mt at 37.5% Fe for 74.625Mt Fe (Wallin & Murphy, 1995)	Evergreen Formation/ Surat Basin	Sedimentary iron formation (mainly goethite and hematite). Held under exploration permit by AARD Metals Ltd.
Deadmans Gully	18.5km WNW of Ravenshoe	Abandoned mine, prospect	Not reported	0.4Mt at 34.89% Fe (Consolidated Tin Mines Limited, 2010)	Hodgkinson Formation/ Hodgkinson Province; Nettle Granite/ Kennedy Province	Tin skarn deposit. Current exploration by Consolidated Tin Mines Ltd.
Elphinstone Creek	3.3km SW of Ravenswood	Deposit	Not mined	1.12Mm^3 at 20kg/m^3 magnetite for 22 400t magnetite (Switzer, 1988)	Quaternary alluvium/ Cainozoic Alluvial and Colluvial Deposits.	Alluvial deposit. Preliminary testing indicated that the magnetite is suitable for coal washing.
Ernest Henry	38km NE of Cloncurry	Operating Cu-Au mine	No magnetite produced	17Mt at 22.6% magnetite (open cut) and 88Mt at 27.9% magnetite (underground) for a total of 28.38Mt magnetite (Xstrata Plc, 2010)	Mount Fort Constantine Volcanics/ Canobie Domain	Breccia hosted iron oxide copper-gold deposit. Ernest Henry is owned by Xstrata Copper and has been producing copper and gold since 1997. The mine is in the process of transitioning from open cut to underground operations. Magnetite will be produced from underground Cu-Au ore and potentially from tailings for steel making.
Eulogie Park Prospect	50km W of Gladstone	Prospect	Not mined	Surface mineable resources of ferrigabbro ore exceeding 100Mt at an average 25% titanomagnetite and ilmenite (15.4 to >21% Fe and 1.9 to >4% Ti) (Thiess Contractors Pty Ltd, 1989).	Eulogie Park Gabbro/ Permo-Triassic Igneous Provinces	Layered gabbro complex and derived alluvial and eluvial material. The deposit has been investigated as a source of iron ore, magnetite for coal washing and heavy minerals for abrasive blast cleaning; currently held under mineral development licence by Belmont Park Investments Pty Ltd and Panorama Ridge Pty Ltd.

Table 14 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Fort Roger	14.8km S of Cloncurry	Deposit	Not mined	0.23Mt magnetite (Kreutzer, 1981)	Marimo Slate/ Marimo-Staveley Domain	Fault infill of hematite-magnetite-quartz ironstone. Unoxidised magnetite would be suitable for coal washing.
Gillian	105km SW of Cairns	Abandoned mine, Prospect	Not reported	3Mt at 29.72% Fe (Consolidated Tin Mines Limited, 2010)	Chillagoe Formation/ Hodgkinson Province; Hammonds Creek Granodiorite/ Kennedy Province	Tin skarn deposit. Held under mineral development licence by Consolidated Tin Mines Ltd.
Goondicum Crater Ilmenite	112km SSE of Gladstone	Care and maintenance	4900t titanomagnetite (2007–2009)	79Mt at 2.85% titanomagnetite (2.26Mt titanomagnetite; Monto Minerals NL, 2005)	Goondicum Gabbro/ Wandilla Province	Layered gabbro complex and derived alluvial and eluvial material. This deposit was being mined by Monto Minerals NL to provide a range of industrial minerals before the company went in voluntary administration in 2008. Titanomagnetite was being trialled for coal washing. Belridge Enterprises Ltd acquired the project and has completed a feasibility study aimed at redevelopment.
Hawkwood	272km NW of Brisbane	Prospect	Not mined	2.6Mt at 23% titanomagnetite (598 000t titanomagnetite; Johnson & Chiu Chong, 1971)	Hawkwood Gabbro, Delubra Quartz Gabbro/ Rawbelle Batholith	Layered gabbro complex and derived alluvial and eluvial material. Currently being evaluated by joint venture between Eastern Iron Ltd and Rugby Mining Pty Ltd
Iron Glen	41km SSW of Townsville	Abandoned mine, active prospect	36 416t ironstone (1955–1969)	Not reported	Fanning River Group/ Burdekin Basin	Magnetite skarn deposit. Mined historically as source of ironstone for cement manufacture. Current exploration by Iron Glen Holdings Ltd.
Iron Island	135km SE of Mackay	Abandoned mine	400 090t magnetite (1907–1921)	2Mt magnetite (Ball, 1904b)	Erebus beds/ Mount Holly Subprovince	Magnetite skarn deposit. Mined historically by Mount Morgan Gold Mining Company Ltd for flux. Iron Island is now within the Great Barrier Reef Marine Park.
Larrads Hill	27km NW of Portland Roads	Deposit	Not mined	2.69Mt at 46.1% Fe and 2.5% Mn (The Broken Hill Proprietary Company Limited, 1962)	Sefton Metamorphics/ Iron Range Province	Manganiferous iron formation overlies magnetite-hematite quartzite lenses in schist; magnetite content is highly variable. Deposit is now within the Iron Range National Park.
Mount Biggenden	38.4km ENE of Gayndah	Operating mine producing crushed aggregate and road base material	740 462.3t magnetite (1942–1954, 1967–1999)	Essentially mined out	Gympie Group/ Gympie Province	Magnetite skarn deposit. Originally mined for gold, copper and bismuth. Mined by Commercial Minerals Pty Ltd to produce magnetite for coal washing. Currently operated to produce crushed aggregate from the waste dumps.

Table 14 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount Leviathan	3.6km WSW of Cloncurry	Deposit	Not mined	2Mt at 57% Fe (Dunstan, 1920a)	Mitakoodi Quartzite/ Mitakoodi Domain	Fault infill of hematite-magnetite-quartz ironstone. Unoxidised magnetite may be suitable for coal washing.
Mount Lucy	128km WSW of Cairns	Prospect	45 344t ironstone (1903–1942)	>3Mt at >60% iron ore (Intermet Resources Limited, 2010)	Chillagoe Formation/ Hodgkinson Province; Lucy Granite/ Kennedy Province	Magnetite skarn deposit. Mount Lucy was mined historically to provide flux for the Chillagoe smelters. Magnetite at Mount Lucy is very high-grade, with up to 70.18% Fe and very low phosphorus and silica.
Mount Moss	100km W of Townsville	Operating mine	90 741t magnetite (2008–2010)	Confidential	Perry Creek Formation/ Camel Creek Subprovince	Magnetite-base metal skarn.Mt Moss Mining Pty Ltd produces magnetite for steel production and coal washing.
Mount Philp	54.4km ESE of Mount Isa	Prospect	Not mined	4.165Mt at 36.6% Fe and 39% Si (Carter & Brooks, 1955)	Corella Formation/ Mary Kathleen Domain	Fault infill of hematite-magnetite-quartz ironstone. Unoxidised magnetite may be suitable for coal washing. Currently being evaluated for hematite ore by Kings Minerals NL.
Osborne	195km SE of Mount Isa	Care and maintenance (Cu-Au mine)	No magnetite produced	15.5Mt tailings at 35% magnetite (Coe & Evans, 2008)	Soldiers Cap Group/ Kuridala-Selwyn Domain	Ironstone and breccia hosted iron oxide copper-gold deposit. Osborne is now owned by Ivanhoe Australia Ltd; previous owner Barrick Gold Corporation had been producing copper and gold from here since 1995. Barrick had proposed to produce magnetite from Cu-Au ore and mine tailings for use in steel production and coal washing. Ivanhoe Australia has not yet stated whether it will pursue magnetite production when Cu-Au production resumes.
Paddy		Abandoned mine, prospect	Not reported	0.1Mt at 58.4% Fe (Connah, 1955)	Chillagoe Formation/ Hodgkinson Province	Magnetite skarn deposit. Current exploration by Intermet Resources Ltd.
Perry Mountain Ironstone	6.3km ESE of Mount Perry	Abandoned mine	Not reported	101 600t at 34% Fe (Reid, 1919)	Aranbanga Volcanic Group/ South East Queensland Volcanic and Plutonic Province	Transported ironstone deposit developed on hematite-magnetite quartzite bed. This deposit was mined by the Queensland Copper Company Ltd in 1902 to supply ironstone flux for the Mount Perry copper smelters.
Pinnacles	6km NE of Mount Garnet	Abandoned mine, prospect	Not reported	1.87Mt at 17.5% Fe (Consolidated Tin Mines Limited, 2010)	Hodgkinson Formation/ Hodgkinson Province; Pinnacles Granite/ Kennedy Province	Comprises four tin skarn deposits – Wafer, Sniska, Hartog and Llahsram. Current exploration by Consolidated Tin Mines Ltd.
Rocklands	15km W of Cloncurry	Prospect	Not mined	157Mt at 2.9% magnetite (CuDeco Limited, 2010a)	Mitakoodi Quartzite/ Mitakoodi Domain	Breccia hosted iron oxide copper-gold deposit. Testing by CuDeco Ltd has shown that magnetite associated with the Cu-Au ore is acceptable for coal washing.

Table 14 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Scrubby Hill	30km NW of Portland Roads	Occurrence	Not mined	100 000t at 33.4% Fe and 14.3% Mn (The Broken Hill Proprietary Company Limited, 1962)	Sefton Metamorphics/ Iron Range Province	Manganiferous iron formation overlies magnetite-hematite quartzite lenses in schist; magnetite content is highly variable. Deposit is now within the Iron Range National Park.
TPM	5.4km SSW of Mount Coolon	Prospect	Not mined	60 960t magnetite (Chiu Chong & Sedgman, 1972)	Anakie Metamorphic Group/ Anakie Orogen	Magnetite-Cu-Au skarn deposit. Drummond Gold Ltd is investigating the Cu-Au potential. Previous explorers have been interested in the magnetite for coal washing.
Wateranga	25.3km SE of Mount Perry	Prospect	Not mined	Hard rock resources are 345Mt at ~23% magnetite, with potential for an additional 450Mt of hard rock ore (sourced from Queensland Industrial Minerals Ltd website, April 2009).	Wateranga Gabbro/ Permo-Triassic Igneous Provinces	Layered gabbro complex and derived alluvial and eluvial material. Currently being evaluated by Queensland Industrial Minerals Ltd.
Whispering Ridge Magnetite Prospect	37km S of Ravenshoe	Prospect	Not mined	Confidential	Chillagoe Formation/ Hodgkinson Province	Magnetite skarn deposit. Pre-feasibility study carried put for supply of magnetite for coal washing.

LITHIUM

Lithium is an alkali metal and is the lightest metal and least dense solid element. It is highly reactive and does not occur in its elemental form in nature. The main sources of lithium are from pegmatites (spodumene, petalite, amblygonite, lepidolite and zinnwaldite), continental brines, geothermal brines, oilfield brines and the clay mineral hectorite.

Lithium is used in the glass, ceramics and chemical industries, for high strength to weight alloys in aircraft, in lithium and lithium-ion batteries, in mobile phones and optical modulators, in lubricants, fireworks, flares and rocket propellants, as a flux for welding and soldering, in air purifiers, and in the pharmaceutical industry.

Lithium occurs in lepidolite and amblygonite, along with tantalite, cassiterite and ilmenite, in pegmatite dykes in dolerite (Cobbold Metadolerite) and metasediments (Lane Creek Formation) adjacent to greisenised granite at Buchanan's Creek and Grant's Gully, 31km south-west of Georgetown (Figure 21; Culpeper & others, 1996). The prospects are being investigated by Gascoyne Metals Pty Ltd.

Lithium and rare earth element mineralisation occurs in association with manganese and cobalt at the Bitumen and Cobree prospects, 33.5km east-north-east of Greenvale in the Broken River Province. A bed of bituminous, manganese oxide-cemented quartzose sandstone contains Li-, Ce-, Co- and Ni-rich manganese oxides, as well as a variety of rare earth-bearing phases, including manganiferous wad, asbolane, hollandite and lithiophorite. The deposits are interpreted as forming by cementing of Tertiary sands by manganese oxides and hydrothermal clays precipitated from hot aqueous solutions emanating from thermal springs; Co, Li and rare earths were leached from glassy mafic and silicic volcanic rocks (Teale, 1989; Barker & others, 1997).

Lepidolite has been reported from the Lord Nolan tin veins, 23.2km south-west of Stanthorpe (Denaro & Burrows, 1992); zinnwaldite has been reported to occur in the Ruby Creek Granite at Swipers Gully, 15.2km west-north-west of Stanthorpe.

MERCURY

Mercury has been used in thermometers, barometers and similar instruments, scientific apparatus, electrical switches and electronics, lighting, industrial chemicals, pharmaceuticals and dentistry. Mercury use is regulated in many countries due to the extreme toxicity of mercury and its compounds. Mercury occurs as the native metal and in cinnabar, corderoite and livingstonite; cinnabar is the most common ore.

The majority of Queensland's historic production and known resources of mercury are in the Kilkivan area in south-east Queensland, where mercury occurs in epithermal systems confined to north-north-west-trending fracture zones, predominantly within the Neara Volcanics (Figure 21). The mineralisation comprises cinnabar veinlets and disseminations in multiphase carbonate quartz veins (Rands, 1892; Ball, 1914;

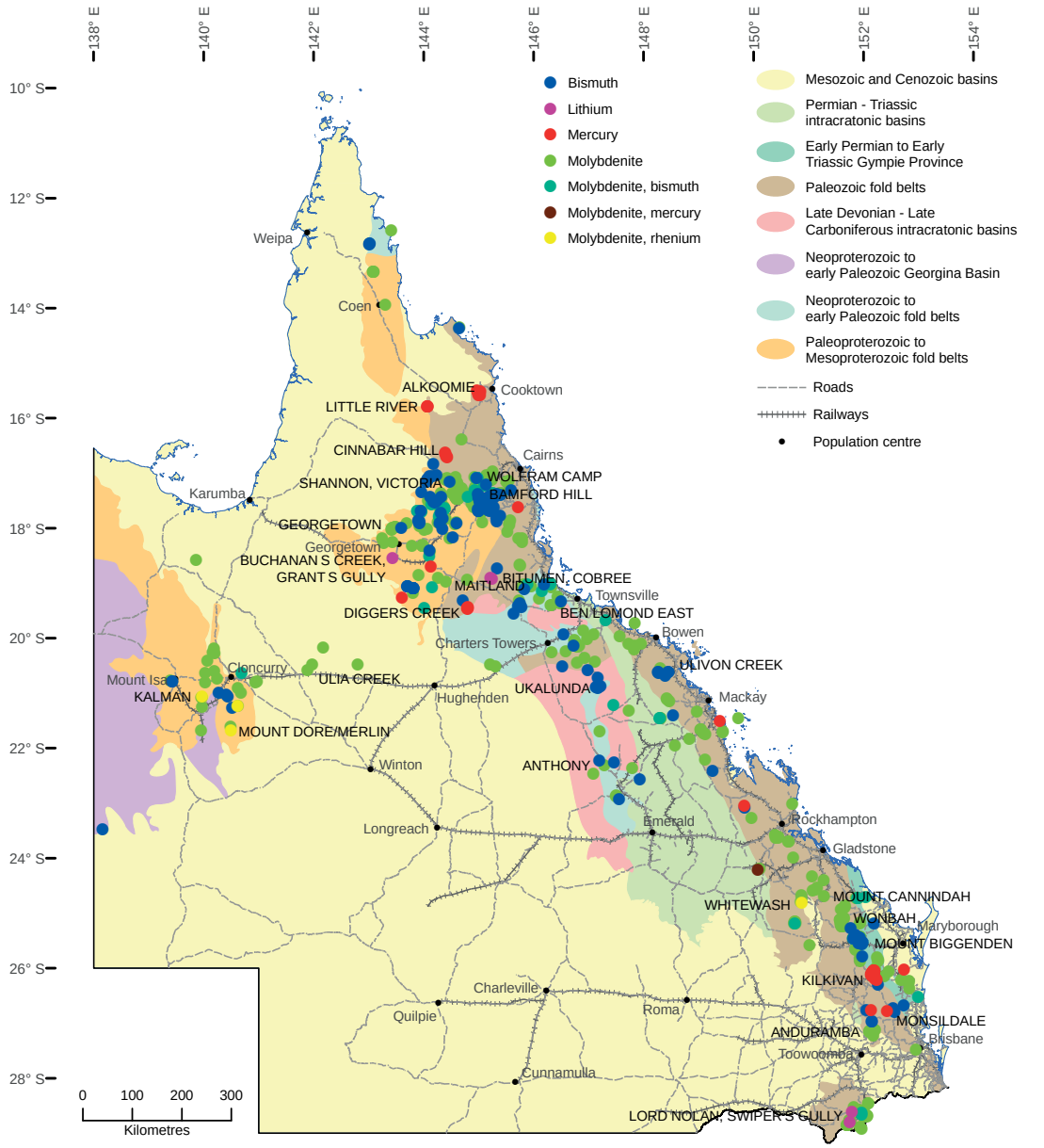

Figure 21: Lithium, mercury, molybdenum, bismuth and rhenium occurrences and deposits

Dunstan, 1917b; Dunstan & Ridgway, 1931; Shepherd, 1935; Denmead, 1945a; Denmead, 1945b; Brooks & others, 1974). The carbonates are mainly ferroan ankerite and calcite, with lesser late-stage coarse calcite and minor dolomite and siderite. Narrow alteration envelopes characterised by pervasive carbonatisation, with lesser silicification, sericitisation, argillisation and chloritisation, enclose the veins. Cinnabar also occurs in alluvial deposits shed from the lodes (Rands, 1892). Total production from the Kilkivan area was 15.33t mercury from 1874 to 1892 and 1930 to 1945 (Brooks & others, 1974; Murphy & others, 1976); the largest producers were Cirsons (4.17t mercury) and Commotion (5.62t).

The Commotion alluvial and eluvial cinnabar deposit, west of Kilkivan, is the most significant mercury resource identified in Queensland. It is estimated to contain 611 644m^3 at a grade of 454g/m^3 mercury (Bracewell, 1933) and comprises alluvial and eluvial material derived from cinnabar-bearing veins in diorite of the South-East

Queensland Volcanic and Plutonic Province. This resource is poorly defined from historical literature. A small hardrock mercury resource (7000t at 907g/t Hg) has been defined at the ML 108 deposit, north-west of Kilkivan (Brooks & others, 1974).

Cinnabar and native mercury occur in quartz-calcite breccia and veins in mudstone and tuff of the Triassic Bryden Formation at Monsildale, 43km east-south-east of Nanango. Some 38kg of mercury was produced from 1930 to 1937 (Ball, 1914; Cribb, 1937).

Cinnabar, along with gem quality sapphire, zircon and garnet, black spinel and traces of gold, has been reported from the heavy mineral fraction of alluvium in the Diggers Creek area, south-south-east of Pandanus Homestead in the Broken River Province (Croker & Croker, 1989).

Cinnabar occurs in gold-bearing epithermal quartz veins in metasediments of the Hodgkinson Formation in the Cinnabar Hill area, 25km east south-east of Bellevue Homestead (Lord, 1987). Copper-mercury mineralisation in the Little River area, north of Palmerville, occurs in veins in lenses of basic volcanics and breccias of the Chillagoe Formation; ~8t of ore grading 30% Cu and 5–6% Hg was produced from 1905 to 1907 (Ball, 1909; Ball, 1914; Dunstan, 1917b; Denaro & others, 1994b). Mercury geochemical anomalies in the Hodgkinson Formation in the Alkoomie area, 26.5km west of Cooktown, are associated with high-level epithermal veining (Burban, 1985; Culpeper & others, 1994; Denaro & others, 1994a).

MOLYBDENUM, BISMUTH AND RHENIUM

Molybdenum is a transition metal that is used in high-strength steel alloys and stainless steels. Molybdenum compounds are used in ceramics for heating elements, adhesives, pigments for paints, ceramics and plastics, and in plant nutrients. The ore mineral molybdenite is used as a solid lubricant and in high-pressure, high-temperature greases, as well as being the main source of molybdenum metal.

Bismuth is a post-transition metal. It occurs naturally but its important ores are sulphides and oxides. Bismuth is used in metal alloys (particularly as a substitute for lead) for casting, galvanising, solders, thermocouples, electrical fuses, automatic fire alarm and sprinkler systems, and ammunition. Bismuth compounds are used in cosmetics, pigments and pharmaceuticals; it is lower in toxicity than other heavy metals.

Rhenium is a transition metal and has the third highest melting point of any element. Rhenium is used to produce superconductive alloys, electrical contacts, thermocouples, filaments, medical applications, nickel-based superalloys for jet engines, and as a catalyst for producing lead-free high octane petrol. Rhenium is one of the rarest elements in the earth's crust and is among the most expensive of the industrial metals. The major commercial source is molybdenite, which can contain up to 0.2% Re.

Table 15: Significant molybdenum, bismuth and rhenium deposits of Queensland

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Anduramba Prospect		14km NNE of Crows Nest	Abandoned mine, active prospect, feasibility study	Not reported	31.6Mt at 0.05% Mo, 0.014% Cu and 4.7g/t Ag for 17 083t Mo, 149 395kg Ag and 4338t Cu (D'Aguilar Gold Limited, 2008b)	Eskdale Granodiorite/ South East Queensland Volcanic and Plutonic Province	Porphyry Mo-Cu deposit in granite. Held under Mineral Development Licence by Archer Resources Pty Ltd (D'Aguilar Gold Ltd).
Anthony		67km NNW of Clermont	Active prospect, scoping study in progress	Not mined	260Mt at 0.04% Mo for 105 700t Mo (Zamia Metals Limited, 2011)	Anakie Metamorphics/ Anakie Orogen	Porphyry Mo-Cu deposit in hornfelsed metasediments and schist. Held under Exploration Permit by Zamia Metals Ltd.
Bamford Hill		47km ESE of Chillagoe	Abandoned mine, active prospect	170t molybdenite, 2000t wolframite, 20t bismuthinite (1893–1981)	Not estimated	Bamford Granite/ Kennedy Province	Sheeted quartz veins and pipes associated with greisen zone in granite. Held under Exploration Permit by Tropical Metals Pty Ltd, in joint venture with Planet Metals Ltd.
Georgetown Uranium Project	Far West 5	33km NW of Georgetown	Active prospect	Not mined	90 830t at 0.18% Mo and 0.12% uranium oxide for 163t Mo and 104t uranium oxide (Potts, 1979)	Gilberton Formation/ Gilberton Basin	Unconformity-related uranium-molybdenum-fluorite mineralisation in arkosic sediments. Held under Exploration Permit by Mega Georgetown Pty Ltd (Mega Uranium Ltd).
	Far West 7	32km N of Georgetown	Active prospect	Not mined	65 600t at 0.16% Mo and 0.09% uranium oxide for 108t Mo and 61t uranium oxide (Potts, 1979)	Gilberton Formation/ Gilberton Basin	Unconformity-related uranium-molybdenum-fluorite mineralisation in arkosic sediments. Held under Exploration Permit by Mega Georgetown Pty Ltd (Mega Uranium Ltd).
	Maureen	45km N of Georgetown	Active prospect	Not mined	3.278Mt at 0.09% uranium oxide and 0.06% Mo for 2980t uranium oxide and 2028t Mo (Mega Uranium Limited, 2008)	Gilberton Formation/ Gilberton Basin	Unconformity-related uranium-molybdenum-fluorite mineralisation in arkosic sediments. Held under Exploration Permit by Mega Georgetown Pty Ltd (Mega Uranium Ltd).
Julia Creek V-Mo Project	Alisona-Richmond	16.5km ENE of Julia Creek	Active prospect	Not mined	4820Mt at 0.27% vanadium oxide and 0.02% molybdite for 13 203Mt vanadium oxide and 1.072Mt molybdite (Intermin Resources Ltd, 2009)	Toolebuc Formation/ Eromanga Basin	Oxidised oil shale. Held under Exploration Permit by Intermin Resources Ltd.
	Lilyvale	40km NW of Richmond	Active prospect	Not mined	410.67Mt at 0.44% vanadium oxide and 0.03% molybdite for 1.807Mt vanadium oxide and 0.136Mt molybdite (Intermin Resources Ltd, 2010)	Toolebuc Formation/ Eromanga Basin	Oxidised oil shale. Held under Exploration Permit by Intermin Resources Ltd.
	St Elmo-Burwood	27km NE of Julia Creek	Active prospect	Not mined	3077.98Mt at 0.32% vanadium oxide and 0.03% molybdite for 9.883Mt vanadium oxide and 0.845Mt molybdite (Intermin Resources Ltd, 2009)	Toolebuc Formation/ Eromanga Basin	Oxidised oil shale. Held under Exploration Permit by Intermin Resources Ltd.

Table 15 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Julivon Creek Prospect		58.5km S of Bowen	Inactive prospect	Not mined	35Mt at 0.16% Cu and 0.01% Mo for 54 600t Cu and 3850t Mo (Leitch & Fletcher, 1972)	Hecate Granite/ Urannah Batholith	Porphyry Cu-Mo deposit in granodiorite. Held under Exploration Permit by Australia Oriental Minerals NL
Kalman		61km south-east of Mount Isa	Active prospect, scoping study in progress	Not mined	60.8Mt at 0.32% Cu, 0.05% Mo, 1.19g/t Re and 0.15g/t Au for 30 400t Mo, 194 700t Cu, 9120kg Au and 72 352kg Re (Kings Minerals NL, 2010)	Corella Formation/ Mary Kathleen Domain	Shear zone-hosted Cu-Mo-Au-Re veins in calc-silicate rocks associated with the Pilgrim Fault Zone. Held under Exploration Permits by Cerro Resources NL (formerly Kings Minerals NL) and Syndicated Metals Ltd
Maitland Copper Prospect		61km SE of Einasleigh	Abandoned mine, active prospect	293t Cu, 18kg Ag, 0.034kg Au (1909–1944)	1.49Mt at 1.45% Cu and 0.02% Mo for 22 041t Cu and 294t Mo (Glengarry Resources Limited, 2008)	Einasleigh Metamorphics/ Etheridge Province	Shear-hosted Cu-Mo veins in schist and gneiss. Held under Exploration Permit by Kagara Ltd.
Merlin (including Little Wizard)		147km SE of Mount Isa	Active prospect, scoping study in progress	Not mined	Merlin – 6.7Mt at 1.32% Mo, 23.05g/t Re, 8.28g/t Ag, 0.33% Cu, 0.13% Zn, 0.02% Pb, 0.01% Co and 0.08g/t Au for 88 800t Mo, 154 470kg Re, 55 590kg Ag, 22 330t Cu, 9580t Zn, 1340t Pb, 544t Co and 546kg Au Little Wizard – 15 999t at 6.49% Mo, 83.9g/t Re, 25g/t Ag, 2.29% Cu, 0.63g/t Au and 0.01% Pb for 973t Mo, 1258kg Re, 375kg Ag, 343t Cu, 9kg Au and 1t Pb (Ivanhoe Australia Limited, 2010a)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted breccia in metasediments along Mount Dore Fault Zone. Held under mining leases by Ivanhoe Australia Ltd. Construction of an access decline commenced in the second half of 2010. Underground mine, molybdenum concentrator and roaster are planned, with production to commence in 2012.
Mount Cannindah	Monument	110km WNW of Bundaberg	Active prospect	Not mined	8.022Mt at 0.4% Cu and 0.02% Mo for 32 088t Cu and 1243t Mo (Queensland Ores Limited, 2005)	Rockhampton Group/ Yarrol Province	Cu skarn in sandstone and siltstone near a Permo-Triassic granodiorite intrusion. Held under Mining Lease by Mount Cannindah Mining Pty Ltd (Planet Metals Ltd).
	United Allies	110km WNW of Bundaberg	Abandoned mine, active prospect	2t Cu (1896)	1.974Mt at 0.5% Cu and 0.02% Mo for 9870t Cu and 388t Mo (Queensland Ores Limited, 2005)	Rockhampton Group/ Rockhampton Subprovince	Porphyry Cu–Mo–Au deposit. Held under Mining Lease by Mount Cannindah Mining Pty Ltd (Planet Metals Ltd).

Table 15 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount Biggenden	38.4km ENE of Gayndah	Operating mine producing crushed aggregate and road base material	1612.5t bismuthinite, 1511.3kg Au, 5.9t Cu, 203.2t limestone, 740 462.3t magnetite (1890–1895, 1901–1912, 1931–1938, 1942–1954, 1967–1999)	Essentially mined out	Gympie Group/ Gympie Province	Magnetite skarn deposit. Originally mined for gold, copper and bismuth. Mined by Commercial Minerals Pty Ltd to produce magnetite for coal washing. Currently operated to produce crushed aggregate from the waste dumps.
Mount Dore	147km SE of Mount Isa	Active prospect, scoping study in progress	6t Cu (1936)	Copper zone with 144.4Mt at 0.52% Cu, 0.01% Mo, 0.1g/t Re, 0.1g/t Au, 5.94g/t Ag, 0.30% Zn, 0.05% Pb and 0.01% Co for 747 880t Cu, 14 440t Mo, 14 440kg Re, 14 154kg Au, 857 960kg Ag, 433 410t Zn, 75 130t Pb and 11 497t Co (Ivanhoe Australia Limited, 2010a)	Kuridala Formation/ Quamby–Malbon Subprovince	Shear zone hosted breccia in metasediments along Mount Dore Fault Zone. Held under mining leases by Ivanhoe Australia Ltd. Heap-leach SX-EW processing planned for oxide ore.
Shannon	5.5km W of Chillagoe	Active prospect	Not recorded	1.01Mt at 20.2g/t Ag, 1.23% Cu, 0.53% Zn, 0.96g/t Au, 0.08% Bi and 0.07% cassiterite for 20 402kg Ag, 12 423t Cu, 5353t Zn, 970kg Au, 808t Bi and 707t cassiterite (Verwoerd & Sargeant, 1971)	Chillagoe Formation/ Hodgkinson Province	Skarn deposit along contact of Chillagoe Formation and Ruddygore Granodiorite. Held under Mining Lease by Mungana Pty Ltd.
Ukalunda	79km SW of Collinsville	Abandoned mines	243.2t dressed Cu-Au-Ag-Bi ore (1889–1898, 1919–1920)	Not estimated	Sunbeam Granodiorite/ Bulgonunna Volcanic Province	Intrusive-related polymetallic veins in Sunbeam Granodiorite.
Victoria	12.5km NW of Chillagoe	Abandoned mine, active prospect	29t Pb, 25.5kg Ag and 34t Cu (1922–1923)	3.44Mt at 5.09% Zn, 22.23g/t Ag, 0.96% Cu, 0.14g/t Au and 14.8ppm Mo for 175 020t Zn, 76 490kg Ag, 33 160t Cu, 489kg Au and 51t Mo (Kagara Ltd, 2010)	Chillagoe Formation/ Hodgkinson Province	Cu skarn. Held under Exploration Permit by Mungana Pty Ltd.

Table 15 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Whitewash/ Gordons	26.5km WNW of Monto	Active prospect	Not mined	71.5Mt at 0.034% Mo, 0.1% Cu and 1.2g/t Ag for 24 135t Mo, 85 200kg Ag and 70 600t Cu (Aussie Q Resources Limited 2008, Aussie Q Resources Limited, 2009)	Wingfield Granite/ Rawbelle Batholith	Porphyry Mo-Cu deposit in granodiorite. Held under Exploration Permit by Aussie Q Resources Ltd.
Wolfram Camp Tungsten Prospect	21km NW of Dimbulah	Care and maintenance, active prospect	159.6t molybdenite, 6870.5t wolframite, 1535t bismuthinite (1893–1990, 2008–2009)	1.42Mt at 0.6% WO_3 and 0.12% Mo for 8528t WO_3 and 1718t Mo (Planet Metals Limited, 2010)	James Creek Granite/ Kennedy Province	Quartz veins and pipes associated with greisen zone in granite. Held under Mining Leases by Tropical Metals Pty Ltd and Wolfram Camp Mining Pty Ltd. Mined by Queensland Ores Ltd (now Planet Metals Ltd) in 2008 but closed due to metallurgical issues.
Wonbah Molybdenite	9.7km NE of Mount Perry	Abandoned mine, inactive prospect	100t molybdenite (1914–1939)	10 160t at 0.5% molybdenite for 51t molybdenite (Dickson, 1972)	Wonbah Granodiorite/ South East Queensland Volcanic and Plutonic Province	Molybdenite-quartz pipe in granite. Held under Exploration Permit by Acapulco Mining Pty Ltd.

Queensland has a long history of molybdenum and bismuth mining although there is no current production. These metals occur as accessory phases in porphyry-style and intrusive-related tin, tungsten and copper deposits (Cameron, 1904; Ball, 1911b; Dunstan, 1917d; Dunstan, 1920c; Dunstan, 1926; Horton, 1978; Horton, 1982); molybdenite also occurs associated with uranium veins (Figure 21, Table 15). However, Queensland's largest molybdenum resources are associated with oxidised oil shales of the Toolebuc Formation in the Julia Creek area.

With the discovery of high-grade molybdenum-rhenium deposits in the Cloncurry area, a significant boost to Queensland and world resources in molybdenum and rhenium has been unlocked. These new discoveries include the world-class Merlin Mo-Re deposit and the Kalman Cu-Mo-Re project.

NICKEL AND COBALT

Nickel and cobalt are both transition metals that are ferromagnetic at room temperature. The main use of nickel is as an alloy metal in stainless steels, nickel cast irons, nickel-copper alloys and others. Nickel is also used in magnets, coinage, rechargeable batteries, computer hard drives, guitar strings, special alloys, electroplating, glass tinting and as a catalyst.

Cobalt is used to produce wear resistant high-strength superalloys for applications such as gas turbines, jet engines, medical prosthetics and magnets. Cobalt compounds are used in batteries, as catalysts, in adhesives in tyre manufacture, and as a blue pigment in glass, ceramics, inks, paints and varnishes. Cobalt is also used in electroplating and as a catalyst in hydro-treating and desulphurisation of oil and gas and the conversion of natural gas to liquid petroleum fuels.

Nickel and cobalt occur in two basic forms in nature:

- as sulphides in primary deposits; and
- as oxides and silicates in laterites.

Queensland's current nickel-cobalt production comes from either imported ores or as a by-product of treating base metal ores. Queensland Nickel Pty Ltd is Queensland's sole producer of nickel and treats imported ores from New Caledonia, Indonesia and the Philippines at its Yabulu Nickel Refinery near Townsville. The Yabulu refinery produces ~30 000t of nickel and 1500t of cobalt annually. The Sun Metals zinc smelter, also located at Townsville, produces minor by-product cobalt and nickel (von Gnielinski, 2010).

Most of Queensland's nickel–cobalt resources (Table 16, Figure 22) are contained in lateritic deposits formed by weathering of nickeliferous serpentinites and other ultrabasic rocks. The State's current laterite resources and reserves contain >1.15Mt of nickel and >86 000t of cobalt. Lateritisation involves the movement of groundwater through the nickeliferous rock and the dissolution of small quantities of metal from the mineral assemblage. These mobile metals migrate and redeposit lower down in

Table 16: Significant nickel and cobalt deposits of Queensland

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Barbara	North Lode	51km NE of Mount Isa	Abandoned mine, active prospect	29.85t Cu (1970–1075)	1.99Mt at 1.16% Cu, 2.22g/t Ag, 0.026% Co and 0.1g/t Au for 23 124t Cu, 4424 kg Ag, 512t Co and 199kg Au (Syndicated Metals Limited, 2010)	Leichhardt Volcanics/ Mary Kathleen Domain	Shear zone hosted veins and breccia in schist and volcanics. Held under Exploration Permit by Syndicated Metals Ltd andMt Isa Metals Ltd.
	South Lode	51km NE of Mount Isa	Abandoned mine, active prospect	Not recorded	3.34Mt at 1.57% Cu, 2.67g/t Ag, 0.03% Co and 0.19g/t Au for 52 338t Cu, 8905 kg Ag, 910t Co and 631kg Au (Syndicated Metals Limited, 2010)	Leichhardt Volcanics/ Mary Kathleen Domain	Shear zone hosted veins and breccia in schist and volcanics. Held under Exploration Permit by Syndicated Metals Ltd.
Brolga		43km NW of Rockhampton	Abandoned mine, active prospect	15 271t Ni and 613t Co (1969–1970, 1993–1996)	Not defined	Princhester Serpentinite/ Marlborough Block	Ni-Co laterite. Mined to supplement ore imported for Yabulu Ni refinery. Held under Mining Lease by QNI Resources Pty Ltd and QNI Metals Pty Ltd.
Cobra Central (Main Deposit)		82km NW of Rockhampton	Active prospect	Not mined	0.928Mt at 0.6% Ni and 0.17% Co for 5568t Ni and 1577t Co (Cobra Resources NL, 1998)	Princhester Serpentinite/ Marlborough Block	Ni-Co laterite. Held under Mining Lease by Marlborough Nickel Pty Ltd (Gladstone Pacific Nickel Ltd).
Cobra's Camp		84km NW of Rockhampton	Active prospect	Not mined	20Mt at 1.0% Ni for 200 000t Ni. 0.545Mt at 0.9% Ni and 0.04% Co for 4905t Ni and 218t Co (Cobra Resources N,L 1998)	Princhester Serpentinite/ Marlborough Block	Ni-Co laterite. Held under Mining Lease by Marlborough Nickel Pty Ltd (Gladstone Pacific Nickel Ltd).
Gladstone Pacific Nickel Project (Slopeaway, Slopeaway North, Gumigil East, Coorumburra East, Coorumburra Central, Coorumburra West, Whereat)		75km NW of Rockhampton	Under development	Not mined	70.9Mt at 0.91% Ni and 0.06% Co for 650 760t Ni and 42 720t Co (Gladstone Pacific Nickel Ltd, 2008)	Princhester Serpentinite/ Marlborough Block	Ni-Co laterite. Held under Mining Lease by Marlborough Nickel Pty Ltd (Gladstone Pacific Nickel Ltd).
Jasper Block		1.9km NNE of Cloncurry	Abandoned mine, active prospect	Not recorded	1.4Mt at 1.0% Cu and 0.04% Co for 14 000t Cu and 490t Co (Exco Resources NL, 2006)	Toole Creek Volcanics/ Canobie Domain	Shear zone hosted veins and breccia in jasper, quartzite, limestone and metasediments. Held under Exploration Permit by Exco Resources Ltd.

Table 16 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Lucky Break	95km W of Townsville	Active prospect, definitive feasibility study completed	Not mined	1.49Mt at 0.76% Ni and 0.05% Co for 11 373t Ni and 724t Co (Metallica Minerals Limited, 2009b)	Argentine Metamorphics/ Cape River Province	Ni-Co laterite. Held under Mining Leases by Nornico Pty Ltd (Metallica Minerals NL). Mine development by Metals Finance Ltd.
Merlin (including Little Wizard)	147km SE of Mount Isa	Active prospect, scoping study in progress	Not mined	Merlin – 6.7Mt at 1.32% Mo, 23.05g/t Re, 8.28g/t Ag, 0.33% Cu, 0.13% Zn, 0.02% Pb, 0.01% Co and 0.08g/t Au for 88 800t Mo, 154 470kg Re, 55 590kg Ag, 22 330t Cu, 9580t Zn, 1340t Pb, 544t Co and 546kg Au Little Wizard - 15 999t at 6.49% Mo, 83.9g/t Re, 25g/t Ag, 2.29% Cu, 0.63g/t Au and 0.01% Pb for 973t Mo, 1258kg Re, 375kg Ag, 343t Cu, 9kg Au and 1t Pb (Ivanhoe Australia Limited, 2010a)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted breccia in metasediments along Mount Dore Fault Zone. Held under mining leases by Ivanhoe Australia Ltd. Construction of an access decline commenced in the second half of 2010. Underground mine, molybdenum concentrator and roaster are planned, with production to commence in 2012.
Mount Cobalt	153km SE of Mount Isa	Abandoned mine, active prospect	536t Cu concentrate, 291.5t Co (1919–1943, 1996-1997)	Not defined	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted veins and breccia in schist and quartzite. Held under Mining Leases by Mount Cobalt Mining Pty Ltd and Ivanhoe Australia Ltd.
Mount Dore	147km SE of Mount Isa	Active prospect, scoping study in progress	6t Cu (1936)	Copper zone with 144.4Mt at 0.52% Cu, 0.01% Mo, 0.1g/t Re, 5.94g/t Ag, 0.30% Zn, 0.05% Pb and 0.01% Co for 747 880t Cu, 14 440t Mo, 14 440kg Re, 857 960kg Ag, 433 410t Zn, 75 130t Pb and 11 497t Co. Zinc zone with 35.6Mt at 0.78% Zn, 3.5g/t Ag, 0.13% Pb, 0.11% Cu, 0.005% Co and 0.03g/t Au for 277 680t Zn, 124 600kg Ag, 46 280t Pb, 39 160t Cu, 1708t Co and 1068kg Au (Ivanhoe Australia Limited, 2010a)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted breccia in metasediments along Mount Dore Fault Zone. Held under mining leases by Ivanhoe Australia Ltd. Heap-leach SX-EW processing planned for oxide ore.

Table 16 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount Freda		38.7km SE of Cloncurry	Abandoned mine, active prospect	317.1kg Au (1880–1945, 1975–1989)	1.6Mt at 1.7g/t Au and 0.03% Co for 2720kg Au and 464t Co (Queensland Mining Corporation Limited, 2011b)	Toole Creek Volcanics/ Soldiers Cap Domain	Shear zone hosted veins and breccia in metabasalt, quartzite, slate and schist. Held under mining lease by Spinifex Mines Pty Ltd (Queensland Mining Corporation Ltd).
Mount Isa Copper and Silver–Lead–Zinc Orebodies		Mount Isa	Operating mines	12 903t Co (1996–2005)	Co resources not quantified	Urquhart Shale/ Leichhardt River Domain	Sediment-hosted Ag-Pb-Zn and breccia-hosted Cu-Co in shale, siltstone and dolomite. Operated by Xstrata Plc
Mount Manganese		116km SW of Springsure	Active prospect	Not mined	115 000t at 0.18% Co for 207t Co (Gunson Resources Limited, 2000)	Evergreen Formation/ Eromanga basin	Supergene enriched manganese oxide mineralisation in sandstone. Held under Exploration Permit by Maranoa Resources Pty Ltd.
Mount Oxide		125km N of Mount Isa	Abandoned mine, active prospect, feasibility study	22 816t Cu, 4.5kg Au, 893.4kg Ag (1927–1960, 1967–1982)	4.5Mt at 0.14% Co for 6300t Co (Perilya Limited, 2011)	Gunpowder Creek Formation/ Mount Oxide Domain	Breccia in shale and sandstone. Held under Exploration Permit by Mount Oxide Pty Ltd (Perilya Ltd).
Nornico Project	Bell Creek North West	29km S of Mount Garnet	Active prospect, scoping study	Not mined	5.18Mt at 0.67% Ni and 0.04% Co for 34 706t Ni and 2072t Co (Metallica Minerals Limited, 2008b)	Sandalwood Serpentinite/ Etheridge Province	Ni-Co laterite. Held under Exploration Permit and Mining Lease Application by Nornico Pty Ltd (Metallica Minerals NL).
	Bell Creek South Lease (includes the Neck and the Pod)	34km S of Mount Garnet	Active prospect, scoping study	Not mined	Bell Creek South – 11.41Mt at 0.88% Ni and 0.06% Co for 100 580t Ni and 6693t Co. The Neck - 1.39Mt at 0.73% Ni and 0.02% Co for 10 147t Ni and 278t Co (Metallica Minerals Limited, 2008a). The Pod – 0.28Mt at 0.73% Ni and 0.05% Co for 2044t Ni and 140t Co (Metallica Minerals Limited, 2008b)	Sandalwood Serpentinite/ Etheridge Province	Ni-Co laterite. Held under Mining Lease by Nornico Pty Ltd (Metallica Minerals NL).
	Greenvale Nickel	190km WNW of Townsville	Abandoned mine, active prospect, scoping study	436 430t Ni, 36 456t Co (1974–1995)	8.0Mt at 0.93% Ni, 0.08% Co and 21.8g/t Sc for 83 355t Ni, 6573t Co and 261.3t Sc (Metallica Minerals Limited, 2011)	Sandalwood Serpentinite/ Etheridge Province	Ni-Co laterite. Held under Exploration Permit by Greenvale Operations Pty Ltd (Metallica Minerals NL).

Table 16 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Nornico Project (continued)	Kokomo	98km S of Mount Garnet	Active prospect, scoping study	Not mined	12.2Mt at 0.67% Ni and 0.12% Co for 82 080t Ni and 14 460t Co (Metallica Minerals Limited, 2009a)	Sandalwood Serpentinite/ Etheridge Province	Ni-Co laterite. Held under Exploration Permit and Mining Lease Application by Nornico Pty Ltd (Metallica Minerals NL).
	Lucknow	190km WNW of Townsville	Active prospect, scoping study	Reported that 50 000t of ore may have been mined in past	8.0Mt at 0.29% Ni, – 0.07% Co and 141g/t Sc for 23 139t Ni, 4829t Co and 1129t Sc (Metallica Minerals Limited, 2011)	Gray Creek Complex/ Graveyard Creek Subprovince	Ni-Co laterite. Held under Exploration Permit by Greenvale Operations Pty Ltd (Metallica Minerals NL).
	Minnamoolka	54km S of Mount Garnet	Active prospect, scoping study	Not mined	14.73Mt at 0.66% Ni and 0.03% Co for 97 821t Ni and 4276t Co (Metallica Minerals Limited, 2008b)	Sandalwood Serpentinite/ Etheridge Province	Ni-Co laterite. Held under Mineral Development Licence by Nornico Pty Ltd (Metallica Minerals NL).
Ridleys		15.8km SSE of Kilkivan	Active prospect	Not mined	0.792Mt at 0.87% Ni and 0.07% Co for 6890t Ni and 554t Co (D'Aguilar Gold Limited, 2008a)	Mount Mia Serpentinite/ North D'Aguilar Block	Ni-Co laterite. Held under Exploration Permit by AusNiCo Ltd (D'Aguilar Gold Ltd).
Rocklands Project (Las Minerale)		15km W of Cloncurry	Active prospect	Not mined	41Mt at 0.76% Cu, 0.03% Co and 0.11g/t Au for 312 700t Cu, 13 580t Co and 4580kg Au (CuDeco Limited, 2010a)	Mitakoodi Quartzite/ Mitakoodi Domain	Shear zone hosted veins and breccia in siltstone, quartzite, dolerite and calc-silicate rocks. Held under Mining Lease and Exploration Permit by CuDeco Limited.
Walford Creek		315km NNW of Mount Isa	Active prospect	Not mined	6.5Mt at 0.67% Cu, 0.07% Co, 25g/t Ag, 2.1% Zn and 1.6% Pb for 39 000t Cu, 4550t Co, 162 500kg Ag, 136 500t Zn and 104 000t Pb (Copper Strike Limited, 2006)	Mount Les Siltstone/ Camooweal-Murphy Domain	Sediment-hosted Ag-Pb-Zn and breccia-hosted Cu-Co in shale and siltstone. Held under Exploration Permit by Copper Strike Ltd.
White Range Project	Greenmount	110km ESE of Mount Isa	Abandoned mine, active prospect	Not recorded	12.29Mt at 0.79% Cu, 0.06% Co and 0.32g/t Au for 96 716t Cu, 7263t Co and 3883kg Au (Queensland Mining Corporation Limited, 2010a)	Staveley Formation, Marimo Slate/ Marimo-Staveley Domain	Shear zone hosted veins and breccia in siltstone, slate and schist. Held under Mining Lease and Mineral Development Licence by Queensland Mining Corporation Ltd.
	Kuridala	115km SE of Mount Isa	Active prospect	Not mined	7.2Mt at 0.84% Cu and 0.02% Co and 0.21g/t Au for 60 110t Cu, 1610t Co and 1494kg Au (Queensland Mining Corporation Limited, 2010a)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted veins and breccia in slate and metadolerite. Held under Mining Lease by Queensland Mining Corporation Ltd.

Table 16 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
White Range Project (continued)	McCabe	110km ESE of Mount Isa	Abandoned mine, active prospect	1.22t Cu (–1958)	7.7Mt at 0.57% Cu and 0.02% Co for 43 890t Cu and 1694t Co (Queensland Mining Corporation Limited, 2010c)	Marimo Slate/ Marimo-Staveley Domain	Shear zone hosted veins and breccia in siltstone and sandstone. Held under Mining Lease by Queensland Mining Corporation Ltd.
	Stuart	155km SE of Mount Isa	Abandoned mine, active prospect	21t Cu (1968–1979)	5.58Mt at 0.55% Cu, 0.002% Co and 0.14g/t Au for 30 690t Cu, 122t Co and 781kg Au (Queensland Mining Corporation Limited, 2010b)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted veins and breccia in siltstone, slate and shale. Held under Mining Lease by Queensland Mining Corporation Ltd.
	Vulcan	116km ESE of Mount Isa	Abandoned mine, active prospect	11.95t Cu and 0.019kg Au (1905–1931)	1.42Mt at 0.65% Cu and 0.02% Co for 9230t Cu and 241t Co (Queensland Mining Corporation Limited, 2010d)	Marimo Slate/ Marimo-Staveley Domain	Shear zone hosted veins and breccia in siltstone and sandstone. Held under Mining Lease and Mineral Development Licence by Queensland Mining Corporation Ltd.
Young Australia		117km SE of Mount Isa	Abandoned mine, active prospect	4724.4t Cu (1959–1967, 1994–2003)	Young Australian – 1.519t at 1.07% Cu, 0.01% Co and 2g/t Ag for 16 327t Cu, 164t Co and 3026kg Ag. East Drift – 0.61Mt at 0.8% Cu for 4880t Cu (Queensland Mining Corporation Limited, 2011a)	Answer Slate/ Marimo-Staveley Domain	Shear zone hosted veins and breccia in siltstone, schist and quartzite. Held under Mining Lease by North Queensland Mines Pty Ltd (Queensland Mining Corporation Ltd).

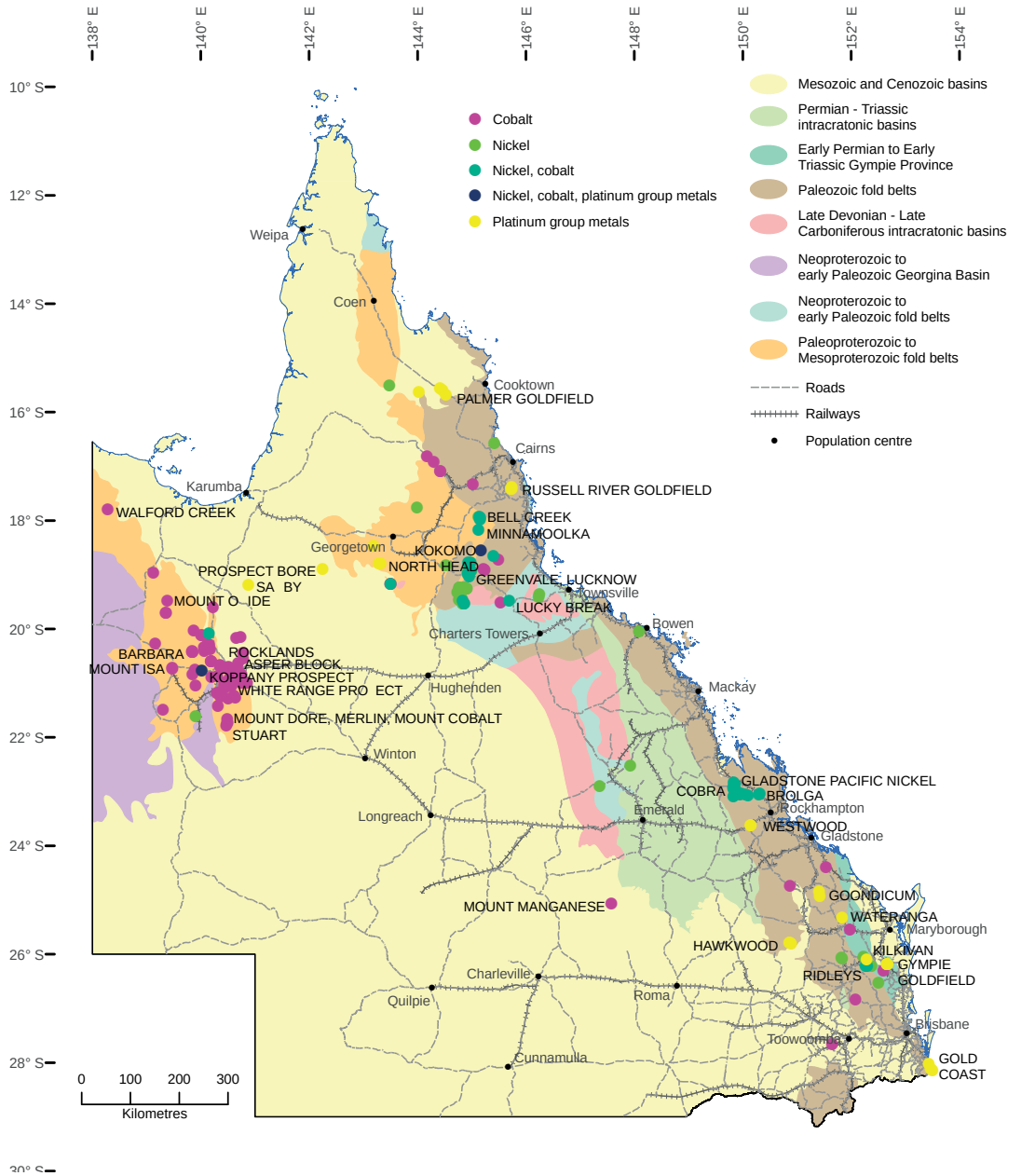

Figure 22: Nickel, cobalt and platinum group metal occurrences and deposits

the weathering profile. Typically, laterites comprise an upper zone in which nickel is combined with iron oxides (limonite zone) and a lower zone where nickel occurs in complex magnesium-rich silicates (saprolite zone). The only mining of nickeliferous laterites in the State has occurred at Greenvale, Lucknow and Brolga in northern and central Queensland. Queensland's nickel and cobalt resources have been described by Dunstan (1917e, 1921d, 1926), Brooks (1979), Wallis (1994, 1998a) and Smart (1999d, 2001, 2002).

The largest unexploited nickel and cobalt laterite resources in Queensland are in the Marlborough, Bell Creek, Minnamoolka and Greenvale areas in central and north Queensland. Ni-Co laterites are also developed on serpentinites in the Kilkivan (Black Snake Plateau) area in south-east Queensland.

Cobalt is also associated with copper in epigenetic, shear-hosted vein and breccia deposits in north-west Queensland, where ~54 700t of cobalt resources have been delineated. The most significant resources are at Mount Dore, Mount Oxide and Rocklands.

PLATINUM GROUP METALS

The platinum group metals (platinum, palladium, iridium, osmium, rhodium and ruthenium) are all transition metals with similar physical and chemical properties and they tend to occur together in the same mineral deposits. This group have outstanding catalytic properties and are highly resistant to wear, tarnish and chemical attack.

The platinum group metals are used as catalysts in the chemical and petrochemical industries and in catalytic converters, fuel cells, spark plugs, and electronic components for engine management, air bag initiators and antilock braking systems in automobiles. A wide range of alloys is used in low-voltage and low-energy contacts, thick- and thin-film circuits, thermocouples and furnace components, electrodes, and smoke detectors. Platinum group metals are also used in pharmaceuticals and the production of fibre optic cables. Platinum and palladium are used in fine jewellery.

Platinum group metals have not been found in economic concentrations in Queensland. Known occurrences (Figure 22; Ball, 1905b; Dunstan, 1917f; Dunstan, 1921e; Dunstan, 1926; Shepherd, 1956; Connah, 1961; Brooks, 1984; Evans & others, 1993; Reeves & Keays, 1995) include:

- Elevated Pt and Pd in layered gabbros complexes and their derived eluvium and alluvium at Goondicum, Hawkwood, Wateranga and Westwood. Layered gabbro complexes have been intersected under cover at Saxby and Prospect Bore.
- Anomalous platinum group metals in the Lucknow and Kokomo Ni-Co laterites
- Pt in gold-quartz veins of the Gympie Goldfield
- Pt and Pd, with Cu-Au-Co-Ni, in shear-hosted veins associated with diorite/gabbro sills at the Koppany Prospect, west of Cloncurry
- Minor Pt has been reported from gold-bearing alluvium in the Gympie Goldfield, creeks draining north from the Palmer Goldfield, Russell River Goldfield, West Coast, Fat Hen and Angella Creeks near Kilkivan, and the North Head area south-west of Forsayth.
- Pt and Os were found in heavy mineral concentrates from beach sand deposits on the Gold Coast.

RARE EARTH ELEMENTS, YTTRIUM, SCANDIUM AND THORIUM

The traditional term rare earths or rare earth elements applies to the 15 chemically similar metallic elements of the lanthanide group, namely, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium. Yttrium, scandium and thorium are often included in the group because they have similar

chemical properties and a natural association with lanthanide elements (Cooper 1990b). The term ‘rare earths’ is an historical misnomer and the crustal abundance of these elements is in fact equal to other elements such as tin and silver. However, in contrast to ordinary base and precious metals, rare earth elements do not tend to be concentrated in exploitable ore deposits. Consequently, most of the world’s supply comes from only a handful of sources.

The lighter rare earth elements (lanthanum to neodymium) are more strongly concentrated in the earth’s crust than the heavier elements. Therefore, deposits containing relatively high grades of the scarcer and more valuable heavy rare earth elements (promethium to lutetium) are particularly desirable.

About 95% of rare earth usage, including yttrium, is in mixed form. Major uses include:

- decolourising and antibrowning agents, polishing compounds, colouring agents, and additives in glasses, optical lenses and ceramics
- catalysts in petroleum cracking and in automotive exhaust catalytic convertors
- as alloying agents in steels, superalloys and magnesium, aluminium and titanium alloys
- as individual elements for phosphors for colour televisions, fluorescent lighting and energy efficient light globes
- in neodymium-iron-boron and samarium-cobalt permanent magnets used in mineral separation, oxygen sensors, microwave ferrites, lasers and hydrogen storage materials.

Scandium and its alloys are used in the aerospace and automotive industries, sports equipment, laser research, specialty welding wire, mobile phones, electronics and high intensity metal halide lamps. Scandium-stabilised zirconia is used as an electrolyte for high efficiency Solid Oxide Fuel Cells with applications in transport and power generation.

Thorium is mainly used in catalysts, welding electrodes, lighting elements, refractory moulds, ceramics, fabricated alloys and aerospace parts. A potentially significant future use is as a fuel in the generation of nuclear energy in breeder reactors.

The three major minerals known to contain rare earths are monazite (a rare earth phosphate containing 55–60% rare earth oxides, particularly Ce, La, Y and Th), bastnaesite (a fluorocarbonate of Ce with 75% rare earths) and xenotime (a yttrium phosphate that also contains other rare earths such as Er, Ce and Th). Other important rare earth minerals include apatite (a calcium fluorophosphate with Ce), allanite (a complex calc-silicate mineral with Ce and Y), stillwellite (a La borosilicate), zircon (which contains Th, Y and Ce) and rare earth-bearing clays.

There is no production of rare earth elements, scandium or thorium in Queensland, but rare earth elements and thorium are present in monazite currently being mined

from heavy mineral beach sand deposits. Historically, Queensland exported monazite for the extraction of both thorium and rare earths between 1952 and 1995. However, monazite is no longer considered to be a commercially viable source of rare earths because of the cost of disposal of radioactive material containing thorium. In current mineral sand operations, the monazite is returned to the mine site and dispersed as stipulated in mining conditions (Mernagh & Miezitis, 2008).

Potential sources of rare earth elements in Queensland (Figure 23) include:

- Uranium deposits in the Mount Isa region. Rare earths were extracted with uranium-bearing skarns at Mary Kathleen and, after processing, ended up in the tailings dam due to a lack of markets. In all, some 9.5Mt of ore with 4.5% rare earths was mined and processed. Other nearby deposits known to contain rare earths include Mount Dorothy and Elaine Dorothy.
- Cu-Au deposits in the Cloncurry region. Ernest Henry is known to carry low concentrations of rare earth elements. Rare earth elements (including heavy rare earth oxides) have been detected in significant concentrations at a number of Cu-Au prospects in the Florence Bore area, south of Cloncurry (Activex Limited, 2011). Rare earth elements and yttrium occur in the Wilgar Cu-Au-Mo polymetallic deposit, 17.3km west-north-west of Cloncurry.
- Monazite in pegmatites in the Mica Creek (Brooks & Shipway, 1960) and Herberton-Mount Garnet areas.
- Intrusive related deposits such as Yatton, where trachytic volcanics intruded by sodic syenite are enriched in lanthnides, Zr, Nb, Y and Th, but not to economic levels (Willett, 1985).
- Lithium and rare earth element mineralisation, in association with manganese and cobalt, at the Bitumen and Cobree prospects, 33.5km east-north-east of Greenvale. A bed of bituminous, manganese oxide-cemented quartzose sandstone contains Li-, Ce-, Co- and Ni-rich manganese oxides, as well as a variety of rare earth-bearing phases, including manganiferous wad, asbolane, hollandite and lithiophorite. The deposits are interpreted as forming by cementing of Tertiary sands by manganese oxides and hydrothermal clays precipitated from hot aqueous solutions emanating from thermal springs; Co, Li and rare earths were leached from glassy mafic and silicic volcanic rocks (Teale, 1989; Barker & others, 1997).
- Late Permian to Late Cretaceous layered gabbro complexes and their derived eluvium and alluvium. Deposits such as Wateranga, Goondicum and Eulogie Park contain significant apatite and, in some cases, zircon; their potential as sources of rare earth elements has not been tested.
- Phosphate deposits of the Georgina Basin, which contain significant amounts of rare earths (de Keyser & Cook, 1972). These deposits comprise carbonate-fluoroapatite with substitution of the lanthanides and yttrium for calcium (Cooper, 1990b) and have been described in the section on phosphate. Krucible Metals Ltd's Korella deposit contains 4.2Mt at 746g/t Y for 3.13t Y (Krucible Metals Ltd, 2011); the yttrium is contained in xenotime. Neodymium and dysprosium have also been detected in potentially economic concentrations.

- Secondary deposits of beach and dune sand, alluvial and fluvial deposits that contain monazite and xenotime, together with other heavy minerals. These deposits and their known production and resources have already been described in the section on heavy minerals.

Queensland's significant scandium resources (Figure 23) are in Ni-Co laterites in the Greenvale area which contains 8.0Mt at 0.93% Ni, 0.08% Co and 21.8g/t Sc for 83 355t Ni, 6573t Co and 261.3t Sc and Lucknow has 8.0Mt at 0.29% Ni, -.07% Co and 141g/t Sc for 23 139t Ni, 4829t Co and 1129t Sc (Metallica Minerals Limited, 2011). Scandium has also been reported from the Bell Creek South and Kokomo deposits.

Grades of up to 30ppm Sc have been reported from the Wateranga layered gabbro (Evans & others, 1993). Drilling in the oxidised zone at the Mount Moss magnetite

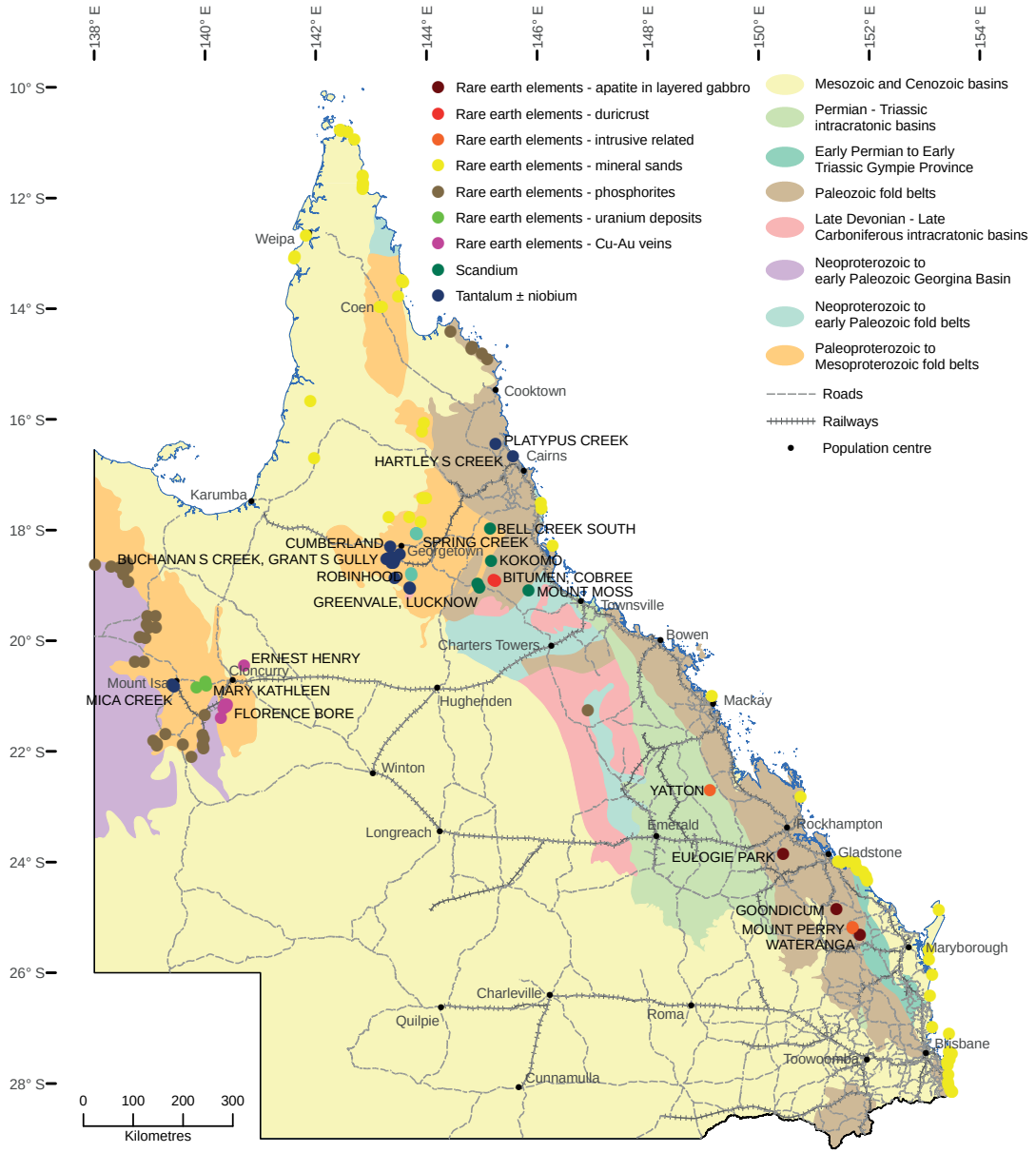

Figure 23: Rare earth element, scandium, thorium, tantalum and niobium occurrences and deposits

skarn, 100km west of Townsville, returned 78m at 20.7g/t Sc, 0.24% Cu and 2.03% Zn from 36m.

Thorium can be extracted from monazite, xenotime and zircon, all of which occur in Queensland's heavy mineral sand deposits. Thorium is also known to occur with uranium in veins in altered Carboniferous rhyolitic intrusions and Proterozoic basement rocks in the Spring Creek (Andrews, 1980) and Robinhood (Schindlmayer, 1975) areas in the Georgetown region. The Mary Kathleen uranium mineralisation contained ~0.025% thorium oxide (Mernagh & Miezitis, 2008). Thorium also occurs in low concentrations in the Georgina Basin marine phosphorites.

SILVER-LEAD-ZINC

After gold, silver is the most malleable and ductile of all metals, and it is also the best conductor of heat and electricity. Most silver is used in jewellery, currency, household silverware and art objects. Silver also has industrial uses such as photography and electronics. It is used as a coating for mirrors, CDs and DVDs, as a catalyst, as a biocide and bacteriostatic in plastics and textiles, as an anti-bacterial agent in applications such as water treatment and wound management, and in dental amalgam, batteries, jet engine bearings, brazes and solders, solar cells, musical instruments and nuclear fission reactor control rods. The use of silver in coinage has declined in recent decades. Silver occurs as the native metal, as an alloy with gold (electrum) and other metals, and in minerals such as argentite, pyrargyrite and argentiferous galena. Most silver is produced as a co-product of lead, zinc, copper and, to a lesser extent, gold mining.

Lead is a soft, malleable, ductile heavy metal. It has a high corrosion resistance but has poor electrical conductivity compared to most other metals. More than half of worldwide lead production is used in lead-acid batteries. Other applications include underwater and high voltage cable sheathing, solder, casting alloys, fusible alloys, construction, chemical compounds, weights and ballast, solders, ammunition, pewter, glassware, ceramic glazes, semiconductors and radiation protection. Galena, cerussite and anglesite are the common lead ore minerals.

Zinc is the fourth most-used metal after iron, aluminium and copper. Almost half of the zinc produced is used for galvanising steel to protect it from rust. Zinc and its compounds are also used in the production of brass, various alloys, batteries, dyes and pigments, rubber, fire retardants, wood preservatives, dietary supplements, sunscreen, toothpaste, shampoos, lasers and agricultural chemicals. The most common zinc ore is sphalerite.

Queensland is Australia's largest producer of silver, lead and zinc and north-west Queensland is one of the world's major zinc, lead and silver producing regions, with major mines at Mount Isa, Cannington and Century. Numerous smaller deposits occur within the Mount Isa Inlier and within rocks of the Tasman Orogenic Zone and Etheridge Province.

In 2009–10, Queensland produced 427 016t lead (comprising 417 319t Pb from 574 197t of lead concentrates and 9697t Pb from zinc concentrates), 831 899t zinc (comprising 831 724t Zn from 1 592 625t of zinc concentrates and 175t Zn from lead concentrates) and 1 684 611kg silver (comprising 47 414kg from copper concentrates, 5kg from alluvial gold, 12 810kg from gold bullion, 1 360 596kg from lead concentrates and 263 786kg from zinc concentrates). Significant silver±lead±zinc deposits in Queensland occur in the following mineralisation styles (Figure 24, Table 17):

- Sediment-hosted Ag-Pb-Zn deposits
- Broken Hill style Ag-Pb-Zn deposits
- Volcanogenic massive sulphide (VMS) deposits
- Base metal skarns
- Epithermal Ag-Au deposits
- Polymetallic veins in various settings
- Porphyry Cu-Mo-Au deposits
- Iron oxide-Cu-Au deposits
- Porphyry-related subvolcanic breccias
- Brecciated sediment-hosted Cu deposits
- Mesothermal to porphyry-related Au-Ag veins.

Queensland's silver, lead and zinc deposits and resources have been described by Kay (1985), Sawers (1990), Wallis (1993c, 1993d, 1996, 1998b, 1998c, 2001a), Sandford (2000) and Geological Survey of Queensland (2011).

Sediment-hosted Ag-Pb-Zn deposits

The majority of major silver–lead–zinc resources within Queensland are located in the Mount Isa Inlier and are of the sediment-hosted Ag-Pb Zn mineralisation style. Significant examples include the world-class Black Star (Mount Isa), Century, George Fisher North and George Fisher South (Hilton) orebodies, advanced prospects such as Lady Loretta and Dugald River, and prospects such as Grevillea and Walford Creek. Century is the world's second-largest zinc mine, producing about 5% of the world's zinc.

Generally, sediment-hosted Ag-Pb-Zn mineralisation comprises stratiform to stratabound basinal accumulations of sulphide and sulphate minerals interbedded with euxinic marine sediments. Sulphides commonly form banded sheet or lens-like tabular orebodies up to a few tens of metres thick. Deposits are typically hosted by the fine-grained sediments of the Western Fold Belt Province and occur within at least four different stratigraphic levels. Mineralisation at Dugald River is an important exception, being hosted by carbonaceous shales of the Eastern Fold Belt Province.

Broken Hill style Ag-Pb-Zn deposits

Broken Hill style Ag-Pb-Zn mineralisation occurs as sheet-like, tabular orebodies of stratabound to stratiform lead and zinc sulphide minerals in iron- and manganese-rich volcano-sedimentary rocks that are locally highly deformed, often within high-grade metamorphic rocks. Cannington and Pegmont are the major examples of Broken Hill style mineralisation in Queensland. Cannington is the world's largest-tonnage and lowest-cost single mine producer of silver and lead. It produces about 6% of the world's silver. Cannington and Pegmont both occur within strongly deformed and metamorphosed rocks of the Eastern Fold Belt Province of the Mount Isa Inlier. Mineralisation at Cannington is hosted by a garnetiferous psammite sequence within a migmatitic quartzo-feldspathic gneiss terrane. The nearby Pegmont mineralisation is a stratabound, banded, graphitic magnetite-quartz-fayalite lode associated with galena-sphalerite-gahnite zones, comparable to mineralisation at Cannington.

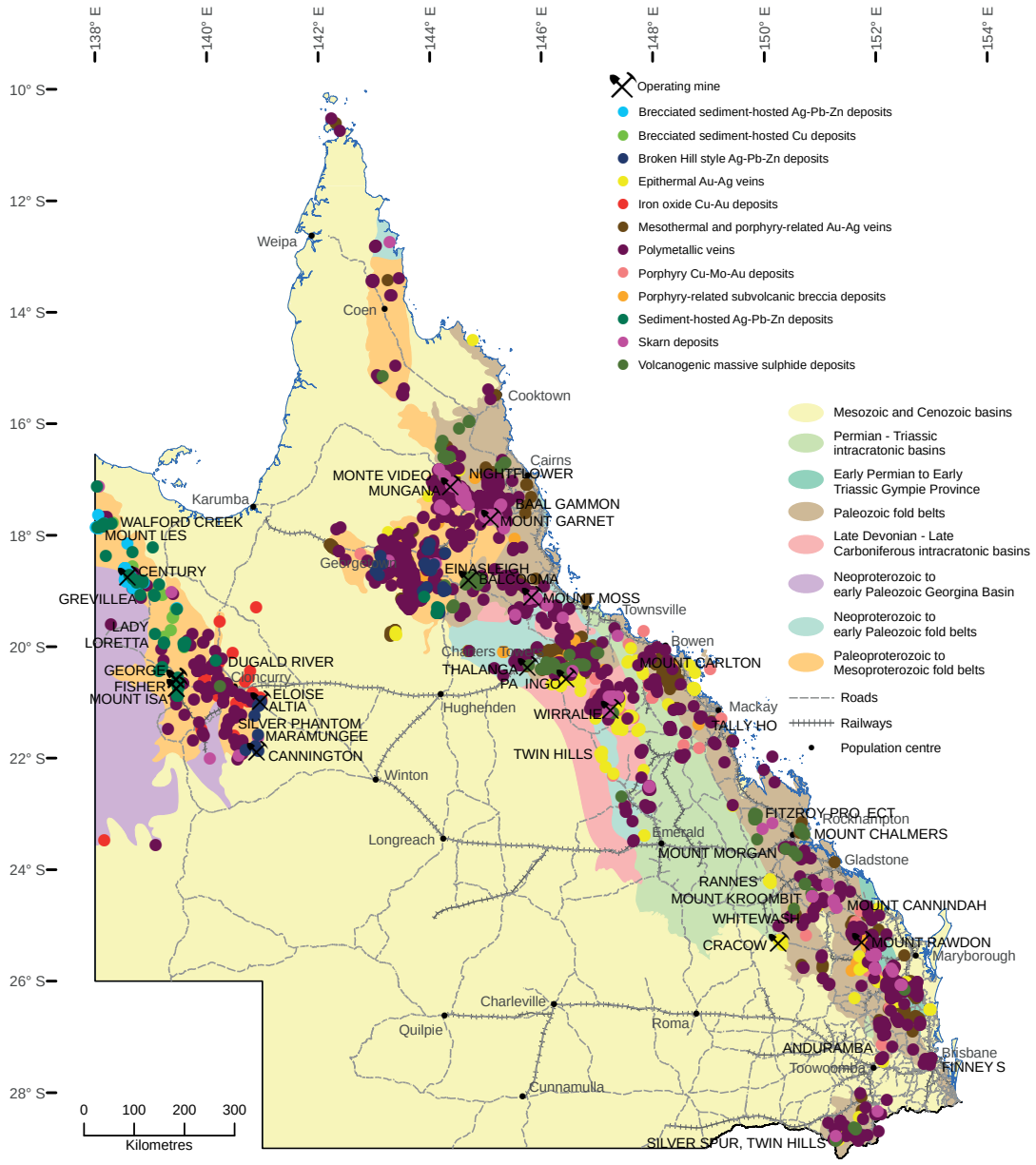

Figure 24: Silver, lead and zinc occurrences and deposits

Several smaller deposits within the Etheridge Province of the Georgetown Orogen, including Chloe (Mount Misery) and the Eveleigh Zinc Prospect, have similarities to Broken Hill style mineralisation. These smaller Broken Hill style deposits are stratabound concentrations of iron and base metal sulphides, commonly associated with epidote- to diopside-bearing quartzite, quartzofeldspathic granofels and gneiss of the Einasleigh Metamorphics.

Volcanogenic massive sulphide deposits

Volcanogenic massive sulphide Ag-Pb-Zn deposits in Queensland occur predominantly within rocks of the Thalanga and Etheridge Provinces in north Queensland. Two significant VMS Ag-Pb-Zn deposits have been defined within Queensland, namely Thalanga and Balcooma. Both deposits are zinc rich and of medium size, with significant associated copper and minor gold mineralisation. Smaller examples occur elsewhere in north Queensland.

The Thalanga deposit occurs within Late Cambrian to early Ordovician rocks of the Seventy Mile Range Group in the Charters Towers area and has a tabular, blanket-type geometry, with rhyolitic volcanic rocks in the footwall and dacite and andesite in the hanging wall.

The Balcooma deposit (including the satellite deposits of Dry River South and Surveyor One) is located in the eastern part of the Georgetown Orogen, and is hosted by metapelite lenses within a meta-arenite sequence of the Balcooma Metavolcanic Group. The group consists of bimodal but predominantly felsic volcanoclastics and lavas. Mineralisation is thought to be about the same age as the deposits in the Seventy Mile Range Group.

Base metal skarns

Significant skarn style base metal mineralisation occurs in the Chillagoe Formation of the Hodgkinson Province in north Queensland. Mineralisation is thought to be associated with late Carboniferous igneous activity of the Kennedy Province. Numerous smaller skarn deposits were mined in this region during the early part of the 20th century. Active exploration is occurring at the Mungana and King Vol deposits.

A small zinc skarn occurs in the Gympie Province at Ban Ban in south-east Queensland.

Epithermal Ag-Au deposits

Conquest Mining Ltd has delineated significant silver resources at its Mount Carlton project, near Collinsville, where high sulphidation Ag-Au-Cu vein stockworks are hosted by rhyodacite and volcaniclastics of the Lizzie Creek Volcanics.

Table 17: Significant Ag-Pb-Zn deposits of Queensland

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Altia		58km ESE of Cloncurry	Active prospect	Not mined	5.78Mt at 3.97% Pb, 40.42g/t Ag and 0.45% Zn for 229 245t Pb, 233 070kg Ag and 28 407t Zn (Breakaway Resources Limited, 2008a)	Toole Creek Volcanics/ Soldiers Cap Domain	Broken Hill style Ag-Pb-Zn deposit in banded iron formation. Held under Exploration Permit and Mineral Development Licence application by Levuka Resources Pty Ltd (Breakaway Resources Ltd), in joint venture with BHP Billiton Minerals Pty Ltd.
Anduramba Prospect		14km NNE of Crows Nest	Abandoned mine, active prospect, feasibility study	Not reported	31.6Mt at 0.05% Mo, 0.014% Cu and 4.7g/t Ag for 17 083t Mo, 149 395kg Ag and 4338t Cu (D'Aguilar Gold Limited, 2008b)	Eskdale Granodiorite/ South East Queensland Volcanic and Plutonic Province	Porphyry Mo-Cu deposit in granite. Held under Mineral Development Licence by Archer Resources Pty Ltd (D'Aguilar Gold Ltd).
Baal Gammon		6.4km W of Herberton	Abandoned mine, active prospect	88.4t cassiterite (1892–1949)	5 482 000t at 0.2% Sn, 29g/t Ag, 0.8% Cu and 29g/t In for 10 964t Sn, 156 907kg Ag, 43 420t Cu and 159 087kg In (Monto Minerals Limited, 2011)	Hodgkinson Formation/ Hodgkinson Province	Cassiterite-Cu-Ag-In-quartz veins and stockworks in meta-arenite and porphyry intrusive. Held under Mining Lease by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd). Kagara Ltd proposes to commence mining copper ore in 2011.
Ban Ban Zinc Lode		40.3km ESE of Gayndah	Active prospect	Not mined	1.5Mt at 7% Zn for 109 200t Zn (Grayson, 2007)	Gympie Group/ Gympie Province	Base metal skarn in interbedded marble and calc-silicate skarn. Held under Mineral Development Licence application by D'Aguilar Gold Ltd.
Barbara	North Lode	51km NE of Mount Isa	Abandoned mine, active prospect	29.85t Cu (1970–1075)	1.99Mt at 1.16% Cu, 2.22g/t Ag, 0.026% Co and 0.1g/t Au for 23 124t Cu, 4424 kg Ag, 512t Co and 199kg Au (Syndicated Metals Limited, 2010)	Leichhardt Volcanics/ Mary Kathleen Domain	Shear zone hosted veins and breccia in schist and volcanics. Held under Exploration Permit by Syndicated Metals Ltd andMt Isa Metals Ltd.
	South Lode	51km NE of Mount Isa	Abandoned mine, active prospect	Not recorded	3.34Mt at 1.57% Cu, 2.67g/t Ag, 0.03% Co and 0.19g/t Au for 52 338t Cu, 8905 kg Ag, 910t Co and 631kg Au (Syndicated Metals Limited, 2010)	Leichhardt Volcanics/ Mary Kathleen Domain	Shear zone hosted veins and breccia in schist and volcanics. Held under Exploration Permit by Syndicated Metals Ltd andMt Isa Metals Ltd.
Bernborough		2.4km S of Mount Isa	Abandoned mine	1750t Pb, 1205kg Ag (1951)	Not calculated	Urquhart Shale/ Leichhardt River Domain	Sediment-hosted Ag-Pb-Zn deposit in siltstone and shale. Held under Mining Lease by Mount Isa Mines Ltd (Xstrata Plc).
Cannington		195km SE of Mount Isa	Operating mine	13 471 184.8kg Ag, 2 924 929t Pb, 770 802t Zn, 41 932t Zn concentrates (1997–2010)	72Mt at 242.3g/t Ag, 6.55% Pb and 3.39% Zn for 17 444 000kg Ag, 4 720 000t Pb, and 2 440 000t Zn (BHP Billiton Plc, 2010)	Mount Norna Quartzite/ Kuridala-Selwyn Domain	Broken Hill style Ag-Pb-Zn deposit in schist, quartzite, gneiss, pegmatite and amphibolite. Held under Mining Lease by BHP Billiton Minerals Pty Ltd.

Table 17 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Century		220km N of Mount Isa	Operating mine	5 010 252t Zn, 1 777 147kg Ag, 740 787t Pb (2000–2010)	37Mt at 11.8 % Zn, 1.5% Pb and 35.2g/t Ag for 4 368 600t Zn, 560 900t Pb and 1 302 100kg Ag (Minmetal Resources Limited, 2010)	Lawn Hill Formation/ Century Domain	Sediment-hosted Ag-Pb-Zn deposit in shale, siltstone, sandstone and dolomite. Held under Mining Lease by MMG Century Ltd (MMG Mining Ltd).
Comeno		8.2km W of Irvinebank	Abandoned mine, inactive prospect	Not recorded	23 400t at 0.37% cassiterite, 136.5ppm Ag, 6.95% Zn, 1.9% Pb and 0.45% Cu for 87t cassiterite, 3194kg Ag, 1626t Zn, 445t Pb and 105t Cu (Younger, 1981)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-Cu-Ag-Zn-Pb-quartz veins in meta-arenite. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
Copper Knob		1.3km N of Ravenswood	Abandoned mine, active prospect	3.28t Cu, 5.3kg Au, 0.89kg Ag (1906–1920, 1943)	2.16Mt at 0,11% Cu, 0.82g/t Au, 0.2% Zn and 4.3g/t Ag for 2468t Cu, 1783kg Au, 4340t Zn and 9312kg Ag (Haoma Mining NL, 1999)	Jessop Creek Tonalite/ Pama Province	Shear-hosted veins in tonalite. Held under Mining Lease by Kitchener Mining NL.
Cracow Goldfield	Cracow Goldfield	Centred on town of Cracow	Operating mine, active prospects	27.3t Au, 21.1t Ag (1932–1993)	See below	Camboon Volcanics/ Auburn Subprovince	Low sulphidation epithermal quartz veins in andesitic volcaniclastics. Held under Mining Leases and Exploration Permits by Newcrest Operations Ltd, Lion Mining Ltd, Sedgold Pty Ltd and Fernyside Pty Ltd.
	Cracow Gold Mine (Royal, Royal Standard, Crown, Klondyke, Kilkenny, Tipperary, Roses Pride, Phoenix, Empire and Sovereign shoots)	3.2km W of Cracow	Operating mine	16 553.4kg Au, 10 633.6kg Ag (2004–2010)	4.8Mt at 6.58g/t Au and 4.17g/t Ag for 31 650kg Au and 20 058kg Ag (Catalpa Resources Limited, 2010)	Camboon Volcanics/ Auburn Subprovince	Low sulphidation epithermal quartz veins in andesitic volcaniclastics. Held under Mining Leases by Newcrest Operations Ltd, Lion Mining Ltd, Sedgold Pty Ltd and Fernyside Pty Ltd.
Dugald River		18.6km NW of Quamby	Active prospect	Not mined	Zn ore – 53Mt at 12.5 % Zn, 1.9% Pb and 36.4g/t Ag for 6 602 400t Zn, 983 000t Pb and 1 929 200kg Ag; Cu ore – 4.4Mt at 1.8% Cu and 0.2g/t Au for 79 200t Cu and 880kg Au (Minmetal Resources Limited, 2010).	Dugald River Shale Member/ Mary Kathleen Domain	Sediment-hosted Ag-Pb-Zn deposit in slate, shale, schist and limestone. Held under Mining Lease by MMG Australia Ltd (MMG Mining Ltd).

Table 17 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Einasleigh Project	Chloe	16km SW of Einasleigh	Active prospect, feasibility study	Not mined	2.7Mt at 0.22% Cu, 5.1% Zn, 2% Pb and 37.7g/t Ag for 5900t Cu, 137 900t Zn, 54 500t Pb and 101 800kg Ag (Copper Strike Limited, 2009)	Einasleigh Metamorphics/ Etheridge Province	Broken Hill-style sulphide or skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd.
	Einasleigh	0.8km NE of Einasleigh	Abandoned mine, active prospect, feasibility study	8237t Cu, 71.2kg Au, 4083kg Ag (1898–1922)	1.1Mt at 2.85% Cu, 0.15g/t Au and 12.5g/t Ag for 31 400t Cu, 170kg Au and 13 800kg Ag (Copper Strike Limited, 2010)	Einasleigh Metamorphics/ Etheridge Province	Skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd.
	Jackson	41km E of Forsayth	Active prospect, feasibility study	Not mined	1.5Mt at 0.13% Cu, 4.6% Zn, 2.1% Pb and 74.3g/t Ag for 1900t Cu, 69 000t Zn, 32 000t Pb and 111 400kg Ag (Copper Strike Limited, 2009)	Einasleigh Metamorphics/ Etheridge Province	Broken Hill-style sulphide or skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd.
	Kaiser Bill	6.3km WSW of Einasleigh	Abandoned mine, active prospect, feasibility study	2.3t Cu, 0.83kg Ag (1909–1922)	15Mt at 0.84% Cu, 0.12g/t Au and 6.5g/t Ag for 126 150t Cu, 1875kg Au and 97 500kg Ag (Copper Strike Limited, 2010)	Einasleigh Metamorphics/ Etheridge Province	Skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd.
	Railway Flat	3.8km SW of Einasleigh	Active prospect, feasibility study	Not mined	0.9Mt at 0.2% Cu, 3.4% Zn, 0.9% Pb and 16g/t Ag for 1800t Cu, 30 600t Zn, 8100t Pb and 14 400kg Ag (Copper Strike Limited, 2010)	Einasleigh Metamorphics/ Etheridge Province	Broken Hill-style sulphide or skarn deposit in gneiss and calc-silicate rocks. Held under Exploration Permit by Copper Strike Ltd.
	Stella	41km E of Forsayth	Active prospect, feasibility study	Not mined	0.4Mt at 0.2% Cu, 3.9% Zn, 1.8% Pb and 51g/t Ag for 800t Cu, 15 600t Zn, 7200t Pb and 20 400kg Ag (Copper Strike Limited, 2009)	Einasleigh Metamorphics/ Etheridge Province	Broken Hill-style sulphide or skarn deposit in gneiss. Held under Mining Lease by Einasleigh Mining Pty Ltd and Copper Strike Ltd.
Eloise		56.4km ESE of Cloncurry	Operating mine	157 923t Cu, 55 343.4t Cu conc., 29 383.2kg Ag, 3312.7kg Au, 266.3kg Au bullion (1996–2009)	3.5Mt at 3.1% Cu, 0.8g/t Au and 9.9g/t Ag for 108 100t Cu, 2880kg Au and 34 740kg Ag (Breakaway Resources Limited, 2008b)	Toole Creek Volcanics/ Soldiers Cap Domain	Iron oxide-Cu-Au deposit in schist, amphibolite and arkose. Held under Mining Leases by Ernest Henry Mining Pty Ltd (Xstrata Plc).

Table 17 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Eveleigh Zn Prospect		44km E of Georgetown	Abandoned mine, active prospect	Not recorded	15Mt at 1.5% Zn for 225 000t Zn (Davies, 1972)	Einasleigh Metamorphics/ Etheridge Province	Broken Hill style Ag-Pb-Zn deposit in calc-silicates and amphibolite. Held under Exploration Permit by KS Mining Pty Ltd.
Finney's Pb-Ag Mine		Indooroopilly, Brisbane	Abandoned mine	1796t Pb, 7071kg Ag (1919–1929)	Mined out	Bunya Phyllite/ South D'Aguilar Block	Polymetallic veins in phyllite. Now used as the University of Queensland's experimental mine.
Fitzroy Project	Scorpion	47.6km N of Rookwood Homestead	Active prospect	Not mined	0.485Mt at 2% Cu, 1.9% Zn, 0.4g/t Au and 13.9g/t Ag for 9700t Cu, 9215t Zn, 194kg Au and 6741kg Ag (Icon Resources Ltd, 2007)	Rookwood Volcanics/ Grantleigh Subprovince	Volcanogenic massive sulphide deposit in basalt and andesite. Held under Exploration Permit by Fitzroy Copper Pty Ltd.
	Sulphide City	47.6km N of Rookwood Homestead	Active prospect	Not mined	1.175Mt at 1.63% Cu, 2.51% Zn, 0.19g/t Au and 7.15g/t Ag for 19 152t Cu, 29 516t Zn, 228kg Au and 8401kg Ag (Icon Resources Ltd, 2007)	Rookwood Volcanics/ Grantleigh Subprovince	Volcanogenic massive sulphide deposit in basalt and andesite. Held under Exploration Permit by Fitzroy Copper Pty Ltd.
George Fisher North		19.2km N of Mount Isa	Operating mine	Production included with that of Mount Isa Silver-Lead Mine	81.3Mt at 8.4% Zn, 116.2g/t Ag and 5.5% Pb for 6 816 900t Zn, 9 449 700kg Ag and 4 485 100t Pb (Xstrata Plc, 2010)	Urquhart Shale/ Leichhardt River Domain	Sediment-hosted Ag-Pb-Zn deposit in siltstone and shale. Held under Mining lease by Mount Isa Mines Ltd (Xstrata Plc).
George Fisher South (Hilton and Handlebar Hill)		17.3km N of Mount Isa	Operating mine	Production included with that of Mount Isa Silver-Lead Mine	154.6Mt at 8.5% Zn, 67.5g/t Ag and 4.3% Pb for 13 136 600t Zn, 10 442 200kg Ag and 6 602 000t Pb (Xstrata Plc, 2010)	Urquhart Shale/ Leichhardt River Domain	Sediment-hosted Ag-Pb-Zn deposit in siltstone and shale. Held under Mining Lease by Mount Isa Mines Ltd (Xstrata Plc).
Girofla		1km SE of Mungana	Abandoned mine, active prospect	6018t Cu, 30 192t Pb, 54 425kg Ag (1902–1953)	Not calculated	Chillagoe Formation/ Hodgkinson Province	Base metal skarn in limestone, chert and breccia. Held under Mining Lease by Mungana Pty Ltd.
Granite Castle		88km NW of Pentland	Abandoned mine, active prospect	26.44kg Au, 0.6t Cu, 188.74kg Ag (1910–1942)	764 704t at 3.14g/t Au and 61.08g/t Ag for 2401kg Au and 46 705kg Ag (Mantle Mining Corporation Limited, 2008)	Upland Granodiorite/ Pama Province	Shear-hosted polymetallic quartz veins in granodiorite. Held under Exploration Permit by Zulu Gold Mining Pty Ltd.
Grevillea		180km NNW of Mount Isa	Active prospect	Not mined	Not calculated	Riversleigh Siltstone/ Century Domain	Sediment-hosted Ag-Pb-Zn deposit in shale, siltstone and volcaniclastics. Held under Exploration Permit by SmartTrans Holdings Ltd (joint venture with MMG Australia Ltd).

Table 17 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Handcuff		32km S of Charters Towers	Active prospect	Not mined	1Mt at 0.4% Cu, 7.4% Zn, 0.2% Pb, 0.2g/t Au and 8.8g/t Ag for 4000t Cu, 74 000t Zn, 2000t Pb, 200kg Au and 8800kg Ag (Dronseika, 1995)	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in chert and rhyolite. Held under Mining Lease by Thalanga Copper Mines Pty Ltd and BML Holdings Pty Ltd.
Highway-Reward		33km SSW of Charters Towers	Care and maintenance, active prospect	173 092t Cu, 7395.5kg Ag, 3302.3kg Au, 1137t Pb, 2866t Zn, 29.3kg Au bullion (1953–1989, 1998–-2006)	Resources mined out	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolite, volcaniclastics and dacite. Held under Mining Lease by Thalanga Copper Mines Pty Ltd and BML Holdings Pty Ltd.
Kagara North Queensland Operations	Mount Garnet Plant	1km SSW of Mount Garnet	Operating copper and polymetallic plants	67 333t Cu, 185 125t Zn, 33 525t Pb, 707.2kg Au, 80 720kg Ag (2005–2010)	Not applicable	Not applicable	Currently processes ore from Mount Garnet, Balcooma and Mungana; has treated Surveyor and Dry River South ore in past. Held under Mining Leases by Kagara Ltd.
	Balcooma	33km NW of Greenvale	Operating mine	Production included in Mount Garnet Plant and Thalanga Plant figures	Balcooma Underground Copper – 1.63Mt at 2.83% Cu, 0.19% Zn, 0.1% Pb, 0.19g/t Au and 11.32g/t Ag for 46 152t Cu, 3077t Zn, 1557t Pb, 312kg Au and 18 430kg Ag. Balcooma Upper Lens Cu – 79 000t at 2.3% Cu, 1.1% Zn, 0.2% Pb, 0.2g/t Au and 7g/t Ag for 1817t Cu, 869t Zn, 158t Pb, 15kg Au and 553kg Ag. Balcooma Lead Oxide – 58 600t at 11.9% Pb and 125g/t Ag for 6973t Pb and 7325kg Ag (Kagara Ltd, 2010)	Balcooma Metavolcanic Group/ Thalanga Province	Volcanogenic massive sulphide deposit in schist and meta-pelite. Held under Mining Leases by Kagara Ltd.
	Dry River South	13.5km SSW of Conjuboy Homestead	Care and maintenance	Production included in Mount Garnet Plant figures	730 300t at 0.95% Cu, 6.9% Zn, 2.5% Pb, 0.64g/t Au and 62.1g/t Ag for 6445t Cu, 50 309t Zn, 18 347t Pb, 469kg Au and 45 356kg Ag (Kagara Ltd, 2010)	Balcooma Metavolcanic Group/ Thalanga Province	Volcanogenic massive sulphide deposit in greywacke and meta-volcanics. Held under Mining Leases by Kagara Ltd.

Table 17 (continued)

	Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Kagara North Queensland Operations (continued)	Griffiths Hill	3km SE of Mungana	Abandoned mine, active prospect	213t Cu (1887–1919)	1.05Mt at 3.06% Cu, 0.62g/t Au and 64g/t Ag for 32130t Cu, 651kg Au and 67 200kg Ag (Kagara Ltd, 2011)	Chillagoe Formation/ Hodgkinson Province	Skarn in limestone, porphyry and breccia. Held under Mining Lease by Mungana Pty Ltd.
	King Vol	24km NW of Mungana	Abandoned mine, active prospect	0.3t Cu, 369t Pb, 257kg Ag (1922–1925)	3.286Mt at 0.76% Cu, 12.9% Zn, 1% Pb and 40.2g/t Ag for 24 971t Cu, 423 164t Zn, 32 195t Pb and 132 079kg Ag (Kagara Ltd, 2010)	Chillagoe Formation/ Hodgkinson Province	Base metal skarn in limestone and siliceous rocks. Held under Exploration Permit and Mining Lease application by Kagara Ltd.
	Liontown	41.9km SSW of Charters Towers	Abandoned mine, active prospect	93kg Au, 1678kg Ag, 528t Pb (1951–1961)	1.845Mt at 0.57% Cu, 7.5% Zn, 2.5% Pb, 0.4g/t Au and 28.3g/t Ag for 10 455t Cu, 137 620t Zn, 45 535t Pb, 736kg Au and 52 275kg Ag (Kagara Ltd, 2010)	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in greywacke, meta-volcanics and volcaniclastics. Held under Mining Lease by Kagara Ltd.
	Monte Video	20.5km WSW of Nychum Homestead	Abandoned mine, active prospect	Not recorded	0.72Mt at 7.7% Zn, 7g/t Ag and 0.5% Pb for 55 440t Zn, 5040kg Ag and 3600t Pb (Kagara Ltd, 2010)	Chillagoe Formation/ Hodgkinson Province	Base metal skarn in calc-silicate rocks. Held under Exploration Permit by Kagara Ltd.
	Mount Garnet	1km SSW of Mount Garnet	Operating mine	12 799t Cu, 13 624t Zn, 29 500kg Ag (1901–1903, 2003). Production since 2005 is included in Mount Garnet Plant figures	1.273Mt at 6.5% Zn, 0.35% Cu, 0.08% Pb and 19.9g/t Ag for 82 527t Zn, 4498t Cu, 1088t Pb and 25 348kg Ag (Kagara Ltd, 2010)	Chillagoe Formation/ Hodgkinson Province	Base metal skarn in limestone and arkose. Held under Mining Leases by Kagara Ltd.
	Mungana	140km W of Cairns	Operating mine	Production included in Mount Garnet Plant figures	Mungana Copper Orebody – 90 000t at 6.4% Cu, 0.8% Zn, 8.7% Pb, 1.83g/t Au and 713g/t Ag for 5760t Cu, 720t Zn, 7830t Pb, 164kg Au and 64 170kg Ag. Mungana Base Metal Orebody – 1.33Mt at 1.9% Cu, 11.6% Zn, 1.4% Pb, 0.99g/t Au and 141g/t Ag for 25 370t Cu, 154 670t Zn, 18 170t Pb, 1314kg Au and 187 110kg Ag (Kagara Ltd, 2010) Mungana Gold Orebody – 48.7Mt at 0.19% Cu, 0.7g/t Au and 13.3g/t Ag for 93 510t Cu, 34 148kg Au and 646 150kg Ag (Mungana Goldmines Ltd, 2011)	Chillagoe Formation/ Hodgkinson Province; unnamed porphyry/ Kennedy Province	Base metal skarn deposit. Held under Mining Leases by Mungana Pty Ltd (Mungana Goldmines Ltd).

Table 17 (continued)

	Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Kagara North Queensland Operations (continued)	Red Dome	140km W of Cairns	Abandoned mine, active prospect	36 059t Cu, 105 855kg Ag, 22 716kg Au (1986–1998)	69.2Mt at 0.24% Cu, 0.63g/t Au and 5.16g/t Ag for 164 060t Cu, 43 687kg Au and 356 770kg Ag (Mungana Goldmines Ltd, 2011)	Chillagoe Formation/ Hodgkinson Province	Porphyry Cu-Mo-Au and base metal skarn deposits. Held under Mining Leases by Mungana Pty Ltd (Mungana Goldmines Ltd).
	Shannon	5.5km W of Chillagoe	Abandoned mine, active prospect	Not recorded	1.01Mt at 0.07% cassiterite, 20.2g/t Ag, 1.23% Cu, 0.53% Zn, 0.96g/t Au and 0.08% Bi for 707t cassiterite, 20 402kg Ag, 12 423t Cu, 5353t Zn, 970kg Au and 808t Bi (Verwoerd & Sargeant, 1971)	Chillagoe Formation/ Hodgkinson Province; Ruddygore Granodiorite/ Kennedy Province	Cu-Zn-Ag-Au-Bi-cassiterite skarn in marble, chert, ironstone and granodiorite. Held under Mining Lease by Mungana Pty Ltd (Mungana Gold Mines Ltd).
	Surveyor	34km NW of Greenvale	Care and maintenance	2720t Cu, 63 289t Zn, 22 291t Pb, 239kg Au, 42 071kg Ag (2003–2005)	119 000t at 11.4% Pb, 2.41g/t Au and 158g/t Ag for 13 566t Pb, 286kg Au and 18 802kg Ag (Kagara Ltd, 2010)	Balcooma Metavolcanic Group/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolitic tuff. Held under Mining Lease by Kagara Ltd.
	Thalanga	11.9km ENE of Homestead	Operating mine	194 900t Cu conc., 158 100t Pb conc., 624 000t Zn conc., 20 277t Cu, 878t Pb, 1998t Zn, 66.8kg Au bullion, 1195.8kg Ag (1991–-2000)	Vomacka – 885 823t at 1.7% Cu, 4.6% Zn, 1.35% Pb, 0.46g/t Au and 44.3g/t Ag for 15 134t Cu, 40 847t Zn, 12 034t Pb, 404kg Au and 39 282kg Ag Orient – 266 000t at 0.95% Cu, 10.5% Zn, 3% Pb, 0.25g/t Au and 58.5g/t Ag for 2516t Cu, 27 893t Zn, 8002t Pb, 67kg Au and 15 566kg Ag West 45 – 532 000t at 0.5% Cu, 7.2% Zn, 3% Pb, 0.26g/t Au and 48g/t Ag for 2660t Cu, 38 304t Zn, 15 960t Pb, 138kg Au and 25 536kg Ag (Kagara Ltd, 2010)	Mount Windsor Volcanics, Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolite and volcaniclastics. Held under Mining Lease by Kagara Copper Pty Ltd.
	Victoria (and Victoria South)	3.5km NE of Mungana	Abandoned mine, active prospect	34t Cu, 29t Pb, 25.5kg Ag (1922–1923)	3.44Mt at 0.96% Cu, 5.1% Zn, 0.14g/t Au and 22.2g/t Ag for 33 160t Cu, 175 020t Zn, 489kg Au and 76 490kg Ag (Kagara Ltd, 2010)	Chillagoe Formation/ Hodgkinson Province	Base metal skarn in limestone and basalt. Held under Exploration Permit by Mungana Pty Ltd.

Table 17 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Kagara North Queensland Operations (continued)	Waterloo	36.9km SSW of Charters Towers	Active prospect	Not mined	476 000t at 2.5% Cu, 13.5% Zn, 2% Pb, 1.42g/t Au and 67.3g/t Ag for 11 844t Cu, 64 104t Zn, 9324t Pb, 677kg Au and 32 036kg Ag (Kagara Ltd, 2010)	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in rhyolite, andesite and volcaniclastics. Held under Exploration Permit by Kagara Copper Pty Ltd.
Kidston		40.7km S of Einasleigh	Abandoned mine	1309kg Au bullion, 112 495kg Au, 60 887kg Ag (1915–1924, 1985–2002)	Mined out	Einsaleigh Metamorphics/ Etheridge Province, Oak River Granodiorite/ Pama Province, Kidston breccia/ Kennedy Province	Porphyry-related subvolcanic breccia pipe in metamorphics, granodiorite, rhyolite and quartz-feldspar porphyry. Held under Mining Lease by Kidston Gold Mines Ltd.
Lady Loretta		105km NNW of Mount Isa	Active prospect	90.4t Zn, 31.9t Pb, 41.4kg Ag (1996–1997)	13.6Mt at 17% Zn, 96g/t Ag and 5.8% Pb for 2 306 300t Zn, 1 305 900kg Ag and 792 200t Pb (Xstrata Plc, 2010)	Lady Loretta Formation/ Mount Oxide Domain	Sediment-hosted Ag-Pb-Zn deposit in siltstone, sandstone and carbonates. Held under Mining Lease by Noranda Pacific Pty Ltd (Xstrata Plc) and Cape Lambert Lady Loretta Pty Ltd.
Magpie		28.9km SSW of Ravenswood	Inactive prospect	Not mined	250 000t at 1.2% Cu, 8.3% Zn, 1.7% Pb, 0.2g/t Au and 37g/t Ag for 3000t Cu, 20 750t Zn, 4250t Pb, 50kg Au and 9250kg Ag (Dronseika, 1995)	Trooper Creek Formation/ Thalanga Province	Volcanogenic massive sulphide deposit in volcaniclastics. Held under Mining Lease by Thalanga Copper Mines Pty Ltd and BML Holdings Pty Ltd.
Maramungee		175km ESE of Mount Isa	Active prospect	Not mined	1.8Mt at 4.4% Zn for 79 200t Zn (Roxburgh & Matthews, 1975)	Mount Norna Quartzite/ Soldiers Cap Domain	Skarn or Broken Hill style Ag-Pb-Zn deposit in gneiss and amphibolite. Held under Exploration Permit by Black Rock Minerals Pty Ltd (Xstrata Plc and Exco Resources Ltd).

Table 17 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Merlin (including Little Wizard)		147km SE of Mount Isa	Active prospect, scoping study in progress	Not mined	Merlin – 6.7Mt at 1.32% Mo, 23.05g/t Re, 8.28g/t Ag, 0.33% Cu, 0.13% Zn, 0.02% Pb, 0.01% Co and 0.08g/t Au for 88 800t Mo, 154 470kg Re, 55 590kg Ag, 22 330t Cu, 9580t Zn, 1340t Pb, 544t Co and 546kg Au Little Wizard - 15 999t at 6.49% Mo, 83.9g/t Re, 25g/t Ag, 2.29% Cu, 0.63g/t Au and 0.01% Pb for 973t Mo, 1258kg Re, 375kg Ag, 343t Cu, 9kg Au and 1t Pb (Ivanhoe Australia Limited, 2010a)	Kuridala Formation/ Kuridala-Selwyn Domain	Shear zone hosted breccia in metasediments along Mount Dore Fault Zone. Held under mining leases by Ivanhoe Australia Ltd. Construction of an access decline commenced in the second half of 2010. Underground mine, molybdenum concentrator and roaster are planned, with production to commence in 2012.
Mount Cannindah		80km SW of Gladstone	Abandoned mine, active prospect	1030t Cu, 933.1kg Au (1906–1907, 1916–1918, 1947–1965)	7.43Mt at 0.98% Cu, 0.38g/t Au and 15.5g/t Ag for 72 815t Cu, 2841kg Au and 115 160kg Ag (Queensland Ores Limited, 2008)	Rockhampton Group/ Rockhampton Subprovince; “The Monument intrusive”/ Permo-Triassic Igneous Provinces	Porphyry Cu–Mo–Au deposit in mudstone, granite, granodiorite and diorite. Held under Mining Lease by Mount Cannindah Mining Pty Ltd (Planet Metals Ltd). Farm-in by Drummond Gold Ltd.
Mount Carlton	Herbert Creek East	41.7km NW of Collinsville	Active prospect	Not mined	0.351Mt at 2.17g/t Au and 4.2g/t Ag for 761kg Au and 1474kg Ag (Conquest Mining Limited, 2009)	Lizzie Creek Volcanics/ Bowen Basin	High sulphidation epithermal quartz vein stockwork in rhyodacite and volcaniclastics. Held under Exploration Permit and Mining Lease application by Conquest Mining Ltd.
	Mount Carlton – Main Hill	44.3km NW of Collinsville	Active prospect, mining development	Not mined	0.966Mt at 0.35% Cu, 1.35g/t Au and 38g/t Ag for 3332t Cu, 1304kg Au and 36 708kg Ag (Conquest Mining Limited, 2009)	Lizzie Creek Volcanics/ Bowen Basin	High sulphidation epithermal quartz vein stockwork in rhyodacite and volcaniclastics. Held under Exploration Permit and Mining Lease application by Conquest Mining Ltd.
	Silver Hill	44km NW of Collinsville	Active prospect, mining development	Not mined	25.8Mt at For 71 520t Cu, 42 717kg Au and 1 152 000kg Ag (Conquest Mining Limited, 2010)	Lizzie Creek Volcanics/ Bowen Basin	High sulphidation epithermal quartz vein stockwork in rhyodacite, breccia and volcaniclastics. Held under Exploration Permit and Mining Lease application by Conquest Mining Ltd.

Table 17 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount Chalmers	80km NW of Gladstone	Abandoned mine, active prospect	22 624t Cu, 19 021t Pb, 7099t Zn, 3619.9kg Au, 21 751.3kg Ag (1860–1982)	3.55Mt at 1.26% Cu, 0.4% Zn, 0.16% Pb, 0.85g/t Au and 8.5g/t Ag for 44 610t Cu, 14 400t Zn, 5760t Pb, 3014kg Au and 30 140kg Ag (Echo Resources Limited, 2006)	Chalmers Formation/ Berserker Subprovince	Volcanogenic massive sulphide deposit in sandstone, dolomite and volcaniclastics. Held under Mining Lease by Affinis Pty Ltd (Echo Resource Ltd).
Mount Dore	147km SE of Mount Isa	Active prospect, scoping study in progress	6t Cu (1936)	Copper zone with 144.4Mt at 0.52% Cu, 0.01% Mo, 0.1g/t Re, 0.1g/t Au, 5.94g/t Ag, 0.30% Zn, 0.05% Pb and 0.01% Co for 747 880t Cu, 14 440t Mo, 14 440kg Re, 14 154kg Au, 857 960kg Ag, 433 410t Zn, 75 130t Pb and 11 497t Co (Ivanhoe Australia Limited, 2010a)	Kuridala Formation/ Quamby–Malbon Subprovince	Shear zone hosted breccia in metasediments along Mount Dore Fault Zone. Held under mining leases by Ivanhoe Australia Ltd. Heap-leach SX-EW processing planned for oxide ore.
Mount Gordon - Mammoth	115km N of Mount Isa	Operating mine	211 167t Cu, 2270t Cu conc., 5461.2kg Ag (1927–1959, 1969–1982, 1989–1998, 2003–2010)	22.1Mt at 2.49% Cu for 550 700t Cu (Aditya Birla Minerals Limited, 2010)	Whitworth Quartzite/ Leichhardt River Domain	Brecciated sediment hosted Cu deposit in quartzite, siltstone and sandstone. Held under Mining Lease by BirlaMt Gordon Pty Ltd (Aditya Birla Minerals Ltd).
Mount Gunyan	12.2km ENE of Texas	Active prospect	Not mined	2.347Mt at 69g/t Ag and 0.08g/t Au for 161 943kg Ag and 188kg Au (Alcyone Resources Limited, 2011)	Silver Spur beds/ Texas Subprovince	Low sulphidation epithermal quartz veins in tuffaceous metasediments. Held under Exploration Permit by Texas Silver Mines Pty Ltd (Alcyone Resources Ltd).
Mount Isa Copper	1.3km W of Mount Isa	Operating mine	7 267 665t Cu, 12 585t Co, 202 649kg Ag, 90t Sb (1942–2010)	483Mt at 1.48% Cu for 7 158 000t Cu (Xstrata Plc, 2010)	Urquhart Shale/ Leichhardt River Domain	Brecciated sediment-hosted Cu deposit in shale and dolomite. Held under Mining Lease by Mount Isa Mines Ltd (Xstrata Plc).
Mount Isa Silver-Lead Mine includes production from George Fisher North and George Fisher South	1.3km W of Mount Isa	Operating mine	8215t Cu, 18 654 240kg Ag, 7 757 899t Pb, 8 064 948t Zn, 2652t Sb, 5030t Cd, 318t Co, 730 769t S (1931–2010)	351.1Mt at 66.8g/t Ag, 4% Zn and 3.1% Pb for 23 453 600kg Ag, 14 125 300t Zn and 10 813 800t Pb (Xstrata Plc, 2010)	Urquhart Shale/ Leichhardt River Domain	Sediment-hosted Ag-Pb-Zn deposit in shale and siltstone. Held under Mining Lease by Mount Isa Mines Ltd (Xstrata Plc).

Table 17 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mount Kroombit	11km SE of Kroombit Dam	Abandoned mine, active prospect, scoping study	Not recorded	Copper ore – 0.857Mt at 1.04% Cu for 8891t Cu. Zinc ore – 5.159Mt at 0.15% Cu and 1.88% Zn for 7931t Cu and 96 849t Zn (Argonaut Resources NL, 2009)	Marble Waterhole beds/ Kroombit Subprovince	Base metal skarn in limestone, mudstone and andesite. Held under Mining Lease by Kelaray Pty Ltd (Argonaut Resources NL).
Mount Les	113km NW of Century mine	Abandoned mine, inactive prospect	Not recorded	1.5Mt at 0.1% Pb for 1500t Pb (Rossiter, 1975)	Mount Les Siltstone, Walford Dolomite/ Camooweal-Murphy Domain	Sediment-hosted Ag-Pb-Zn deposit in siltstone and dolomite. Held under Exploration Permit by MMG Australia Ltd.
Mount Leyshon	23.8km S of Charters Towers	Abandoned mine	107 670kg Au, 68 900kg Ag (1986–2002)	Mined out	Mount Leyshon Complex/ Kennedy Province	Porphyry-related subvolcanic breccia in rhyolite and trachyte. Held under Mining Lease by Leyshon Resources Ltd.
Mount Morgan	36km SW of Rockhampton	Abandoned mine, active prospect, feasibility study completed	360 616t Cu, 215 268kg Au bullion, 78 788kg Au, 36 842kg Ag, 568 000t pyrite (1884–1990)	Mullock – 0.345Mt at 1.85g/t Au for 638kg Au. Slag – 6Mt at 0.34% Cu and 1g/t Au for 20 400t Cu and 6000kg Au (Norton Gold Fields Limited, 2007). Tailings – 8.348Mt at 1.23g/t Au for 0 237kg Au (Norton Gold Fields Limited, 2009).	Mount Warner Volcanics/ Mount Morgan Subprovince	Volcanogenic massive sulphide deposit in tuff, limestone and volcaniclastics. Held under Mining Lease by Norton Gold Fields Ltd.
Mount Moss	100km W of Townsville	Operating mine	90 741t magnetite (2008–2010)	20Mt at 41% Fe, 0.35% Cu and 0.35% Zn for 8.2Mt Fe, 70 000t Cu and 70 000t Zn (Geological Survey of Queensland, 2011)	Perry Creek Formation/ Camel Creek Subprovince	Magnetite-base metal skarn.Mt Moss Mining Pty Ltd produces magnetite for steel production and coal washing.
Mount Oxide	125km N of Mount Isa	Abandoned mine, active prospect, feasibility study	22 816t Cu, 4.5kg Au, 893.4kg Ag (1927–1960, 1967–1982)	15.9Mt at 1.42% Cu and 8.3g/t Ag for 225 600t Cu and 131 520kg Ag (Perilya Limited, 2011)	Gunpowder Creek Formation/ Lawn Hill Subprovince	Brecciated sediment hosted Cu deposit in shale and sandstone. Held under Exploration Permit by Mount Oxide Pty Ltd (Perilya Ltd).
Mount Rawdon	16.5km SE of Mount Perry	Operating mine	868kg Au bullion, 27 023kg Au, 53 067kg Ag (1949–1953, 2000–2010)	57.8Mt at 0.8g/t Au and 2.29g/t Ag for 46 440kg Au and 132 588kg Ag (Lihir Gold Limited, 2009)	Aranbanga Volcanic Group/ South-East Queensland Volcanic and Plutonic Province	Porphyry-related subvolcanic breccia in volcaniclastics, dacite and trachyandesite. Held under Mining Leases by LGL Mount Rawdon Operations Pty Ltd (Newcrest Mining Ltd).

Table 17 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Nightflower		125km W of Cairns	Abandoned mine, active prospect	Not recorded	215 534t at 193g/t Ag, 4.91% Pb, 2.2% Zn and 0.15% Cu for 41 598kg Ag, 10 582t Pb, 4741t Zn and 323t Cu (Axiom Mining Limited, 2008)	Nightflower Dacite/ Kennedy Province	Epithermal polymetallic veins in ignimbrite and porphyry. Held under Exploration Permit by W.P. Laing.
Pajingo	Scott Lode	39.2km NE of Pajingo Homestead	Abandoned mine, active prospect	11 399.4kg Au, 31 806.4kg Ag (1987–1993)	Mined out	Vera-Nancy Volcanics, Pallamana Sandstone/ Drummond Basin	Low sulphidation epithermal quartz veins and stockworks in andesite, tuff, volcaniclastics and sandstone. Held under Mining Lease by NWM Gold No 2 Pty Ltd and HSK Gold Australia Pty Ltd (Conquest Mining Ltd).
	Vera-Nancy	38.6km NE of Pajingo Homestead	Operating mine	67 010.5kg Au, 60 958.6kg Ag (1996–2010)	2.013Mt at 7.5g/t Au for 15 105kg Au (North Queensland Metals Limited, 2008)	Vera-Nancy Volcanics/ Drummond Basin	Low sulphidation epithermal quartz veins and stockworks in andesite, tuff, volcaniclastics and sandstone. Held under Mining Lease by NWM Gold No 2 Pty Ltd and HSK Gold Australia Pty Ltd (Conquest Mining Ltd).
Pegmont		176km SE of Mount Isa	Active prospect	Not mined	8.6Mt at 7.7% Pb and 3.5% Zn for 658 910t Pb and 298 490t Zn (Pegmont Mines NL, 2000)	Starcross Formation/ Kuridala-Selwyn Domain	Broken Hill style Ag-Pb-Zn deposit in ironstone, schist, quartzite, amphibolite and arkose. Held under Mining Leases by Pegmont Mines Ltd.
Rannes Project	Crunchy Granola	13km SW of Rannes	Active prospect	Not mined	4.6Mt at 0.51g/t Au and 50g/t Ag for 2346kg Au and 230 000kg Ag (Solomon Gold Plc, 2011)	Camboon Volcanics/ Auburn Subprovince	Epithermal quartz veins in andesite and metasediments. Held under Exploration Permit by Central Mines Pty Ltd. (D'Aguilar Gold Ltd).
	Kauffmans	9.4km SSW of Rannes	Abandoned mine, active prospect	Not recorded	7.7Mt at 0.68g/t Au and 9g/t Ag for 5236kg Au and 69 300kg Ag (Solomon Gold Plc, 2011)	Camboon Volcanics/ Auburn Subprovince	Epithermal quartz veins in andesite, limestone and tuff. Held under Exploration Permit by Central Mines Pty Ltd. (D'Aguilar Gold Ltd).
Red Dam		11.7km E of Dagworth Homestead	Abandoned mine, active prospect	Not recorded	151 200t at 19.8g/t Au and 33.1g/t Ag for 3001kg Au and 5010kg Ag (Plentex Limited, 2006)	Lane Creek Formation, Cobbold Metadolerite/ Etheridge Province	Shear-hosted hydrothermal quartz veins in metamorphics. Held under Mining lease and Exploration Permit by Deutsche Rohstoff Australia Pty Ltd.
Silver King		220km NW of Mount Isa	Abandoned mine, active prospect	2294kg Ag, 2703t Pb (1897–1967)	0.7Mt at 15.1% Pb, 143g/t Ag and 5.2% Zn for 105 700t Pb, 100 100kg Ag and 36 400t Zn (Minmetal Resources Limited, 2010)	Lawn Hill Formation/ Century Domain	Brecciated sediment-hosted Ag-Pb-Zn veins in tuff, sandstone, shale and siltstone. Held under Mining Lease by MMG Century Ltd (MMG Mining Ltd).
Silver Phantom		115km ESE of Mount Isa	Abandoned mine, active prospect	5400kg Ag (1954–1964)	Not calculated	Mitakoodi Quartzite, Wimberu Granite/ Mitakoodi Domain	Breccia veins in schist, quartzite and granite. Held under Exploration Permit by Carpentaria Exploration Ltd.

Table 17 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Silver Spur		10.2km E of Texas	Abandoned mine, active prospect	990t Cu, 1050t Pb, 690t Zn, 140kg Au, 68 000kg Ag (1892–1976)	Ore – 0.808Mt at 0.17% Cu, 3.56% Zn, 1.25% Pb, 0.9g/t Au and 70g/t Ag for 1373t Cu, 28 764t Zn, 10 100t Pb, 727kg Au and 56 560kg Ag (Macmin Silver Ltd, 2008a). Slag – 90 000t at 0.34% Cu, 15.8% Zn, 3.17% Pb, 0.5g/t Au and 158g/t Ag for 306t Cu, 14 220t Zn, 2853t Pb, 45kg Au and 14 220kg Ag (Macmin Silver Ltd, 2004).	Silver Spur beds/ Texas Subprovince	Volcanogenic massive sulphide deposit in shale, siltstone and greywacke. Held under Mining Lease by Texas Silver Mines Pty Ltd (Alcyone Resources Ltd)
Silver Star (Munholme)		34km WNW of Many Peaks	Abandoned mine, active prospect	Not recorded	Barite lode – 0.167Mt at 0.6% Cu, 3.4% Zn, 1.3% Pb and 180g/t Ag for 1002t Cu, 5678t Zn, 2171t Pb and 30 060kg Ag. Amoeba – 0.105Mt at 2.8g/t Au for 294kg Au (Hall, 2001)	Munholme Quartz Diorite/ Permo-Triassic Igneous Provinces	Porphyry-related polymetallic veins in diorite. Held under Exploration Permit by Echo Resources Ltd.
Tally Ho		30km S of Mirani	Abandoned mine, active prospect	23t Pb (1908–1940)	0.733Mt at 0.1% Cu, 0.83% Zn, 0.09% Pb, 0.06g/t Au and 49g/t Ag for 733t Cu, 6083t Zn, 659t Pb, 43kg Au and 35 917kg Ag (Macmin Silver Ltd, 2008b)	Tally-Ho Igneous Complex/ Connors Subprovince	Porphyry-related polymetallic quartz vein stockwork in granite and granodiorite. Held under Mining Lease by Alcyone Resources Ltd.
Twin Hills		9.3km E of Texas	Care and maintenance	5.6kg Au, 11 669.5kg Au (2006–2008)	Leach dumps – 14.41Mt at 0.07g/t Au and 34.5g/t Ag for 1008kg Au and 497 230kg Ag (Macmin Silver Ltd, 2008a) In-situ – 3.842Mt at 79.3g/t Ag for 304 746kg Ag (Alcyone Resources Limited, 2010)	Silver Spur beds/ Texas Subprovince	Low sulphidation epithermal quartz veins in volcaniclastics. Held under Mining Lease by Texas Silver Mines Pty Ltd (Alcyone Resources Ltd).
Twin Hills	309	21.4km WSW of Avon Downs Homestead	Care and maintenance, active prospect	266.9kg Au, 808.6kg Ag (2005–2007)	3.685Mt at 2.59g/t Au and 3.2g/t Ag for 9533kg Au and 11 808kg Ag (North Queensland Metals Limited, 2009)	Saint Anns Formation, Silver Hills Volcanics/ Drummond Basin	Low sulphidation epithermal quartz veins and breccia in mudstone, sandstone, tuff and volcaniclastics. Held under Mining Lease by HSK Gold Australia Pty Ltd and NWM Gold 2 Pty Ltd (Conquest Mining Ltd).
	Lone Sister	22.7km SW of Avon Downs Homestead	Active prospect	Not mined	1.016Mt at4.09g/t Au and 4.86g/t Ag for 4155kg Au and 4938kg Ag (North Queensland Metals Limited, 2010)	Silver Hills Volcanics/ Drummond Basin	Low sulphidation epithermal quartz veins and breccia in mudstone, rhyodacite and tuff. Held under Mining Lease by HSK Gold Australia Pty Ltd and NWM Gold 2 Pty Ltd (Conquest Mining Ltd).

Table 17 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Walford Creek	315km NNW of Mount Isa	Active prospect	Not mined	6.5Mt at 0.67% Cu, 0.07% Co, 25g/t Ag, 2.1% Zn and 1.6% Pb for 39 000t Cu, 4550t Co, 162 500kg Ag, 136 500t Zn and 104 000t Pb (Copper Strike Limited, 2006)	Mount Les Siltstone/ Camooweal-Murphy Domain	Sediment-hosted Ag-Pb-Zn and breccia-hosted Cu-Co in shale and siltstone. Held under Exploration Permit by Copper Strike Ltd.
Wellington Springs	17.1km WSW of Ravenswood	Abandoned mine, active prospect	3.8t Cu, 15.7kg Au, 92.9kg Ag (1895–1909, 1936–1937)	Ore – 0.112Mt at 0.6% Cu, 3.01g/t Au and 58g/t Ag for 672t Cu, 337kg Au and 6496kg Ag. Tailings – 18 500t at 1.25g/t Au and 22.8g/t Ag for 23kg Au and 421kg Ag (Haoma Mining NL, 2000)	Wellington Springs Tonalite/ Pama Province	Porphyry-related Cu-Au-quartz veins in diorite and granodiorite. Held under Mining Lease by Kitchener Mining NL.
Whitewash/ Gordons	26.5km WNW of Monto	Active prospect	Not mined	71.5Mt at 0.034% Mo, 0.1% Cu and 1.2g/t Ag for 24 135t Mo, 85 200kg Ag and 70 600t Cu (Aussie Q Resources Limited, 2008; Aussie Q Resources Limited, 2009)	Wingfield Granite/ Rawbelle Batholith	Porphyry Mo-Cu deposit in granodiorite. Held under Exploration Permit by Aussie Q Resources Ltd.

The Twin Hills silver deposit, 200km south-west of Brisbane, comprises low sulphidation epithermal style mineralisation with similarities to the major silver mining districts in south-western USA and Mexico. Silver mineralisation occurs as pyrargyrite and native silver hosted by fine-grained volcaniclastic rocks of the Texas Province that have been affected by intense silicification and K-metasomatism.

Epithermal vein deposits that have been mined for gold at Cracow and in the Drummond Basin also contain significant silver contents.

Polymetallic veins

Polymetallic veins are common throughout Proterozoic and Palaeozoic Queensland.

Other deposit styles

Silver is a common by-product commodity of porphyry Cu-Mo-Au, iron oxide-Cu-Au, porphyry-related subvolcanic breccia Au, brecciated sediment-hosted Cu and mesothermal to porphyry-related Au vein deposits

TANTALUM, NIOBIUM

Tantalum and niobium are transition metals that occur naturally in the minerals tantalite and columbite. These minerals form a mineral series, with tantalite having Ta>Nb and columbite having Nb>Ta. Niobium also occurs in the mineral pyrochlore.

Tantalum is part of the refractory metals group and is widely used as a minor component in alloys, particularly superalloys for jet engine components, nuclear reactors and missile parts. It is also used in capacitors and resistors in electronics, in laboratory equipment, surgical equipment and surgical implants, and as a substitute for platinum. Tantalum oxide is used to make glass for camera lenses. Tantalum carbide is used in metal cutting and machining tools.

Niobium is used in alloys, particularly in high-grade structural steels used in gas pipelines and automobiles and in superalloys for jet and rocket engines. Superconducting alloys containing niobium are used in the superconducting magnets of MRI scanners. Niobium is also used in welding, the nuclear industries, electronics, jewellery, optical glass and medical devices such as pacemakers.

Tantalite occurs, along with lepidolite, amblygonite, cassiterite and ilmenite, in pegmatite dykes in dolerite (Cobbold Metadolerite) and metasediments (Lane Creek Formation) adjacent to greisenised granite at Buchanan's Creek and Grant's Gully, 31km south-west of Georgetown (Figure 23; Keid, 1938; Ridgway, 1943b; Culpeper & others, 1996). The prospects are being investigated by Gascoyne Metals Pty Ltd. Tantalite and columbite occur in gold-bearing quartz veins and alluvium in the same region (Ridgway, 1943c). Recorded production comprises 1.49t of tantalite from Cumberland and Grant's Gully in 1996 to 1998 and 0.7kg of columbite from Buchanan's Creek in 1943.

Tantalite and columbite occur with beryl and mica in the Mica Creek Pegmatite, south of Mount Isa (Denmead, 1937; Connah, 1938; Brooks & Shipway, 1960; Brooks, 1965b). Tantalite has been reported to occur with cassiterite in the alluvium of Platypus Creek, 13km west of Mossman. Quartz pegmatite and quartz veins on the altered margins of the Wangetti Granite at Hartley's Creek, 36.9km north-west of Cairns, contain tantalite and cassiterite (Kinnane, 1982b).

TIN

Tin is a post-transition metal that is used in a variety of alloys and as a corrosion protection coating. Other uses include tin solder, chemicals and superconducting magnets. The most important tin ore is the tin oxide cassiterite; minor amounts of tin are recovered from complex sulphides such as stannite.

Queensland produced 3t of cassiterite concentrates in 2009–10, but contains several major tin resources at various stages of development; improving world tin market conditions may stimulate development of these resources.

Tin mining districts, particularly in northern Queensland, have a long mining history. Queensland tin mineralisation can be classified as tin veins (Cornish style), tin greisens, tin skarns and alluvial/eluvial deposits (Figure 25; Table 18; Blake, 1970; Blake, 1972; Krosch, 1981c; Krosch, 1985c; Denaro & Burrows, 1992; Denaro, 1993; Denaro & others, 1994a; Gunther & others, 1994; Denaro & Morwood, 1997).

Tin vein deposits contain quartz-cassiterite±wolframite±base metal sulphides forming fissure fillings associated with reduced, crystal-fractionated S- and I-type granites. Deposits occur as simple veins, sheeted veins, stockworks and breccia-hosted deposits. Jeannie River and the major tin fields of Herberton, Stanthorpe and Cooktown contain numerous examples of tin vein deposits.

Tin greisen deposits form at high temperatures (300–500°C) in the apical portions of acidic, late-fractionated granite melts. Post-magmatic and metasomatic fluids high in silica and volatile components are responsible for this mineralisation, which occurs close to or within the contact zones of the granites. Greisen lodes are located in or near cupolas and ridges developed on the roof or along the margins of granites, and also in associated brecciated masses and dykes. The Collingwood (near Cooktown) and Sailor Tin (near Mount Garnet) prospects are examples of tin greisen deposits. Metals X Ltd (formerly Bluestone Tin Ltd) acquired the Collingwood deposit and commenced ore extraction in late 2005 and production of concentrates in early 2006. The Collingwood project was expected to produce at a rate of 350 000t of ore per annum for a yield of ~5000t of tin concentrates, containing ~3500t of tin metal, but was put on care and maintenance in May 2008.

The Gillian Prospect near Mount Garnet is the largest tin skarn deposit in Queensland. Mineralisation formed through emplacement of the late Carboniferous Hammonds Creek Granodiorite into reactive calcareous sedimentary rocks of the Chillagoe Formation, creating a complex replacement deposit rich in fluorine and iron.

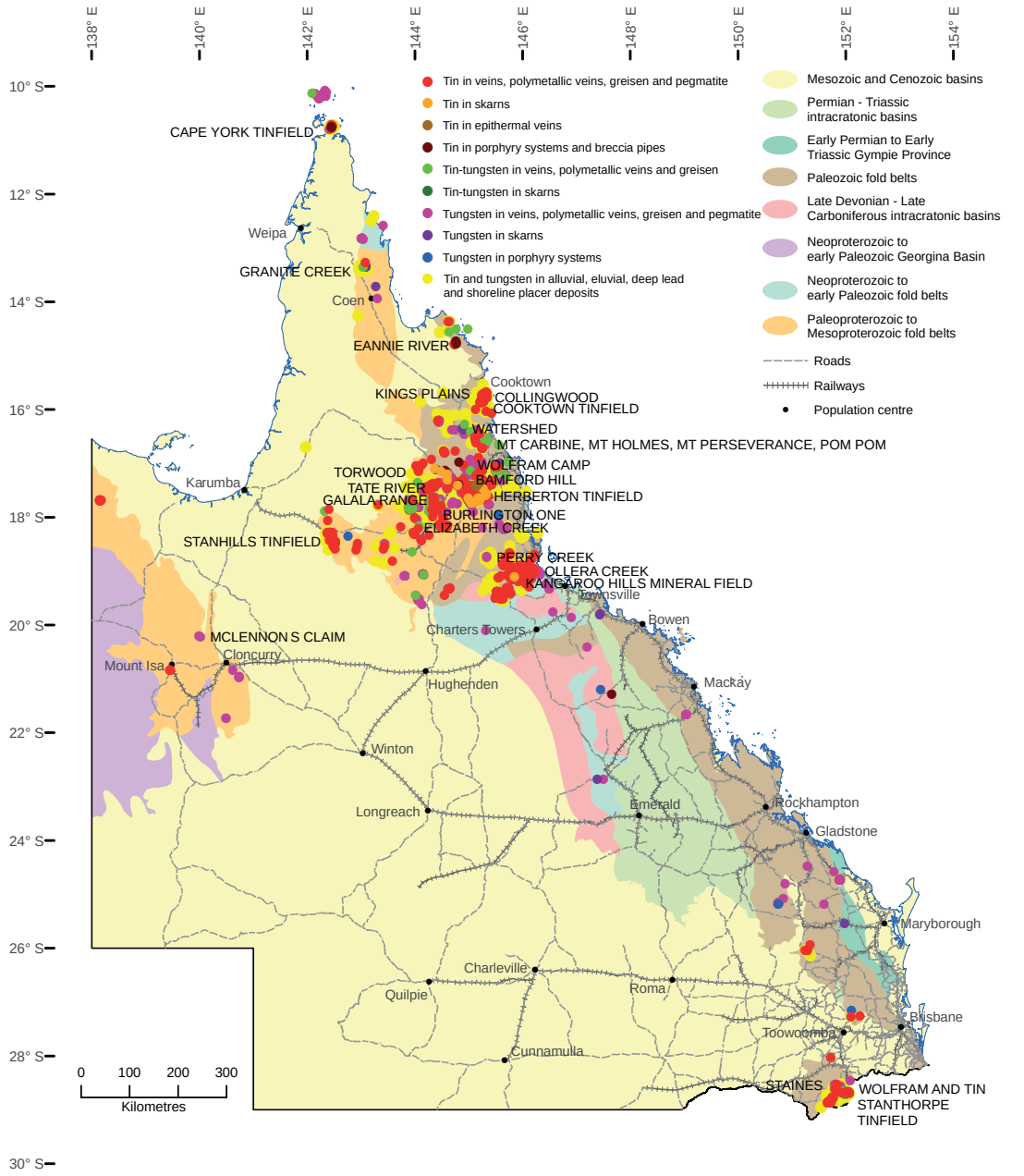

Figure 25: Tin and tungsten occurrences and deposits

A significant amount of Queensland's tin production has come from alluvial, eluvial and deep lead deposits. Alluvial tin deposits were commonly worked by large floating dredges, which operated along the major drainage systems in the Herberton and Stanthorpe tinfields.

TUNGSTEN

Tungsten is a transition metal that is used to produce hard metals based on tungsten carbide for wear-resistant abrasives and cutters for drills, circular saws, milling and turning tools. Tungsten steel and other alloys are used for light bulb filaments, X-ray and cathode ray tubes, integrated circuits, arc welding, armaments, and superalloys for rocket engine nozzles and aerospace applications. Tungsten's high density makes it ideal for heat sinks, weights and ballast in yachts and aircraft. Tungsten compounds

Table 18: Significant tin deposits of Queensland

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Black Adder Flats		43km WNW of Ingham	Abandoned mine, inactive prospect	Not recorded	6.1Mm^3 at 0.04kg/m^3 cassiterite for 238t cassiterite (Gibson, 1965)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite. No current tenure.
Black Cow		135km S of Cairns	Abandoned mine, inactive prospect	Not recorded	175 000m^3 at 0.76kg/m^3 cassiterite for 133t cassiterite (Otterman, 1980)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Deep lead placer cassiterite beneath basalt. Held under Exploration Permit bym. Curtain.
Blue Range		52km SE of Greenvale	Abandoned mine, inactive prospect	1300t cassiterite (1969–1982)	7Mm^3 at 0.66kg/m^3 cassiterite for 4620t cassiterite (Andrews, 1962)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer and deep lead placer cassiterite.
Cape York tinfield	Cape York tinfield	20km NNE of Bamaga	Abandoned mines	>21.5t alluvial and beach placer cassiterite (1950–1986), >15.6t lode cassiterite (1952–1979)	See below	Torres Strait Volcanics/ Cape York-Oriomo Inlier; Alluvium/ Cainozoic Alluvial and Colluvial Deposits; Beach sands/ Modern Coastal Deposits	Alluvial, shoreline placer and cassiterite-quartz veins and stocks in volcanic rocks.
	Booty Flats Extended	16.6km NNE of Bamaga	Inactive prospect	Not recorded	367 000m^3 at 0.42kg/m^3 cassiterite for 154t cassiterite (Hughes, 1990)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit.
	Gibson Flats	20km NNE of Bamaga	Inactive prospect	Not mined	670 000m^3 at 0.3kg/m^3 cassiterite for 201t cassiterite (Hughes, 1990)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit.
	Lady Luck	20.5km NNE of Bamaga	Inactive prospect	Not recorded	660 000m^3 at 0.19kg/m^3 cassiterite for 127t cassiterite (Hughes, 1990)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits; Beach sands/ Modern Coastal Deposits	Alluvial and beach placer cassiterite deposit.
	Laradeenya Creek	14.4km NNE of Bamaga	Inactive prospect	Not mined	7Mm^3 at 0.2kg/m^3 cassiterite for 1372t cassiterite (Hughes, 1990)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit.
	Laradeenya Flats	14.5km NNE of Bamaga	Inactive prospect	Not mined	2.44Mm^3 at 0.45kg/m^3 cassiterite for 1103t cassiterite (Hughes, 1990)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit.
	Laradeenya South	12.3km NNE of Bamaga	Inactive prospect	Not mined	1.43Mm^3 at 0.23kg/m^3 cassiterite for 329t cassiterite (Hughes, 1990)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit.
	Moody Flats	14.9km NNE of Bamaga	Inactive prospect	Not mined	470 000m^3 at 0.48kg/m^3 cassiterite for 226t cassiterite (Hughes, 1990)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit.
	Roma Flats	21.6km NNE of Bamaga	Inactive prospect	Not mined	1.02Mm^3 at 0.2kg/m^3 cassiterite for 204t cassiterite (Hughes, 1990)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit.

Table 18 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Cooktown Tinfield	Cooktown Tinfield	S of Cooktown	Abandoned mines	12 578t alluvial cassiterite, 272t lode cassiterite, 8.3t wolframite (1885–1992)	See below	Hodgkinson Formation/Hodgkinson Province; Cooktown Supersuite/ Kennedy Province; Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Sheeted cassiterite-quartz and greisen veins in metasediments and granite. Alluvial and deep lead placer cassiterite deposits.
	Collingwood	35km S of Cooktown	Care and maintenance	6518.5t cassiterite (2005–2008)	643 000t at 1.19% Sn for 7760t Sn (Metals X Limited, 2009)	Collingwood Granite/ Kennedy Province	Sheeted cassiterite-quartz and greisen veins in granite. Held under Mining Leases and Mineral Development Licences by Bluestone Nominees Pty Ltd (Metals X Ltd)
	Kings Plains Tin Prospect	7.9km WNW of Helenvale	Inactive prospect	Not mined	27.55Mm^3 at 230g/m^3 cassiterite for 6337t cassiterite (Tin Australia NL, 1999)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial and deep lead placer cassiterite deposits. Held under Exploration Permit by MFG Pty Ltd.
	Mungumby Creek Flat	2.8km E of Helenvale	Abandoned mine, inactive prospect	Not recorded	434 760m^3 at 0.4kg/m^3 cassiterite for 174t cassiterite (Kinnane, 1982a)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit. No current tenure.
Elizabeth Creek		34.8km WNW of Mount Surprise	Abandoned mine	136t cassiterite (1977–1993)	Not calculated	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit.
Gowrie Creek		70km SW of Greenvale	Abandoned mine, active prospect	104.5t cassiterite (1973–1979, 1985–1986)	689 000m^3 at 518g/m^3 cassiterite for 357t cassiterite (Tin Australia NL, 1999)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit. Held under Mineral Development Licence application bym. Curtain.
Granite Creek		7km E of Archer River Roadhouse	Abandoned mine, inactive prospect	333.5t cassiterite (1907–1931, 1938–1940, 1975–1980)	4Mm^3 at 1.13kg/m^3 cassiterite for 4400t cassiterite (White, 1991)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit.
Herberton Tinfield	Herberton Tinfield	Herberton-Irvinebank-Mount Garnet-Ravenshoe area	Abandoned mines, active prospects	70 670t lode cassiterite, 39 190t alluvial cassiterite (1879–1968)	See below	Hodgkinson Formation/Hodgkinson Province; various granites/ Kennedy Province; Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Cassiterite in veins, pipes, greisen and skarns; alluvial placer and deep lead placer cassiterite.
	Adventure	6.1km WSW of Irvinebank	Abandoned mine, inactive prospect	2100t cassiterite (1887–1976)	Not calculated	Hodgkinson Formation/ Hodgkinson Province	Cassiterite-W-Cu-quartz vein in metasediments. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
	Baal Gammon	6.4km W of Herberton	Abandoned mine, active prospect	88.4t cassiterite (1892–1949)	5 482 000t at 0.2% Sn, 29g/t Ag, 0.8% Cu and 29g/t In for 10 964t Sn, 156 907kg Ag, 43 420t Cu and 159 087kg In (Monto Minerals Limited, 2011)	Hodgkinson Formation/ Hodgkinson Province	Cassiterite-Cu-Ag-In-quartz veins and stockworks in meta-arenite and porphyry intrusive. Held under Mining Lease by North Queensland Metals Ltd (Conquest Mining Ltd/ Monto Minerals Ltd). Kagara Ltd proposes to commence mining copper ore in 2011.

Table 18 (continued)

	Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Herberton Tinfield (continued)	Battle Creek	7.5km NE of Mount Garnet	Active prospect	Not mined	8.754Mm^3 at 258g/m^3 cassiterite for 2256t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/ Hodgkinson Province; Pinnacles Granite/Kennedy Province; Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite and cassiterite skarn. Held under Mining Lease and Exploration Permit by Consolidated Tin Mines Ltd.
	Boulder West	13.5km NNW of Nymbool	Abandoned mine, active prospect	13.2t cassiterite (1903–1967)	416 000t at 0.75% cassiterite for 3120t cassiterite (Jensen, 1939)	Emu Granite/ Kennedy Province	Cassiterite-quartz veins in greisenised granite. Held under Exploration Permit by Auzex Resources Ltd.
	Comeno	8.2km W of Irvinebank	Abandoned mine, inactive prospect	Not recorded	23 400t at 0.37% cassiterite, 136.5ppm Ag, 6.95% Zn, 1.9% Pb and 0.45% Cu for 87t cassiterite, 3194kg Ag, 1626t Zn, 445t Pb and 105t Cu (Younger, 1981)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-Cu-Ag-Zn-Pb-quartz veins in meta-arenite. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
	Dalcouth	12km NNE of Mount Garnet	Abandoned mine, active prospect	0.8t cassiterite (1940–1973)	30 000t at 0.5% cassiterite for 150t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-quartz veins in metasediments. Held under Mining Lease by Garimperos Ltd.
	Deadman Creek Prospect	10.3km N of Irvinebank	Abandoned mine, inactive prospect	Not recorded	18 450t at 0.9% cassiterite for 166t cassiterite (Tin Australia NL, 1999)	Featherbed Volcanic Group/ Kennedy Province	Cassiterite-Pb-Zn veins in rhyolite and ignimbrite. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
	Deadmans Gully	18.5km WNW of Ravenshoe	Abandoned mine, active prospect	Not recorded	410 500t at 0.49% Sn for 1967t Sn (Consolidated Tin Mines Limited, 2010)	Hodgkinson Formation/Hodgkinson Province; Nettle Granite, Kennedy Province	Cassiterite-magnetite skarn in metasediments and granite. Held under Mineral Development Licence and Exploration Permit by Consolidated Tin Mines Ltd.
	Emuford Tin	1.4km SE of Emuford	Active prospect	Not mined	2Mm^3 (dumps) at 550g/m^3 cassiterite for 1100t cassiterite (Tin Australia NL, 1999)	Emuford Granite/ Kennedy Province	Cassiterite veins in granite. Held under Mining Lease by I.E. Wallace.
	Federation	5.3km W of Herberton	Abandoned mine, inactive prospect	74.3t cassiterite (1888–1968)	375 000t at 0.5% cassiterite for 1875t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-Cu-quartz veins in meta-arenite. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
	Gift	21km NW of Ravenshoe	Abandoned mine, active prospect	93.2t cassiterite (1946–1984)	103 000t at 1% cassiterite for 1030t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-quartz veins in metasediments. Held under Mining Lease by R.H. Ludlow.

Table 18 (continued)

	Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Herberton Tinfield (continued)	Gillian Prospect	7km SW of Mount Garnet	Abandoned mine, active prospect	Not recorded	3 001 200t at 0.8% Sn for 23 964t Sn (Consolidated Tin Mines Limited, 2010)	Chillagoe Formation/ Hodgkinson Province; Hammonds Creek Granodiorite/ Kennedy Province	Cassiterite-magnetite skarn in limestone, sandstone and granite. Held under Mineral Development Licence by Consolidated Tin Mines Ltd.
	Governor Norman	2km E of Irvinebank	Abandoned mine, active prospect	1800t cassiterite (1903–1986)	37 500t at 0.7% cassiterite for 263t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-quartz veins in quartzite. Held under Mining Lease by Walker Resources Pty Ltd.
	Great Northern East	0.5km NE of Herberton	Abandoned mine	2500t cassiterite (1892–1904)	Not calculated	Saint Patricks Hill Granite/ Kennedy Province	Cassiterite-W-quartz veins in granite. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
	Great Northern Gully	0.3km NE of Herberton	Abandoned mine	10 974t cassiterite (1885–1980)	Not calculated	Saint Patricks Hill Granite/ Kennedy Province	Cassiterite-W-quartz veins in granite. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
	Great Southern Tin	2.5km S of Irvinebank	Abandoned mine, active prospect	1382t cassiterite (1885–1985)	20 000t at 1.3% cassiterite for 260t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-W-quartz veins in meta-arenite. Held under Mining Lease by G.W. and J Byrne.
	Hartog	6.6km NE of Mount Garnet	Abandoned mine, active prospect	Not recorded	212 700t at 0.51% Sn for 1084t Sn (Consolidated Tin Mines Limited, 2010)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-magnetite skarn in metasediments. Held under Exploration Permit by Consolidated Tin Mines Ltd.
	Herberton Deep Lead	4.5km S of Herberton	Abandoned mine	4000t cassiterite (1883–1988)	Not calculated	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Deep lead placer cassiterite beneath Cainozoic basalts. Held under Mining Leases and Exploration Permits by a number of individuals and companies.
	Jumna	3.6km NNE of Irvinebank	Abandoned mine, inactive prospect	468t cassiterite (1896–1983)	150 000t at 0.35% cassiterite for 525t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-quartz veins and pipes in metasediments. Under Mining Lease Application by Walker Resources Pty Ltd.
	Lancelot	8.2km ESE of Irvinebank	Abandoned mine	1369t cassiterite, 25.5kg Ag, 6.1t Pb (1897–1988)	Not calculated	Hodgkinson Formation/Hodgkinson Province	Cassiterite-W-Bi-Ag-Pb-Cu-quartz vein in metasediments. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
	M & R	6.7km ESE of Irvinebank	Abandoned mine, active prospect	15.3t cassiterite (1905–1927)	18 000t at 0.9% cassiterite for 162t cassiterite (Duck, 1984)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-quartz veins in metasediments. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).

Table 18 (continued)

	Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Herberton Tinfield (continued)	Mayday Line	9.5km NE of Mount Garnet	Abandoned mine, active prospect	Not recorded	52 500t at 0.57% cassiterite for 300t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-quartz vein in metasediments. Held under Mining Lease by G.F. and R.A. Burtenshaw.
	Mount Ormonde	4.9km E of Irvinebank	Abandoned mine, active prospect	27.8t cassiterite (1907–1979)	21 500t at 0.62% cassiterite for 133t cassiterite (Plath, 1982)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-quartz veins in metasediments. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
	Nettle Creek	14km E of Mount Garnet	Abandoned mine, active prospect	Not recorded	Nettle Creek Deep Lead - 5Mm^3 at 500g/m^3 cassiterite for 2500t cassiterite (Consolidated Tin Mines Limited, 2008). Nettle Creek South Dredge – 1.3Mm^3 at 90g/m^3 cassiterite for 117t cassiterite (Tin Australia NL, 1999)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer and deep lead placer cassiterite beneath Cainozoic basalts. Held under Mining Leases by Consolidated Tin Mines Ltd.
	Nettle Creek North Tin	12.5km NE of Mount Garnet	Abandoned mine, inactive prospect	Not recorded	5Mm^3 at 550g/m^3 cassiterite for 2750t cassiterite (Tin Australia NL, 1999)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit. Held under Exploration Permit by Consolidated Tin Mines Ltd.
	Never Can Tell	16.5km NE of Mount Garnet	Abandoned mine, active prospect	7.4t cassiterite (1905–1966)	15Mt at 0.2% cassiterite for 30 000t cassiterite (Noranda Exploration Company Limited, 1965)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-quartz veins in metasediments. Held under Exploration Permit by Consolidated Tin Mines Ltd.
	Nymbool Tin	9km NW of Mount Garnet	Abandoned mine, inactive prospect	Not recorded	183 000m^3 at 650g/m^3 cassiterite for 119t cassiterite (Tin Australia NL, 1999)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit. Held under Exploration Permit by Xtreme Resources Ltd.
	Peacemaker	14.2km WNW of Herberton	Abandoned mine, active prospect	449t cassiterite (1896–1989)	20 000t at 1.4% cassiterite for 280t cassiterite (Tin Australia NL, 1999)	Lass O'Gowrie Granite/ Kennedy Province	Cassiterite-Cu-Mo-W greisen in granite. Mining Lease application by Walker Resources Pty Ltd.
	Sailor Tin Prospect	21km NW of Ravenshoe	Active prospect	Not mined	10Mt at 0.1% cassiterite for 10 000t cassiterite (Tin Australia NL, 1999)	Go Sam Granite/ Kennedy Province	Cassiterite-W greisen in granite. Held under Mining Leases by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
	Smiths Creek	11km NW of Mount Garnet	Abandoned mine, inactive prospect	2709.7t cassiterite, 2t wolframite (1903–1935)	200 000t at 1% cassiterite for 2000t cassiterite (Tin Australia NL, 1999)	Nymbool Granite/ Kennedy Province	Cassiterite-W-Cu-quartz veins in granite. Held under Exploration Permit by Xtreme Resources Ltd.

Table 18 (continued)

	Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Herberton Tinfield (continued)	Smith's Creek Alluvial Tin	10.5km NW of Mount Garnet	Inactive prospect	Not mined	2Mm^3 at 160g/m^3 cassiterite for 320t cassiterite (Tin Australia NL, 1999)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial tin deposit. Held under Exploration Permit by Xtreme Resources Ltd.
	Sniska	6km NE of Mount Garnet	Abandoned mine, active prospect	Not recorded	306 900t at 0.32% Sn, 12% F and 22.9% Fe for 982t Sn, 36 828t F and 70 280t Fe (Consolidated Tin Mines Limited, 2010)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-W-magnetite skarn in metasediments. Held under Exploration Permit by Consolidated Tin Mines Ltd.
	Summer Hill Tin	14km NE of Mount Garnet	Abandoned mine, active prospect	Not recorded	127 500t at 0.43% cassiterite for 545t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-quartz veins in metasediments. Held under Mining Lease by Garimperos Ltd.
	Valetta	1.7km ENE of Irvinebank	Abandoned mine, active prospect	125.2t cassiterite (1904–1973)	20 000t at 0.8% cassiterite for 160t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-quartz veins in sandstone. Held under Mining Lease by G.H. Smith.
	Viking	13km NE of Mount Garnet	Abandoned mine, inactive prospect	Not recorded	34 815t at 0.7% cassiterite for 244t cassiterite (Tin Australia NL, 1999)	Hodgkinson Formation/Hodgkinson Province	Cassiterite veins in arenite. Held under Exploration Permit by Consolidated Tin Mines Ltd.
	Vulcan Tin Mine	0.9km W of Irvinebank	Abandoned mine, active prospect	13 961t cassiterite (1888–1933)	Not calculated	Hodgkinson Formation/Hodgkinson Province	Cassiterite-W-Bi-Ag-Pb-Cu-quartz-chlorite pipe in metasediments. Held under Mining Leases by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd) and Walker Resources Pty Ltd.
	Wafer	6km NE of Mount Garnet	Abandoned mine, active prospect	Not recorded	1 351 300t at 0.4% Sn and 26.64% Fe for 5488t Sn and 360 006t Fe. 348 300t at 18.54% F for 64 574t F (Consolidated Tin Mines Limited, 2010)	Hodgkinson Formation/Hodgkinson Province; Pinnacles Granite/ Kennedy Province	Cassiterite-magnetite skarn in limestone, basalt, hornfels and granite. Held under Exploration Permit by Consolidated Tin Mines Ltd.
	Windermere Prospect	18.5km WNW of Ravenshoe	Active prospect	Not mined	2.103Mt at 0.55% Sn for 11 566t Sn (Consolidated Tin Mines Limited, 2010)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-magnetite skarn in limestone and metasediments. Held under Mineral Development Licence by Consolidated Tin Mines Ltd.
	World's Fair	2.4km E of Irvinebank	Abandoned mine, inactive prospect	19.3t cassiterite (1906–1977)	53 600t at 0.6% cassiterite for 322t cassiterite (Boyd, 1982)	Hodgkinson Formation/Hodgkinson Province	Cassiterite veins in metasediments. Held under Exploration Permit by North Queensland Metals Ltd (Conquest Mining Ltd/Monto Minerals Ltd).
	Wyndham	11km NNE of Mount Garnet	Abandoned mine, inactive prospect	Not recorded	3Mm^3 at 550g/m^3 cassiterite for 1650t cassiterite (Tin Australia NL, 1999)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit.

Table 18 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Horse Creek Dimbulah		7.3km ENE of Dimbulah	Abandoned mine, inactive prospect	Not recorded	750 000m^3 at 350g/m^3 cassiterite for 263t cassiterite (Cohen, 1983)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit. No current tenure.
Hunter Tin		105km SW of Cairns	Inactive prospect	Not mined	6.615Mm^3 at 176g/m^3 cassiterite for 1164t cassiterite (Tin Australia NL, 1999)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit. Held under Exploration Permit by Consolidated Tin Mines Ltd.
Jeannie River		94km NW of Cooktown	Active prospect	Not mined	6.7Mt at 0.8% cassiterite for 53 600t cassiterite (Lord & Fabray, 1990)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-W-Cu-Ag-Pb-Zn-quartz veins in metasediments. Held under Exploration Permit by Friends Exploration Pty Ltd in joint venture with Independence Group NL.
Kangaroo Creek		64km SW of Mungana	Abandoned mine, active prospect	421.9t cassiterite (1980–1988, 2001–2006)	1Mm^3 at 0.7kg/m^3 for 700t cassiterite (from Intierra database, 37/3/99).	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer and palaeoplacer cassiterite deposits. Held under Mining Leases by Staldor Mining Pty Ltd and Exploration Permit by Republic Gold.
Kangaroo Hills Mineral Field	Kangaroo Hills Mineral Field	60km SW of Ingham	Abandoned mines	8980t cassiterite, 474t stannite (1885–1993)	See below		
	Ewan Tin Prospect	6.3km NW of Ewan	Abandoned mine, active prospect	Not recorded	20 000t at 3% cassiterite and 1.8% Cu for 600t cassiterite and 360t Cu (SMC Resources Limited, 1997)	Perry Creek Formation/ Camel Creek Subprovince	Cassiterite-stannite veins in metasediments. Held under Mining Lease byMt Moss Mining Pty Ltd.
	Lion Extended	5.9km SW of Ewan	Abandoned mine, inactive prospect	3.7t cassiterite (1965)	38 550t at 1.29% cassiterite for 496t cassiterite (Levingston, 1971)	Running River Metamorphics/ Cape River Province	Cassiterite-quartz veins in schist. Held under Exploration Permit by Nextstar Pty Ltd.
	Sardine	6.1km NW of Ewan	Abandoned mine, active prospect	1466t cassiterite, 466t stannite (1919–1990)	Not calculated	Perry Creek Formation/ Camel Creek Subprovince	Cassiterite-Bi-Cu-quartz-chlorite veins in metasediments. Held under Mining Claims and Leases byMt Moss Mining Pty Ltd.
Koorboora Creek		12.5km SE of Almaden	Active prospect	55t cassiterite (1900–1980)	0.75Mm^3 at 140g/m^3 cassiterite for 105t cassiterite (Tin Australia NL, 1999)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit. Held under Mining Lease by I.E. Wallace.
Leichhardt Creek Tin Mine		11.9km ESE of Mount Carbine	Abandoned mine, active prospect	94t cassiterite (1995–1997)	1.3Mm^3 at 393g/m^3 Sn for 511t Sn (Consolidated Tin Mines Limited, 2008)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit. Under Mining Lease application by I.E. Wallace.
Mount Holmes		10.1km S of Mount Carbine	Abandoned mine, active prospect	180t cassiterite (1897–1985)	10Mt at 0.07% cassiterite and 0.01% WO_3 for 7000t cassiterite and 1000t WO_3 (Henry, 1990)	Hodgkinson Formation/Hodgkinson Province	Sheeted Sn-wolframite-Bi-Cu-quartz veins in greisenised metasediments. Held under Exploration Permit by Kangaroo Metals Ltd (Icon Resources Ltd).

Table 18 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Shannon		5.5km W of Chillagoe	Abandoned mine, active prospect	Not recorded	1.01Mt at 0.07% cassiterite, 20.2g/t Ag, 1.23% Cu, 0.53% Zn, 0.96g/t Au and 0.08% Bi for 707t cassiterite, 20 402kg Ag, 12 423t Cu, 5353t Zn, 970kg Au and 808t Bi (Verwoerd & Sargeant, 1971)	Chillagoe Formation/ Hodgkinson Province; Ruddygore Granodiorite/ Kennedy Province	Cu-Zn-Ag-Au-Bi-cassiterite skarn in marble, chert, ironstone and granodiorite. Held under Mining Lease by Mungana Pty Ltd (Mungana Gold Mines Ltd).
Soda Springs Tin		29km WSW of Muldiva	Abandoned mine, active prospect	Not recorded	2Mm^3 at 625g/m^3 cassiterite for 1250t cassiterite (Consolidated Tin Mines Limited, 2008)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial tin deposit. Held under Exploration Permit by Consolidated Tin Mines Ltd.
Stanhills Tinfield		40km SE of Croydon	Abandoned mines	78.2t alluvial cassiterite and 201.3t lode cassiterite (1900–1949)	Not calculated	Croydon Volcanic Group, Esmeralda Granite/ Croydon Province; Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Cassiterite-quartz veins, pipes and greisen lodes in granite and volcanic rocks.
Stanthorpe Tinfield	Stanthorpe Tinfield	Centred on Stanthorpe	Abandoned mines	56 537t alluvial cassiterite (1872–1989), >337t lode cassiterite (1887–1956)	Not calculated	Texas beds/ Texas Subprovince; Stanthorpe Granite, Ruby Creek Granite/ New England Batholith; Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Cassiterite veins, greisen and alluvial deposits. No active exploration for tin.
	Dalcouth Creek	5.6km E of Stanthorpe	Abandoned mine	Not recorded	130 000m^3 at 2.7kg/m^3 cassiterite for 351t cassiterite (from old MDL 152 application)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial cassiterite deposit. No current tenure.
	Sugarloaf Creek	15km ESE of Stanthorpe	Abandoned prospect	1157.3t cassiterite (1913–1931)	86 000m^3 at 3.5kg/m^3 cassiterite for 301t cassiterite (from old MDL 154 application)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial cassiterite deposit. No current tenure.
	Sundown Tin Mine	33.6km SW of Stanthorpe	Abandoned mine	288t cassiterite (1897–1956)	Not calculated	Texas beds/ Texas Subprovince	Cassiterite-W-Cu-As veins in metasediments.
Station Creek		13.3km SE of Mount Carbine	Active prospect	Not mined	46Mm^3 at 180g/m^3 cassiterite for 8280t cassiterite (Beattie, 1973)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial cassiterite-W deposit. Held under Exploration Permit by Kangaroo Minerals Pty Ltd.
Tate River		39km SSW of Mungana	Abandoned mine, active prospect	1595t cassiterite (1883–1987)	3.5Mm^3 alluvium at 0.4kg/m^3 cassiterite for 14000t cassiterite. 9.76Mm^3 tailings and dumps at 587g/m^3 cassiterite for 5729t cassiterite (Tin Australia NL, 1999)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial placer cassiterite deposit. Held under Exploration Permit by Consolidated Tin Mines Ltd.

Table 18 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Torwood Sand Ridge	73km W of Almaden	Inactive prospect	Not mined	105Mm^3 at 45g/m^3 cassiterite for 4725t cassiterite (Davis, 1995)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial palaeoplacer cassiterite-heavy mineral-gold deposit. Held under Exploration Permit by Fusion Resources Pty Ltd (Paladin Energy Ltd).
Two Jacks	10.5km SSW of Petford	Abandoned mine, active prospect	451t cassiterite (1906–1964)	30 000t at 0.6% cassiterite for 180t cassiterite (Stevenson, 1970)	Hodgkinson Formation/Hodgkinson Province	Cassiterite-W-Bi-Pb veins in metasediments. Held under Exploration Permit by Tropical Metals Pty Ltd; Planet Metals Ltd farming-in.
Ugly Corner	50km NE of Greenvale	Abandoned mine, inactive prospect	1.1t cassiterite (1951–1955)	650 000m^3 at 0.6kg/m^3 cassiterite for 390t cassiterite (Pratt & Driessen, 1963)	Alluvium/ Cainozoic Alluvial and Colluvial Deposits	Alluvial palaeoplacer cassiterite.

are used industrially in high temperature lubricants, ceramic glazes, pigments, paints, fluorescent lighting, scintillation detectors, tanning and as catalysts. The important ores of tungsten are wolframite and scheelite.

In Queensland, tungsten occurs in skarns, greisens, sheeted vein systems, quartz pipes, porphyries and alluvial and eluvial deposits (Figure 25; Table 19; Cameron, 1904; Dunstan, 1905b; Ball, 1911b; Krosch, 1985c). Tungsten vein/greisen deposits contain wolframite, scheelite, molybdenite and base metal sulphides in quartz vein swarms, usually in fracture systems associated with felsic intrusives. There is no strong affinity with a specific granite type or redox state. In Queensland, there is a strong spatial association between tungsten vein mineralisation and tin vein deposits, particularly in the Herberton tinfield. Tungsten skarns are commonly associated with granites that were emplaced at moderate depths in the crust and developed large contact metamorphic aureoles. The most significant tungsten skarn in Queensland is Watershed, which comprises fine- to coarse-grained disseminated scheelite in quartz vein swarms, in stratabound replacement lenses in calc-silicate rocks of the Hodgkinson Formation, and in dyke-like intrusions of albitised granite.

Queensland's historical tungsten production has come almost entirely from the Mount Carbine deposit, which closed in 1986. In 2008-09, Queensland produced 15t of wolframite concentrates, all from Queensland Ores Ltd's Wolfram Camp mine west of Cairns. Mining operations were suspended in late 2008 due to economic considerations.

URANIUM

Uranium is a mildly radioactive member of the actinide series. Peaceful uses of uranium include nuclear power reactors, the manufacture of radioisotopes for medical applications, and nuclear science research using neutron fluxes. Depleted uranium is used in alloys for kinetic energy penetrators, armour plating and radioactivity shielding. Uranium-bearing minerals include uraninite, pitchblende, carnotite, autunite, brannerite, uranophane, torbernite, davidite, gummite and coffinite. Significant uranium concentrations may also occur in phosphate rock deposits and monazite sands.

Queensland contains 2% of Australia's known uranium resources and reserves and Australia is currently the world's third largest producer of uranium oxide (U_3O_8) behind Canada and Kazakhstan (Geoscience Australia, 2009).

Queensland has been a significant past producer of uranium, with the abandoned Mary Kathleen mine producing ~8882t of U_3O_8 from 9.25Mt of ore. Queensland's major uranium resources are confined to Proterozoic deposits in north-west Queensland (for example, Westmoreland and Valhalla) and Palaeozoic deposits in north-east Queensland (for example, Ben Lomond and Maureen) (Figure 26; Table 20). Renewed interest in uranium as an energy source has seen significant renewed interest in Queensland's numerous deposits (von Gnielinski, 2010).

Table 19: Significant tungsten deposits of Queensland

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Bamford Hill	3.7km N of Petford	Abandoned mine, active prospect	2000t wolframite, 170t molybdenite, 20t bismuthinite (1893–1981)	Not calculated	Bamford Granite/ Kennedy Province	Wolframite-Sn-Mo-Bi in sheeted veins and quartz pipes in greisen in granite. Held under Exploration Permit by Tropical Metals Pty Ltd; Planet Metals Ltd earning up to 85%.
Burlington One	16.5km WSW of Lyndbrook	Abandoned mine, active prospect	Not recorded	3.75Mt at 0.5% WO_3 for 18 750t WO_3 (Ekstrom & Isley, 1982)	Burlington Granite/ Kennedy Province	Wolframite-quartz veins in granite. Held under Exploration Permit by Resolve Geo Pty Ltd.
Galala Range	23km NNW of Lyndbrook	Abandoned mine, active prospect	52t wolframite (1910–1945	Not calculated	Blackman Gap Complex/ Pama Province	Wolframite-Mo-Au-Cu-Bi-quartz veins in sericite-silica altered granite. Held under Exploration Permit by Auzex Resources Ltd. Active exploration for Mo resource.
McLennon's Claim	79km NE of Mount Isa	Abandoned mine	6t W	Not calculated	Corella Formation/ Mary Kathleen Domain	Scheelite-quartz veins in schist. No current tenure.
Mount Carbine	75km NW of Cairns	Abandoned mine, active prospect, feasibility study in progress	16 400t wolframite and scheelite, >7.8t cassiterite (1894–1921, 1937–1942, 1950–1952, 1972–1986)	113.6Mt at 0.06% WO_3 for 68 160t WO_3 (Icon Resources Ltd, 2010). 1.6Mt tailings at 0.11% wolframite for 1760t wolframite (Icon Resources Ltd, 2008). ~18Mt in low-grade stockpiles.	Hodgkinson Formation/ Hodgkinson Province	Sheeted wolframite-Mo-Sn-Bi-quartz veins in metasediments, close to contact with granite; eluvial deposits. Held under Mining Lease by Mt Carbine Quarries Pty Ltd, which is producing aggregate from the waste dumps. Icon Resources Ltd secured the rights to explore for and mine tungsten in 2008.
Mount Holmes	10.1km S of Mount Carbine	Abandoned mine, active prospect	180t cassiterite (1897–1985)	10Mt at 0.07% cassiterite and 0.01% WO_3 for 7000t cassiterite and 1000t WO_3 (Henry, 1990)	Hodgkinson Formation/ Hodgkinson Province	Sheeted Sn-wolframite-Bi-Cu-quartz veins in greisenised metasediments. Held under Exploration Permit by Kangaroo Metals Ltd (Icon Resources Ltd).
Mount Perseverance	14.4km N of Mount Molloy	Abandoned mine, inactive prospect	130t wolframite, 1.7t cassiterite (1917–1974)	13Mt at 0.03% WO_3 for 3900t WO_3 (Brachmanski, 1979)	Hodgkinson Formation/ Hodgkinson Province	Sheeted wolframite-Sn-Cu-quartz veins in metasediments. No current tenure.
Neville	40km SE of Chillagoe	Abandoned mine	590t wolframite (1904–1919)	Not calculated	Hodgkinson Formation/ Hodgkinson Province	Wolframite-Sn-quartz pipe in metasediments. Held under Exploration Permit by Tropical Metals Ltd.
Ollera Creek	60km NW of Townsville	Abandoned mines, active prospect	255t wolframite, 22.3t molybdenite, 10t Bi, 7.2t Bi-W and Mo-W concentrates (1895–1953)	Not calculated	Paluma Rhyolite, Rollingstone Granite/ Kennedy Province	Wolframite-Mo-Bi-quartz pipes and veins in greisenised granite and porphyry; alluvial and eluvial deposits. Held under Exploration Permit by G.M. Steine and A.J. Weil.

Table 19 (continued)

Name	Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Perry Creek	49km NE of Greenvale	Abandoned mine, active prospect	8t scheelite (1944–1970)	0.1Mt at 0.8% scheelite for 800t scheelite (Murdock and others, 1981)	Unnamed granite/ Kennedy Province	Scheelite-quartz veins in granite. Held under Exploration Permit by Sandy Resources Pty Ltd (Anchor Resources Ltd).
Pom Pom	7.4km WNW of Mount Molloy	Abandoned mine, inactive prospect	2t wolframite (1918–1980)	32 206t at 1.08% wolframite for 350t wolframite (Greaves, 1980)	Hodgkinson Formation/ Hodgkinson Province	Wolframite-Sn-Cu-Mo-quartz veins in metasediments. No current tenure.
Staines Wolfram Mine	19.4km NW of Stanthorpe	Abandoned mine	7.1t wolframite (1916, 1940)	Not calculated	Texas beds/ Texas Subprovince; Ruby Creek Granite/ New England Batholith	Wolframite-quartz veins in hornfels and granite. No current tenure.
Watershed	34km NW of Mount Carbine	Active prospect, pre-feasibility study completed	Not mined	15.1Mt at 0.46% WO_3 for 69 460t WO_3 (Vital Metals Ltd, 2009)	Hodgkinson Formation/ Hodgkinson Province; Unnamed granite/ Kennedy Province	Scheelite skarn in calc-silicate rocks and granite. Held under Mining Leases by Vital Metals Ltd.
Wolfram and Tin	2.8km E of Stanthorpe	Abandoned mine	14.5t wolframite, 5t cassiterite (1883, 1916, 1956)	Not calculated	Ruby Creek Granite/ New England Batholith	Sheeted wolframite-Sn-Mo-Bi-Cu-quartz veins in granite. No current tenure.
Wolfram Camp	80km W of Cairns	Care and maintenance	6855t wolframite, 1535t bismuthinite, 135t molybdenite (1893–1990, 2008–2009)	1.42Mt at 0.6% $WO_3$and 0.12% Mo for 8528t WO_3 and 1718t Mo (Planet Metals Limited, 2010)	James Creek Granite/ Kennedy Province	Wolframite-Mo-Bi-quartz pipes and veins in greisenised granite; eluvial deposits. Held under Mining Leases by Planet Metals Ltd (85%) and Tropical Metals Pty Ltd (15%). Mined by Queensland Ores Ltd (now Planet Metals Ltd) in 2008 but closed due to metallurgical issues.

Skirrow & others (2009) and Huston (2010) divided uranium deposit types into:

- Basin and surface-related uranium systems, including:
  - » Sandstone-related (roll-front) systems
  - » Unconformity-related systems, for example, Westmoreland, Maureen, Ben Lomond (Wall, 2006),
- Metamorphic-related systems, including:
  - » Metasomatic systems, for example, Valhalla, Andersons, Bikini, Skal, Watta, Eldorado North,
- Hybrid systems, including
  - » Uranium-bearing iron oxide-Cu-Au systems, for example, E1 Camp, Monakoff, Swan, and
- Magmatic-related systems, including:
  - » Orthomagmatic systems
  - » Magmatic-hydrothermal systems, for example, Mary Kathleen, Oasis, Mount Hogan.

Other papers describing Queensland uranium mineralisation styles and deposits include Brooks (1972), Noon (1979), Allen (1983) and McKay & Miezitis (2001).

VANADIUM

Vanadium is a transition metal that is used to produce specialty steel alloys. It is also used in welding, nuclear engineering and superconducting magnets. Vanadium pentoxide is used as a catalyst in the production of sulphuric acid, in the desulphurisation of sour gas and oil, and in the making of ceramics.

Vanadium is one of the most expensive elements to recover and economic ore generally grades at least 1.5% vanadium pentoxide. World production is obtained from vanadium-bearing magnetite in layered gabbro intrusions, from slag as a by-product of steel making, and from waste ash and oil residues. Vanadium is also present in bauxite and in fossil fuel deposits.

Queensland's major vanadium resources occur in the extensive marine oil shale sediments of the Toolebuc Formation in the Julia Creek area in north-west Queensland (Figure 26, Table 21). The Toolebuc Formation is a flat-lying, Early Cretaceous sedimentary sequence that comprises an upper, coarse limestone-clay-oil shale unit and a lower, fine-grained carbonate-clay-oil shale unit. In the upper part of the Toolebuc Formation, oxidation has increased the concentration of vanadium pentoxide and produced a soft, friable limestone-clay mix. This ore type is known as soft oxide coquina and averages 0.25% V_2O_5. Coquina is a bedded limestone that consists predominantly of shells and shell pieces.

Uranium deposits in the Valhalla area, north of Mount Isa, are known to contain vanadium mineralisation. Drill intersections have included grades of 0.05 to 0.36% V_2O_5.

Minor low-grade vanadium mineralisation is associated with the Eulogie Park and Hawkwood layered gabbro complexes in central Queensland.

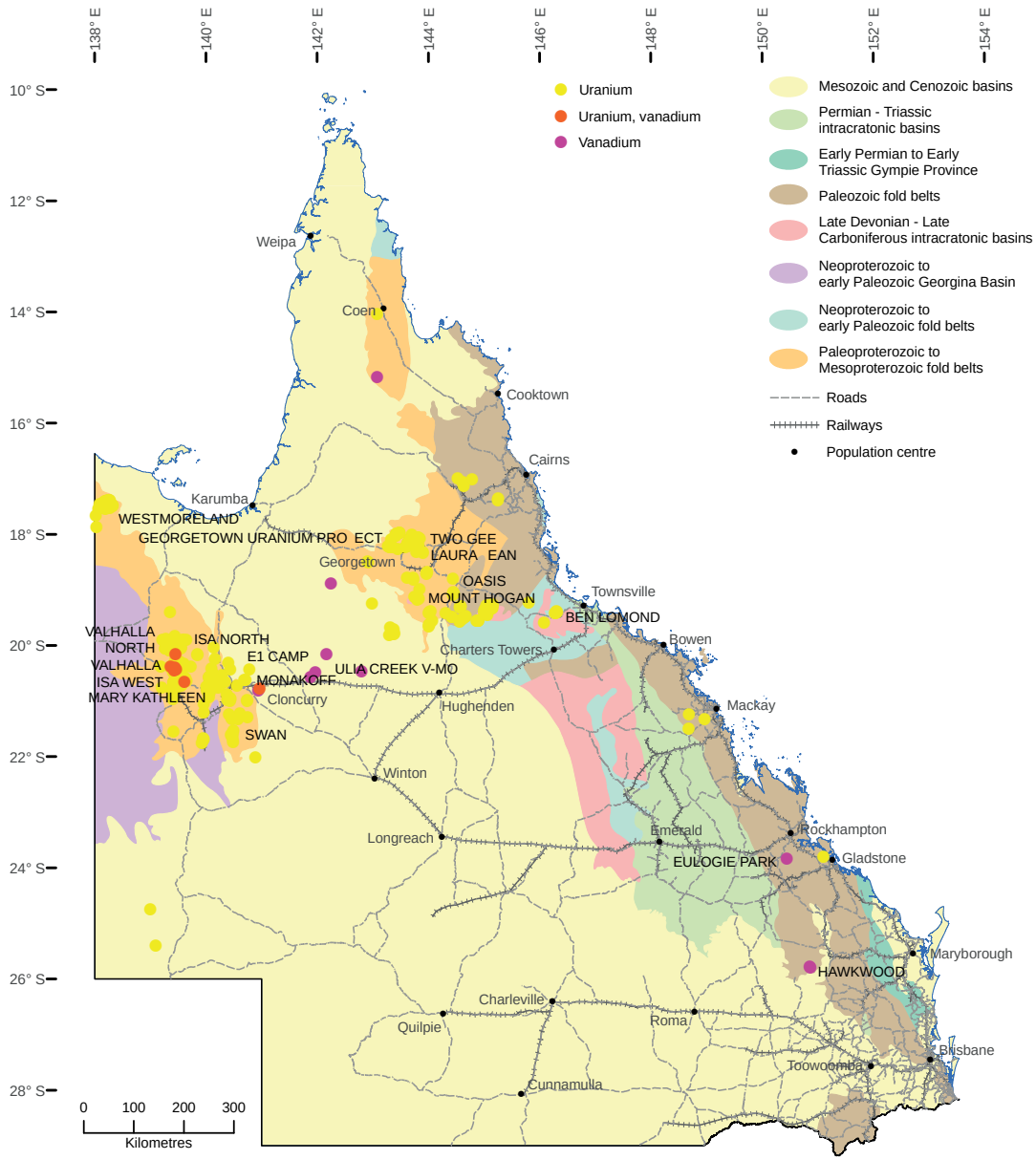

Figure 26: Uranium and vanadium occurrences and deposits

Table 20: Significant uranium deposits of Queensland

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Ben Lomond		50km W of Townsville	Abandoned mine, active prospect	Production not exported	1.931Mt at 0.021% U_3O_8 for 4195t U_3O_8 (Vigar & Jones, 2005)	Saint James Volcanics./ Burdekin Basin	Unconformity-related uranium-molybdenum mineralisation in volcanics. Held under Mining Leases by Uranium Mineral Ventures Incorporated (Mega Uranium Ltd).
E1 Camp		34km NE of Cloncurry	Active prospect	Not mined	26.23Mt at 0.013% U_3O_8 for 3120t U_3O_8 (Exco Resources NL, 2007)	Mount Fort Constantine Volcanics/ Canobie Domain	Uranium-bearing Cu±Au±iron oxide deposit in breccia, metavolcanics and metasediments. Held under Mining Lease by Eliza Creek Mines Ltd (Exco Resources NL).
Elaine Dorothy		51.6km WSW of Cloncurry	Active prospect	Not mined	83 000t at 0.013% U_3O_8 and 3236g/t rare earths for 23t U_3O_8 and 268 588kg rare earths (China Yunnan Copper Australia Limited, 2010a)	Corella Formation/ Mary Kathleen Domain	Magmatic-hydrothermal uranium-rare earth element deposit in calc-silicates, quartzite, amphibolite and skarn. Held under Exploration Permit by Goldsearch Ltd in joint venture with China Yunnan Copper Australia Ltd.
Isa North	Queen's Gift	78km NNW of Mount Isa	Active prospect	Not mined	0.85Mt at 0.04% U_3O_8 for 332t U_3O_8 (Deep Yellow Limited, 2010)	Cromwell Metabasalt Member/ Leichhardt River Domain	Metasomatic uranium. Lenses and stratabound mineralisation in sandstone, schist and metabasalt. Held under Exploration Permit by Superior Uranium Pty Ltd (Deep Yellow Ltd).
	Slance	91km N of Mount Isa	Active prospect	Not mined	0.46Mt at 0.055% U_3O_8 for 244t U_3O_8 (Deep Yellow Limited, 2010)	Cromwell Metabasalt Member/ Leichhardt River Domain	Metasomatic uranium. Veins and stratabound mineralisation in quartzite and metabasalt. Held under Exploration Permit by Deep Yellow Ltd.
Isa West area	Bambino	8.9km NW of Mount Isa	Active prospect	Not mined	1.04Mt at 0.04% U_3O_8 for 391t U_3O_8 (Deep Yellow Limited, 2010)	Alpha Centauri Metamorphics/ Leichhardt River Domain	Metasomatic uranium. Lenses and stratabound mineralisation in gneiss, amphibolite and schist. Held under Exploration Permit by Mount Isa Mines Ltd (Xstrata Plc) in joint venture with Deep Yellow Ltd.
	Eldorado North	6km NW of Mount Isa	Active prospect	Not mined	160 000t at 0.05% U_3O_8 for 80t U_3O_8 (Deep Yellow Limited, 2010)	Alpha Centauri Metamorphics/ Sybella Domain	Metasomatic uranium. Lenses and stratabound mineralisation in gneiss, amphibolite and schist. Held under Exploration Permit by Mount Isa Mines Ltd (Xstrata Plc) in joint venture with Deep Yellow Ltd.
	Thanks-giving	7.8km NW of Mount Isa	Active prospect	Not mined	1.13Mt at 0.046% U_3O_8 for 498t U_3O_8 (Deep Yellow Limited, 2010)	Alpha Centauri Metamorphics/ Sybella Domain	Metasomatic uranium. Lenses and stratabound mineralisation in gneiss, amphibolite and schist. Held under Exploration Permit by Mount Isa Mines Ltd (Xstrata Plc) in joint venture with Deep Yellow Ltd.
Laura Jean		24.9km E of Georgetown	Active prospect	Not mined	10t U_3O_8 and 1500t fluorite (Andrews, 1980)	Routh Dacite/Kennedy Province	Unconformity-related uranium-fluorite mineralisation in volcanics. No current tenure.

Table 20 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Mary Kathleen		53km W of Cloncurry	Abandoned mine	8882t U_3O_8 (1958–1963, 1975–1982)	1200t U_3O_8 in remnant ore (Huston, 2010)	Corella Formation/ Mary Kathleen Domain	Magmatic-hydrothermal uranium. Vein and replacement ore in skarn host related to intrusion of Burstall Granite.
Georgetown Uranium Project	Central 50	23km WNW of Georgetown	Active prospect	Not mined	374 500t at 0.16% U_3O_8 for 580t U_3O_8 (Okill, 1981)	Corbett Formation/ Etheridge Province; Forsayth Granite/ Etheridge Province; Mount Darcy Microgranite/ Kennedy Province	Unconformity-related uranium mineralisation in metasediments and granite. Held under Exploration Permit by Mineral Development Australia Pty Ltd (Mega Uranium Ltd).
	Far West 5	33km NW of Georgetown	Active prospect	Not mined	90 830t at 0.12% U_3O_8 and 0.18% Mo for 104t U_3O_8 and 163t Mo (Potts, 1979)	Gilberton Formation/ Gilberton Basin	Unconformity-related uranium-molybdenum-fluorite mineralisation in arkosic sediments. Held under Exploration Permit by Mega Georgetown Pty Ltd (Mega Uranium Ltd).
	Far West 7	32km NW of Georgetown	Active prospect	Not mined	65 600t at 0.09% U_3O_8 and 0.16% Mo for 61t U_3O_8 and 108t Mo (Potts, 1979)	Gilberton Formation/ Gilberton Basin	Unconformity-related uranium-molybdenum-fluorite mineralisation in arkosic sediments. Held under Exploration Permit by Mega Georgetown Pty Ltd (Mega Uranium Ltd).
	Maureen	45km N of Georgetown	Active prospect	Not mined	3.278Mt at 0.09% U_3O_8 and 0.06% Mo for 2980t U_3O_8 and 2028t Mo (Mega Uranium Limited, 2008)	Gilberton Formation/ Gilberton Basin	Unconformity-related uranium-molybdenum-fluorite mineralisation in arkosic sediments. Held under Exploration Permit by Mega Georgetown Pty Ltd (Mega Uranium Ltd).
Monakoff		20.8km ENE of Cloncurry	Abandoned mine, active prospect	466.6t Cu, 0.367kg Au (<1958, 1997–1998)	1.902Mt at 0.02% U_3O_8 for 348t U_3O_8 (Exco Resources NL, 2007)	Mount Norna Quartzite/ Soldiers Cap Domain	Iron oxide-Cu-Au deposit in siltstone, amphibolite and shale. Held under Mining Lease by Great Australian Operations Pty Ltd (Exco Resources Ltd) but recently sold to Xstrata Copper.
Two Gee		21.5km NE of Georgetown	Active prospect	Not mined	0.642Mt at 0.12% U_3O_8 for 770t U_3O_8 (Rutten, 1983)	Daniel Creek Formation/ Etheridge Province	Unconformity-related uranium-fluorite mineralisation in volcanics. Held under Exploration Permit by Mineral Development Australia Pty Ltd (Mega Uranium Ltd).

Table 20 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Valhalla area	Anderson's Lode	14.5km NE of Mount Isa	Active prospect	Not mined	2Mt at 0.11% U_3O_8 for 2100t U_3O_8 (Summit Resources Limited, 2007a)	Cromwell Metabasalt Member/ Leichhardt River Domain	Metasomatic uranium. Veins in greywacke, quartzite and metabasalt. Held under Exploration Permit by Summit Resources (Australia) Pty Ltd.
	Bikini	34.3km NNW of Mount Isa	Active prospect	Not mined	10.1Mt at 0.05% U_3O_8 for 5221t U_3O_8 (Summit Resources Limited, 2008)	Cromwell Metabasalt Member/ Leichhardt River Domain	Metasomatic uranium. Veins and stratabound mineralisation in quartzite, schist and metabasalt. Held under Exploration Permit and Mineral Development Licence application by Summit Resources (Australia) Pty Ltd.
	Mirrioola	33km NNW of Mount Isa	Active prospect	Not mined	215 321t at 0.093% U_3O_8 for 201t U_3O_8 (Queensland Mines Limited, 1970)	Cromwell Metabasalt Member/ Leichhardt River Domain	Metasomatic uranium. Veins and stratabound mineralisation in quartzite, siltstone and metabasalt. Held under Exploration Permit and Mineral Development Licence application by Summit Resources (Australia) Pty Ltd.
Valhalla area (continued)	Odin	41km NNW of Mount Isa	Active prospect	Not mined	8.2Mt at 0.06% U_3O_8 for 4685t U_3O_8 (Summit Resources Limited, 2010)	Eastern Creek Volcanics/ Leichhardt River Domain	Metasomatic uranium. Veins and stratabound mineralisation in tuff, shale and metabasalt. Held under Exploration Permit and Mineral Development Licence application by Summit Resources (Australia) Pty Ltd
	Skal	32km N of Mount Isa	Active prospect	Not mined	12.7Mt at 0.053% U_3O_8 for 6596t U_3O_8 (Summit Resources Limited, 2009)	Cromwell Metabasalt Member/ Leichhardt River Domain	Metasomatic uranium. Veins and stratabound mineralisation in quartzite, siltstone, schist and metabasalt. Held under Exploration Permit and Mineral Development Licence application by Summit Resources (Australia) Pty Ltd.
	Valhalla	40km NNW of Mount Isa	Active prospect	Not mined	36.39Mt at 0.086% U_3O_8 for 31 688t U_3O_8 (Summit Resources Limited, 2009)	Cromwell Metabasalt Member/ Leichhardt River Domain	Metasomatic uranium. Veins in tuff, shale and metabasalt. Held under Exploration Permit and Mineral Development Licence application by Summit Resources (Australia) Pty Ltd.
	Watta	64km N of Mount Isa	Active prospect	Not mined	4.2Mt at 0.04% U_3O_8 for 1722t U_3O_8 (Summit Resources Limited, 2007b)	Leander Quartzite Member/ Leichhardt River Domain	Metasomatic uranium. Veins in tuff, quartzite and metapelite. Held under Exploration Permit and Mineral Development Licence application by Summit Resources (Australia) Pty Ltd.

Table 20 (continued)

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Valhalla North	Duke-Batman	84km NNW of Mount Isa	Active prospect	Not mined	2.11Mt at 0.065% U_3O_8 for 1404t U_3O_8 (Fusion Resources Limited, 2008)	Cromwell Metabasalt Member/ Leichhardt River Domain	Metasomatic uranium. Shear-hosted veins in siltstone, quartzite and metabasalt. Held under Exploration Permit by Fusion Resources Ltd (Paladin Energy Ltd).
	Honey Pot	99.5km N of Mount Isa	Active prospect	Not mined	2.56Mt at 0.07% U_3O_8 for 1792t U_3O_8 (Fusion Resources Limited, 2008)	Cromwell Metabasalt Member/ Leichhardt River Domain	Metasomatic uranium. Shear-hosted veins in siltstone, quartzite and metabasalt. Held under Exploration Permit by Fusion Resources Ltd (Paladin Energy Ltd).
Westmoreland	Huarabagoo	350km NNW of Mount Isa	Active prospect	Not mined	3.868Mt at 0.1% U_3O_8 for 3835t U_3O_8 (Laramide Resources Limited, 2009)	Westmoreland Conglomerate/ Camooweal-Murphy Domain	Unconformity-related uranium mineralisation in sandstone, conglomerate and dolerite. Held under Exploration Permit by Tackle Resources Pty Ltd (Laramide Resources Ltd).
	Jack (Redtree)	350km NNW of Mount Isa	Active prospect	Not mined	17.325Mt at 0.085% U_3O_8 for 14 564t U_3O_8 (Laramide Resources Limited, 2009)	Westmoreland Conglomerate/ Camooweal-Murphy Domain	Unconformity-related uranium mineralisation in sandstone, conglomerate and dolerite. Held under Exploration Permit by Tackle Resources Pty Ltd (Laramide Resources Ltd).
Westmoreland (continued)	Junnagunna	350km NNW of Mount Isa	Active prospect	Not mined	6.514Mt at 0.08% U_3O_8 for 5147t U_3O_8 (Laramide Resources Limited, 2009)	Westmoreland Conglomerate/ Camooweal-Murphy Domain	Unconformity-related uranium mineralisation in sandstone, conglomerate and dolerite. Held under Exploration Permit by Tackle Resources Pty Ltd (Laramide Resources Ltd).
	Junnagunna South	350km NNW of Mount Isa	Active prospect	Not mined	0.545Mt at 0.055% U_3O_8 for 299t U_3O_8 (Evans, 1979)	Westmoreland Conglomerate/ Camooweal-Murphy Domain	Unconformity-related uranium mineralisation in sandstone. Held under Exploration Permit by Tackle Resources Pty Ltd (Laramide Resources Ltd).
	Langi	350km NNW of Mount Isa	Active prospect	Not mined	91 670t at 0.12% U_3O_8 for 110t U_3O_8 (Battey and others, 1987)	Westmoreland Conglomerate/ Camooweal-Murphy Domain	Unconformity-related uranium mineralisation in sandstone, conglomerate and dolerite. Held under Exploration Permit by Tackle Resources Pty Ltd (Laramide Resources Ltd).
	Outcamp	350km NNW of Mount Isa	Active prospect	Not mined	1.112Mt at 0.09% U_3O_8 for 945t U_3O_8 (Battey and others, 1987)	Westmoreland Conglomerate/ Camooweal-Murphy Domain	Unconformity-related uranium mineralisation in sandstone, conglomerate and dolerite. Held under Exploration Permit by Tackle Resources Pty Ltd (Laramide Resources Ltd).
	Sue	350km NNW of Mount Isa	Active prospect	Not mined	410 000t at 0.17% U_3O_8 for 679t U_3O_8 (Evans, 1980)	Westmoreland Conglomerate/ Camooweal-Murphy Domain	Unconformity-related uranium mineralisation in sandstone, conglomerate and dolerite. Held under Exploration Permit by Tackle Resources Pty Ltd (Laramide Resources Ltd).

Table 21: Significant vanadium deposits of Queensland

Name		Location	Status	Total historical production (years)	Known resources (source)	Host formation/ Province	Comments
Julia Creek V-Mo Project	Alisona-Richmond	16.5km ENE of Julia Creek	Active prospect	Not mined	4820Mt at 0.27% vanadium oxide and 0.02% molybdite for 13 203Mt vanadium oxide and 1.072Mt molybdite (Intermin Resources Ltd, 2009)	Toolebuc Formation/ Eromanga Basin	Oxidised oil shale. Held under Exploration Permit by Intermin Resources Ltd.
	Lilyvale	40km NW of Richmond	Active prospect	Not mined	410.67Mt at 0.44% vanadium oxide and 0.03% molybdite for 1.807Mt vanadium oxide and 0.136Mt molybdite (Intermin Resources Ltd, 2010)	Toolebuc Formation/ Eromanga Basin	Oxidised oil shale. Held under Exploration Permit by Intermin Resources Ltd.
	Linfield	35km NE of Julia Creek	Active prospect	Not mined	170Mt at 0.46% vanadium oxide for 780 000t vanadium oxide (Fimiston Mining NL, 1999)	Toolebuc Formation/Eromanga Basin	Oxidised oil shale. Held under Exploration Permit by Intermin Resources Ltd.
	St Elmo-Burwood	27km NE of Julia Creek	Active prospect	Not mined	3077.98Mt at 0.32% vanadium oxide and 0.03% molybdite for 9.883Mt vanadium oxide and 0.845Mt molybdite (Intermin Resources Ltd, 2009)	Toolebuc Formation/ Eromanga Basin	Oxidised oil shale. Held under Exploration Permit by Intermin Resources Ltd.

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