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A REVIEW OF THE QUEENSLAND BUILDING STONE INDUSTRY

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COVER PHOTOGRAPH:

Old Global Marble quarry,Chillagoe Formation; now quarried by Carrington Marble.

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SUMMARY

The use of natural stone - granite, marble, sandstone and slate - as a building material has experienced a great resurgence of interest in Australia since the early 1980s; previously, the building stone industry had been fragmented, outdated, and of low capacity. Usage is still small by world standards, and Australia remains an import rather than export nation with at least half the requirements being met from overseas. This is despite new plants in southern States and an improvement in Australia's competitive position in international markets.

In Queensland, this renewed interest has resulted in increased exploration, reopening of several historic sources, upgrading of existing processing facilities, and proposals to develop new quarries and processing facilities in eastern Queensland by the mid 1990s. Whilst sandstone is the major product, followed by marble and slate, there is also increasing interest in locating granite resources.

The major sandstone resources, located between Helidon and Toowoomba and at Stanwell via Rockhampton, have been quarried for building purposes for the past 100 years and several new quarries have been established in recent times. The sandstone is used for external and internal cladding, landscaping and, more recently, for tiles. Sandstone is also quarried from the Gilbert River southwest of Cairns.

Marble is mined singly from the Chillagoe district in north Queensland, but deposits are known in the Gladstone hinterland and Warwick-Stanthorpe districts. Several companies are currently undertaking feasibility studies into quarrying and processing of marble blocks for slab and tile manufacture. Chillagoe marble has been exported in block form, and tiles and slabs for the domestic market are manufactured in Cairns. In central Queensland, several companies are currently undertaking feasibility studies into quarrying and processing marble for slab and tile manufacture. Marble was previously quarried at Ulam between 1919 and 1969. Small-scale production of limestone and marble chips for terrazzo has taken place in the Warwick-Texas area. There has been renewed interest in these deposits as a possible source of dimension stone.

Granite is quarried in small quantities near Stanthorpe, Gracemere, Mount Surprise and Mount Isa. The Australian demand for granite products has grown to over 400 000m^2 per annum, with domestic supply still meeting less than 50% of this demand. Potential export markets to Taiwan, Japan, U.S.A. and Italy exist for granite blocks as well as granite tiles, slabs and billets. As a result, several companies are investigating granite resources throughout the State, and feasibility studies are nearly completed for multi-million dollar granite processing facilities in southeast Queensland, Bowen and Townsville. Granite blocks are also road transported to interstate processing facilities, mainly in New South Wales and Victoria.

Small quantities of Slate are produced from a number of sources throughout the State for mainly local use as tiles, pavers, facing or pitching stone and landscaping purposes.

Welded tuffs or ignimbrites are quarried from a number of sources in the Herberton area for paving and landscaping purposes. Small quantities of basalt kerbstones are still produced from quarries at Toowoomba. Historically, Brisbane Tuff has been widely used in Brisbane buildings but this stone is now in short supply.

KEYWORDS: Building stones; ornamental stone; granite; marble; sandstone; siltstone; slate; schist; porphyries; volcanic rocks; volcanic tuff; quarrying applications; paving stone; standards; material tests; industry statistics; Queensland.

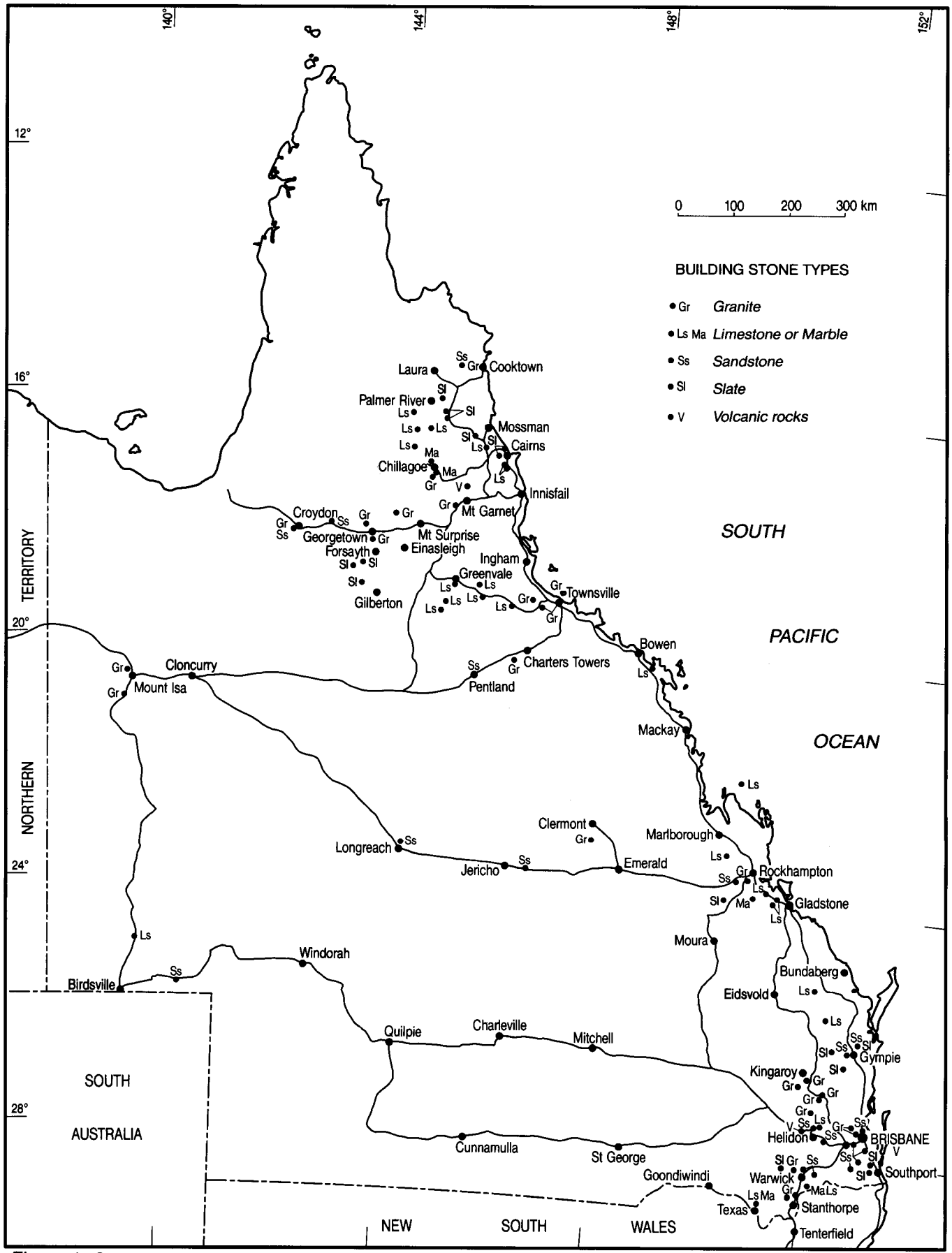

Figure 1: Queensland Locality Map

INTRODUCTION

DIMENSION stone is any naturally occurring stone which has been selected for trimming and cutting to specified shape and size, largely for application as building stone in the construction industry, and also as monumental and statuary stone (ASTM C119, 1983b). The definition includes dressed or finished stone and non-dressed stone, including sandstone, limestone, marble, granite, slate, siltstone and various volcanic rocks. Essentially, it encompasses any natural stone material that has the required durability, colour and texture for particular applications, and if it can be economically extracted.

Dimension stone is a premium building material for use as internal or external veneer or cladding, floor tiles and pavers, and masonry material (load-bearing), because of its natural beauty and diversity, and its durability in most applications.

The dimension stone industry in Queensland was virtually defunct from the late 1950s until the mid 1980s, when there was considerable renewed interest in Australian, including Queensland's, resources of building stone. Recent developments in New South Wales, South Australia and Western Australia, facilitated by an improved competitive position including devaluation of the Australian dollar and coupled with reported world demand for stone and depletion of some overseas (mainly Italian) resources (Allison, 1984; Robbins, 1986b), have led to an increase in the development of Australia's resources and establishment of export markets for marble and granite. Increased domestic and foreign demand for dimension stone has resulted in the construction of several new stone processing facilities in New South Wales, and similar plants are planned for commissioning in eastern Queensland by the mid 1990s.

The resurgence of interest in the Queensland industry - stone resources, quarries, producers and processing facilities - by local and overseas companies has been reflected by the substantially increased number of enquiries (on all facets of the industry) attended to by the Department of Resource Industries, (formerly Department of Mines). These enquiries have come from various groups including mining companies, entrepreneurs, stone masons, geological and financial consultants, and overseas trading houses wishing to identify and further develop known and new resources. To date, this advice to industry has been limited to descriptions of historic sources previously described by Richards (1918) and Wolff (1957), and by reference to numerous recent reports and records dealing with specific quarries, building projects, or regional commodity surveys. Such advice has often been inadequate, out of date and lacking the technical background relevant to current quarrying and processing techniques, standards and market requirements.

It was recognised in 1988 that a comprehensive review was required to encourage the establishment of a viable dimension stone industry in Queensland. The aims of the review were to raise the awareness of the availability and attractiveness of Queensland building stones, to promote possible market and business opportunities in value-added processing stone in Queensland, and finally to develop a better understanding of various facets of this integrated industry. These aims were achieved through extensive literature research and discussions with various industry groups, including most current quarry operators, producers, processors, stone masons, stone fixing companies, and retail outlets.

Field surveys of building stone quarries in eastern Queensland were commenced in late 1988 and completed in April, 1989. The data compiled on all building-stone quarries, historic or currently worked sources, and potential

future resources are presented in Appendices 1 to 5 and, eventually, this information will be included in a computer data base intended to maintain a current register of quarries and titles in the State.

The report describes all historic and current sources of building stone (sandstone, granite, marble, slate and volcanic rocks) in Queensland. All sources - current and historic - are outlined on the map (Page 2). Recent administrative changes are discussed. The Australian building stone industry, including both domestic and foreign trade statistics, is reviewed and current industry trends in quarrying, processing and building construction are discussed.

A further study is planned to commence later in 1990 to identify additional potential resources of premium building stones - black granite and the various coloured granites (blue, green, dark red, brown, white), gneisses and serpentinites. The massive, textured volcanic sequences such as the Bulgonunna Volcanics and Featherbed Volcanics of north Queensland are also discussed.

Testing, Standards and Specifications

There are no current Australian Standards for the testing of building stones for engineering purposes. However, in 1982, a working group (CE/12/6/4) was set up to establish methods for the sampling and testing of building stones (AS 2758, Part 7), and several draft methods: sodium sulphate soundness (full immersion), compressive strength, modulus of rupture, water absorption, effective porosity, block density and flexural strength, have been compiled and circulated for comment (Spry, 1988). In this draft standard, extensive reference is made to AS 1141 - Methods for Sampling and Testing of Aggregates, in order to maintain a degree of compatibility between the old and new standards. Most, if not all, of the above draft test methods exist in overseas standards, or at least are accepted by recognised authorities and testing organisations in Australia.

The American Society for Testing and Materials (ASTM) has published and revised a number of standards relating to natural building stones; an annual book of ASTM standards is published (Section 4, Volume 04.08). Such standards may refer to specific test procedures for all rock types or may specify limits for a particular stone type for a given use (external or internal). All relevant ASTM standards are listed in Table 1 and ASTM specifications in Table 2. They are a statement of a set of requirements to be satisfied by the material, product, or service and indicate the procedures for determining whether each of the requirements is satisfied. They are intended to be aids to the building stone industry and their use is voluntary.

The British Standards Institution has also published several standards (BS 435, 1240, 2847, 5390, 5534 and CP 298) which have been used as a guide by sections of the Australian stone industry.

The widely adopted ASTM Standard C119 (1983b) defines the standard terms (scientific and commercial) relating to building stones. Specific terms relating to the various rock types are described later (in Resources). It is quite apparent that in some sections of the stone industry, the commercial definitions of certain stone types (marble/limestone/serpentinite, and granite/metamorphic rocks) depart significantly from the standard geologic or scientific nomenclature, and care must be taken in their usage. Two useful glossaries of building stone and masonry terms have been published in the United States (Patton, 1974) and Great Britain (British Standards Institution BS 2847; 1957).

TABLE 1: AMERICAN (ASTM), BRITISH (BS) & AUSTRALIAN STANDARDS FOR DIMENSION STONES

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

C97-47	Absorption & bulk specific gravity of natural building stone.	Reapproved 1983 See AS 2758.7, draft method 7
C99-52	Modulus of rupture of natural building stone.	Reapproved 1981 See AS 2758.7, draft method 6
C119-50	Standard definitions of terms relating to natural building stones	Reapproved 1983
C120-52	Flexure testing of **slate** (modulus of rupture, modulus of elasticity)	Reapproved 1981 Refer also to BS 1240
C121-48	Water absorption of **slate.**	Reapproved 1981 See AS 2758.7, draft method 5
C170-50	Compressive strength of natural building stone.	Reapproved 1981 See ASTM 2938-78
C217-58	Weather resistance of **natural slate.**	Reapproved 1981
C218-48	Combined effect of temperature cycles & wash salt solutions on natural building stones.	
C241-51	Abrasion resistance of stone subject to foot traffic.	Reapproved 1981
C406-58	Standard specification for **roofing slate.**	Reapproved 1984
C488-88	Standard strength of anchors in concrete and masonry elements.	
C503-62	**Marble** building stone (exterior).	Reapproved 1989
C543-81	Specification for **slate blackboards.**	
C568-67	Standard specification for **limestone** building stone.	Reapproved 1979
C615-68	Standard specification for **granite** building stone.	Reapproved 1980
C616-68	Standard specification for **sandstone** building stone.	Reapproved 1980
C629-68	Standard specification for **slate** building stone.	Reapproved 1980
C880-78	Flexural strength of natural building stone.	Reapproved 1979 See AS 2758.7, draft method 5
STP887-87	Selection, purchase and delivery of building stone.	
STP996-88	Stone on precast or steel in wall design or construction.	
D2845-83	Laboratory determination of pulse velocities & ultrasonic elastic constants of rock.	
D2845-83	Pulse velocities and ultrasonic elastic constants of rocks.	
D2938-79	Unconfined compressive strength of intact rock core specimens.	
D3148-80	Elastic moduli of intact rock (core specimens) in uniaxial compression.	

BRITISH STANDARDS INSTITUTION

BS CP298: 1972	Natural stone cladding
BS 435: 1975	Dressed natural stone kerbs, channels, quadrants and setts
BS 2847: 1957	Glossary of terms for stone used in building
BS 5390: 1976	Code of practice for stone masonry
BS 5534: 1985	Code of practice for slating and tiling
BS 8298: 1989	Code of practice for design and installation of natural stone cladding and lining.

STANDARDS ASSOCIATION OF AUSTRALIA

AS1141	Methods of sampling & testing aggregates.	Sections: 4. Bulk density (Under revision) 6. Particle density & water absorption (Under revision) 24. Soundness (by use of sodium sulphate solution) ZZ. Secondary mineral content (In preparation)
AS2938	Compressive strengths.	
AS2758	Aggregates & rocks for engineering purposes.	In preparation Part 7: Building Stone Drafts of the following methods have been circulated (AS 2758.7) Method 3: Sodium sulphate soundness test (full immersion); 5: Compressive strength; 6: Modulus of rupture; 7: Water absorption, effective porosity & block density; 8: Flexural strength.
AS2904	Buildings: damp proof courses and flashings.	

TABLE 2: ASTM STANDARD SPECIFICATIONS FOR MARBLE, LIMESTONE, GRANITE, SLATE AND SANDSTONE.		Classification	Absorption (by weight), maximum %	Density, minimum t/m³	Compressive strength, minimum MPa	Modulus of rupture, minimum MPa			Abrasion resistance, minimum hardness	Acid resistence, maximum mm	Depth of softening, maximum mm.	
							Across grain, minimum MPa	Along grain, minimum MPa				
ROCK TYPE			C97	C97	C170	C99	C120	C120	C241	C217	C217	ASTM
Marble exterior (ASTM 503)	Calcite	I	0.75	2.595	52	7			10			Marble for exterior use should be sound, free of spalls, cracks, open seams, pits and other defects which may impair its strength, durability or appearence.
	Dolomite	II	0.75	2.80	52	7			10			
	Serpentine	III	0.75	2.69	52	7			10			
	Travertine	IV	0.75	2.305	52	7			10			
Lime-stone (ASTM C568)	Low-density	L	12.0	1.76	12	2.9			10			Limestone should be sound, durable, and free of visible defects or concentrations that will cause staining or weakening.
	Medium-density	M	7.5	2.16	28	3.4			10			
	High-density	H	3.0	2.56	55	6.9			10			
Granite (ASTM C615)			0.4	2.56	131	10.34						Granite shall be sound, durable, and free of defects such as starts, cracks, and seams, and free of minerals causing staining.
Slate (ASTM C629)	Exterior	I	0.25				62.1	49.6	8	0.38		Slate shall be sound, free of spalls, pits and cracks, or other defects that would impair strength and durability.
	Interior	II	0.45				62.1	49.6	8	0.64		
Roofing slate (ASTM C406)		S1	0.25				62.0				0.05	S1-service life over 75 years.
		S2	0.36				62.0				0.20	S2-service life of 40-75 years.
		S3	0.45				62.0				0.36	S3-service life of 20-40 years.

Testing of materials is an essential requirement throughout the process of resource identification, quarrying, processing, selection and final fixing of stone products. Far too many companies and individuals undertake minimal or even no testing of materials, thus placing the industry's reputation at considerable risk when an inferior stone fails. If the Australian stone industry is to expand into export markets then all stones will require certification of quality through comprehensive testing and past performance details. Quality control and recent failures are described by West (1989).

Testing may be preliminary, (during the resource identification and quarry development stage), or may be quite comprehensive with regard to selection

and procurement, product evaluation, marketing and architectural design. Nearly all testing is restricted to the physical and chemical attributes of the stone, to predict its likely service performance, particularly in situations where new stone products have no history of use. It should be noted that there is a risk of eliminating a satisfactory stone now in use on the basis of these tests. Tests (especially empirical tests) are only a guide to a particular stone's likely performance in use. In addition, a test sample from a large rock mass cannot truly represent the entire rock mass with any degree of certainty as natural stone is rarely homogeneous.

The physical and chemical properties of a stone are primarily dependant upon its mineral composition, texture (grain size, shape, arrangement and bonding), structure (foliation, bedding, jointing) and the weathering processes to which the rock has been subjected. These inherent properties cannot be changed. All stone is required to be durable, dimensionally stable and chemically inert, able to resist disintegration by mechanical stress, and to resist decomposition by natural weathering and other chemical agents (acidic rain, pollutants).

Producers and manufacturers, therefore, desire satisfactory methods by which the durability of a stone may be determined in terms of physical constants. Natural weathering processes are too slow, so laboratory tests have been devised to accelerate the natural processes and to compensate for time. Nevertheless, it is evident that caution is needed in the interpretation of test results pertaining to untried sources of stone, and that there is no substitute for prolonged performance testing over a range of conditions of exposure and application.

The aim of any test procedure for the selection of stone is to ensure that the stone is durable, and that no significant chemical reactions or physical changes will occur during its specified use. The desired properties of dimension stone will differ for intended uses, be they exterior or interior cladding, monumental, statuary or paving applications. Generally, colour, texture, pattern and durability and strength are the main criteria for stone selection.

Amdel has published comparisons of the physical properties of Australian sandstones (Spry, 1983) and marble (Spry, 1986). Widely or commonly practiced standard test procedures for stone and interpretation of quantitative limits are reviewed by Spry (1988, 1989), and are briefly summarised below.

Selection is commonly made on the general **appearance** of the stone - its colour, texture, structure and lustre. Colour is probably regarded as the most important criteria, and does not affect application of the stone unless it indicates the presence of deleterious minerals. The colour will depend on the mineral composition, presence of pigments, grain size, and surface finish of the end product. Polished crystalline rocks are often darker, whereas tooled stone (bush hammered, sawn, or honed) may be lighter coloured. Colour changes are noted along joint and fault planes, and some stones change colour shortly after exposure due mostly to oxidation and, to lesser extent, dehydration.

Ideally, dimension stone should be **massive** (structureless) - essentially homogeneous throughout with an absence of defects. Thin bedding, banding and foliation surfaces, joints and cleavage, will limit the size of extractable blocks.

Lustre is important in polished stone, where grains or crystals of mica, calcite, feldspar and quartz reflect light which adds to the beauty of the stone.

Durability is not easily defined and is not measurable by tests in terms of years. It is related to the lasting qualities or 'service life' of the stone for a certain use; it is not a function of hardness. A durable stone for internal use (marble), may not withstand exposure to the elements in external environments.

Soundness tests (AS 1141.24, and AS 2758.7) or sodium sulphate soundness test are normally carried out if there is insufficient data on the weathering performance of stone; the quantitative losses allow classification of sandstones (Spry, 1989). Only small weight losses are recorded with the more durable stones such as granite, marble and slate. This is quite a severe empirical test for stone exposed to extreme environmental conditions or for stone prone to soluble salts and susceptible to loss of soundness.

Specific gravity and bulk density (ASTM C97, 1983a; AS 2758.7, (7)) provide a comparison with similar stones which have a satisfactory service history. Low values may also indicate the presence of deleterious minerals and may be associated with weak and absorptive stone (Martin, 1981).

Porosity (ASTM C97, 1983a; AS 2758.7,(7)) refers to the volume of pore spaces between grains (Currier, 1960) and is measured by the amount of water absorbed by a standard-sized specimen. Porosity should be low for exterior stone applications (Spry, 1989). **Absorption** is the amount of water a stone will absorb upon immersion. Both values are dependant on the shape and size of the grains. Generally, rocks of dense or compact textures (interlocking or mosaic) have low porosities; they include commercial granites, marble and some slates and quartzites.

The **compressive strength** or crushing strength (ASTM C170, 1981b; D 2938, 1979c; and AS 2758.7) is a measure of the stone's ability to support load-bearing structures. It has been used as a method of distinguishing durable and less durable sandstone (Wallace, 1971; Spry, 1983) but has little significance where the bulk of the stone for construction purposes is now used as non-load bearing cladding or veneer. In most cases, compressive strengths are reduced in saturated or wet conditions, a point to be considered where external application of the stone is being considered. Spry (1989) classified stone on strength (dry compressive strengths) from very weak (<7 MPa) to very strong (140MPa).

The **flexural strength** (or modulus of rupture) is a very important factor in the design of thin veneers (Spry, 1989); values range from less than 1MPa (very weak) to over 14MPa (very strong stone). The standards (ASTM C 99, 1981d; C120, 1981e; C880, 1978; and draft AS 2758.7, (6)) test for transverse strength by measuring the flexural strength due to uneven pressure or bending of the stone.

Secondary mineral content is a quantitative estimate of the secondary deleterious minerals present in the stone. These minerals may result in dimensional instability, chemical reactions, solution cavities, loss of strength and colour changes. Microscopic examination for deleterious minerals is applicable to igneous rocks and sandstones. Small proportions of salts (0.5%), sulphide (2 to 3%) and clay (3%) may cause deterioration (Spry, 1989). Martin (1981) made the point, that petrological examination can be very cost-effective in quickly identifying potentially faulty stone, and that when done up front as part of an initial reconnaissance, this 'test' alone could be adequate to rule out material proposed for external use.

The **hardness** of a stone depends on the relative proportion of minerals, binding or cementing minerals, texture and porosity. A dense, interlocking-textured stone will display a greater resistance to pressure by impact than a loosely bound, porous stone. Toughness or resistance to impact (point load) is rarely measured in stone.

Abrasion resistance is an important factor in determining the suitability of softer stones (sandstone, limestone and marble) for use as paving materials. Several test procedures have been developed to measure the abrasive hardness or resistance of stone - Taber test (ASTM C2240), Kessler (ASTM 241) and pendulum friction test (AS 1141, (42)). The minimum Taber abrasion values are light-duty domestic (8), light commercial (12) and heavy duty (15) (Spry, 1989).

Present Administration of Building Stone Extraction

Stone in block form for building purposes is not a mineral as defined by the *Mining Act 1968-1986*, and the Department of Resource Industries has no direct control over the quarrying of these materials. However, there are several exceptions to the above Act and these are:

1.The Governor in Council may declare any substance to be a mineral for the purposes of the Mining Act (s.7(2)). Such cases include the following:

- Within the Chillagoe Mining Field of north Queensland, marble has been declared to be a mineral and its extraction is only permitted from Mining Leases (Order in Council, March 1985).
- Under section 7(2) of the Act, granite and slate in block form were declared to be minerals when occurring on Mining Lease 6964 (Herberton) (Order in Council, 31.7.1986).

2. Prior to the 1st January, 1977, stone in block form was defined as a mineral under this Act but was removed from the Mining Act (Government Gazette 14.12.1976). Several Mining Leases granted previously for stone are still in force.

3. By definition, stone is a mineral under the *Mines Regulation Act 1964-1983*; which provides for the safety and health of persons working in or about mines or major quarries (5.6 (2)a). Such quarries must comply with the provisions of this Act and are inspected regularly by Department of Resource Industries Inspectors.

Building stone quarried from Crown Lands is administered by the Queensland Forest Service, and under provisions of the *Forestry Act*, the Conservator is empowered to sell any quarry material which is the property of the Crown on all Crown lands and holdings, State Forests, Timber Reserves, Forest Entitlement Areas and all lands granted in trust or reserved for or dedicated to public purposes.

Quarry material is defined under the Forestry Act as any materials - stone, gravel, sand, clay, earth and soil; it does not include minerals within the Mining Act.

Under this Act, a Permit to Search may be granted giving the holder exclusive rights to search for quarry materials. It does not imply that the holder will be automatically granted a quarry sale within the permit area. Further, the holder may be given authority to conduct an investigation survey to determine the quality and extent of the resource, and after such survey, the holder may submit an application for a non-competitive sales permit.

The Conservator of Forests is not empowered to sell quarry material on any Mining Lease, other than a lease over the whole or part of a State Forest or Timber Reserve.

Within private or freehold lands, the Local Authorities under provisions of the *Local Government Act* regulate quarries not under the control of State Government Departments. The issue of extractive industry permits must abide by town-planning by-laws of the Local Authority. However, in some cases, such control may also apply to Crown holdings and other Crown lands and it is recommended that all major quarry material sales agreements under the Forestry Act provide for the purchaser to comply with the lawful requirements of the relevant Local Authority.

New Mineral Resources Legislation

The Department of Resource Industries has adopted a complete review of the mining legislation and associated procedures. The new *Mineral Resources Act* has been passed by Parliament but not yet proclaimed.

Under provisions of this new legislation, the definition of *mineral* has been widened to include 'rock mined in block or slab form for building purposes and marble'. The Crown's property in minerals has been retained.

Further, all land other than National Parks and Environment Parks is divided into two categories:

- occupied land is all land whether freehold, leasehold or reserve (including

Deeds of Grant in Trust for aboriginal and islander inhabitants) for which there is an owner; and

- unoccupied land.

The benefits of the new Act include greater security of title through mining leases, improved access to land for the purposes of prospecting, exploration and mining, and finally to minimise land-use conflicts by encouragement of multiple land-use practices. Protection of existing infrastructures such as dwellings, buildings, dams, bores and other artificial water storages are incorporated in the Act.

For prospecting and full-scale exploration, exploration permits for all minerals other than coal will be granted for a term of up to 5 years. The new exploration title is based on the provisions of the existing legislation relating to Authorities to Prospect.

A new initiative without equivalent in the existing legislation is the Mineral Development Licence with maximum initial term of 5 years. This licence will only be available to the holder of an exploration permit who can satisfy the Minister of the existence of a significant zone of mineral potential needing further studies before mining. This would give the holder priority for consideration for the granting of a Mining Lease, but not the right to mine.

Savings Provisions

Any persons lawfully extracting rock in block or slab form for building purposes prior to the proclamation of this Act will be required, within 3 months of that date or such longer period as the Minister approves to apply for a Mining Lease. Until the Mining Lease is determined that person may continue to operate under the authority held at the date of commencement of the new legislation.

Royalty

Under the Mineral Resources Act the following payment of royalty provisions are proposed

- in respect of any Crown land (either occupied or unoccupied) royalty will be payable to the Crown at the rate prescribed pursuant to the proposed legislation; and
- in respect of all other land (where the Crown has the property in the mineral) for which there exists an agreement except that where the amount paid to the owner is less than that prescribed pursuant to the proposed legislation, the difference shall be payable to the Crown.

Previous Investigations

Stone for construction or building purposes has been widely used throughout Queensland since 1825, but very little information has been published on these sources of stone during the latter half of 1880s.

One of the earliest reports on the sandstones of the southern districts of Queensland was prepared by a Select Committee appointed by the Queensland Legislative Assembly (Anon, 1888). Ball (1905) briefly mentions important granite and marble resources being developed at that time, but the section on sandstone was incomplete.

The comprehensive work of Richards (1918) describes in considerable detail the major building stones and their architectural use in Queensland. Nearly 40 years later, Wolff (1957) updated and summarised the then current information on building stones. Numerous reports have been published on specific building stones, buildings, restoration projects and these are described separately in the following sections of this report.

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QUEENSLAND RESOURCES AND PRODUCTION

Sandstone

Sandstone is a sedimentary rock made up of transported quartz and feldspar grains, and rock fragments within the sand-size range of 0.0625 to 2mm. The matrix or binding materials may be the fine-grained weathering products of the source rocks (clay or argillaceous material), or a secondary cement such as calcite, silica, or one of the iron-oxides (ASTM C119; 1983b). For building purposes most sandstones are composed largely of quartz grains, with 60 to 90% free silica (Class I) as detrital quartz grains or authigenic silica (ASTM C616; 1980). Siliceous or quartzitic sandstones (Class II) and quartzites (Class III) are much harder and difficult to work, but they are more durable.

Sandstone is initially classified according to grain size

Coarse to very coarse-grained: 0.5 to 2.0mm

Medium-grained: 0.25 to 0.5mm

Very fine to fine-grained: 0.0625 to 0.25mm

and by mineralogy (quartzose, feldspathic, or labile) or rock fragments present (arenite, arkose). Components of coarser sediments (such as rudite, conglomerate and breccia) are termed granules (2-4mm), pebbles (4-64mm), cobbles (64-256mm) and boulders (>256mm).

Most Australian sandstones (for building purposes) are fine-grained, quartzose and massive (Spry, 1983); the light yellow, yellow, and brown sandstones being the most highly sought after materials.

ASTM C616 (1980a) sets out recommended minimum values for density, modulus of rupture, compressive strength and abrasion resistance, together with maximum value for absorption by weight (Table 2).

The strength of sandstones is largely dependant on the proportion of quartz-quartz to quartz-clay boundaries, and the ratio of clay to quartz (Spry, 1983). Compressive strength or the ability of the sandstone to bear a load may indicate durability; Wallace (1971) has demonstrated a division at 40MPa between durable and less durable sandstones. Dry compressive strengths for strongly cemented sandstones exceed 70MPa; while moderately cemented stone have a range of 34 to 70MPa (Spry, 1983).

Sandstones with a bulk density less than 2.2t/m^3 are often of poor quality (Spry, 1983), but Wallace (1971) has found that bulk density alone is not a reliable indicator of durability. Quantitative results from soundness tests have been used as a basis for the classification of sandstones (Spry, 1989): the poorer quality stone for domestic use have losses (by weight) exceeding 10%. The desirable porosity values for sandstone (external applications) range from 8 to 12%; durability is lower in those sandstones with high porosities (Spry, 1989).

Many of Queensland's historic buildings were built of local sandstone and today, architects are eager to recapture the aesthetic qualities of character in modern buildings. The use of natural sandstone as a building material is gaining popularity in Queensland and the building stone industry is gearing up to meet this growing demand.

This renewed interest has resulted in the reopening of several historic sources (Helidon and Stanwell) and the upgrading of existing quarries and processing facilities at Helidon. Sandstone is now widely used for both interior and exterior cladding on buildings, and in domestic and commercial areas as floor tiles, pavers, furniture, bench tops and stair treads.

Sandstone production, in particular, has reflected the demand for quality building stone and is the highest for any Queensland stone, followed by marble and slate. Granite production is anticipated to continue to rise within the

next few years. A major factor of the sudden increase in production has been the demand from large development projects including Bond University, tourist resorts (Sanctuary Cove and Sheraton Mirage, Gold Coast), and from restoration works including St. Stephen's Cathedral and St. John's Cathedral, Brisbane.

It is difficult to determine accurate production figures, but industry sources put the total production of quarried sandstone for 1988/89 in excess of 19,000t. This represents an increase of nearly 11 000t over the previous year. Sandstone tile production is estimated to be nearly 40 000 square metres a month, retailing at $30 to $60 a square metre for 20mm tiles and $110 a square metre for 75mm blocks. The larger producers anticipate increased growth in export markets. At present, Queensland sandstone is exported to Japan and New Zealand; negotiations are continuing for possible sales to other South East Asian countries including Singapore and Taiwan, and also to the United States.

Sandstone production is centred in the Helidon district, west of Brisbane, where stone for building and monumental purposes has been quarried for over a hundred years. The major producers are J.H. Wagner and Sons Pty Ltd, Helidon Sandstone Company, Comerford Sandstone, Lockyer Sandstone and R.C. Ziegler Quarries. Most of these companies have undertaken expansion of their quarry operations and have invested in upgrading and expansion of processing plants to meet increased demand for stone. In most cases, mechanisation has been the major contributor to increased production. In recent years, sandstone quarries have been opened on the Gilbert River west of Georgetown (Ribbonstone Pty Ltd) and near Gympie (Anderleigh Quarries). In 1988, the historic Stanwell quarry, west of Rockhampton, was reopened by Stone Products Pty Ltd.

The earliest report (Anon, 1888) on sandstone resources resulted from the inquiry into the sandstone quarries of the southern district (Brisbane, Helidon, Mount Sturt and Beaudesert), and was completed by a Select Committee appointed by the Queensland Legislative Assembly. Many of these now abandoned sandstone quarries of the Moreton region were important sources of stone for our historic buildings. Sandstone quarries of the Brisbane-Ipswich area were briefly described by Rands (1890), Richards (1918), Houston (1967), Wolff (1957) and Willmott & others (1979), and in the Beaudesert area by Marks (1910) and Willmott & others (1978). Sandstone resources and quarries in the Helidon and Murphys Creek area were described by Zahawi (1979), O'Flynn (1980), and Willmott (1979).

Quarries have been opened recently in the Gympie area (O'Flynn & Graham, 1987). The Stanwell quarry west of Rockhampton was inspected by Willmott (1976), Trezise (1982, 1989) and Trezise & others (1983). Sandstone resources of western Queensland were briefly reviewed by Jauncey (1965), Vine & Doutch (1972), Senior (1973) and Doutch (1977). Sandstone (or silcrete) for use in the Stockman's Hall of Fame, Longreach, was evaluated by Draper (1983). In far north Queensland, sandstone resources of the Cooktown hinterland were briefly described by Lucas & de Keyser (1965).

A summary of all known sandstone sources is given in Appendix 1; The more important current producing areas are described in detail below.

Georgetown

Small quantities of sandstone for building stone purposes have been quarried from the Gilbert River homestead, west of Georgetown. The sandstone, which occurs in the Late Cretaceous *Coffin Hill Member*, is fine grained and variously coloured (in bands or ribbons) from cream through to red, brown, and grey.

Stone has been quarried from this area since the early 1970s, but the only current operations are the shallow pits near Rockfields homestead occasionally

worked by Ribbonstone. Large blocks (up to 3m long) are excavated and stockpiled on site; their thickness is usually less than 1 metre due to bedding and micaceous laminations. Bands of iron oxide (limonite and goethite) are common. Resources remaining in this area appear to be large but haulage distances to the company's processing plant in Cairns may be prohibitive. The stone is cut using block saws to manufacture tiles, random and crazy pavers, and furniture for local and export markets.

Gympie

The Late Triassic to Early Jurassic *Myrtle Creek Sandstone*, the basal unit of the Maryborough Basin, crops out extensively north and east of Gympie. This unit comprises basal conglomerates overlain by sequences of shale, carbonaceous shale, siltstone, sandstone and minor coal seams. A thick sequence of medium to coarse-grained sandstone and minor interbedded finer sediments was deposited over broad plains by braided streams. In 1887, sandstone was quarried from the Rocks, Heron Road and Scrubby Creek area for building stone, but current quarrying is restricted to the Anderleigh quarry.

Anderleigh Quarries has developed two quarries in the Myrtle Creek Sandstone about 20km north of Gympie, but only the eastern, small to medium sized quarry is still worked, where three thin sandstone beds are exposed in 4.5m high quarry face. The stone is medium to coarse grained, quartzose, and white to light grey-brown; it is poorly cemented (O'Flynn & Graham, 1987). The stone is sawn at the company's nearby slate plant where colonial blocks (ashlar), facing or pitching stone and pavers are produced. Its durability as a paving material in heavily trafficked areas is suspect due to its poor cementing characteristics. The material is marketed locally and in Brisbane; production is small, in the order of 1000t/year.

Helidon

During Late Triassic to Early Jurassic times, the *Helidon Sandstone* (part of the Bundamba Group) was deposited in the Moreton Basin as fluviatile sands in a sheet-braided system (Day & others, 1983; Carmichael, 1987). The resultant sandstone now forms a broad plateau north of Helidon. The plateau margins are deeply incised, particularly to the west (Alice Creek) but elevations gently slope away towards Helidon, generally reflecting the regional dip of bedding. This unit comprises quartzose sandstone, siltstone, shale and conglomerate. In general, the sandstones are massive, medium to coarse grained, with a clayey or argillaceous matrix; conglomeratic bands and conglomeratic sandstones are common. Cross-bedding is apparent in some areas. Environments of deposition of the various lithofacies within the Helidon Sandstone and mechanisms for the formation of liesegang banding were studied and described by Carmichael (1987).

It is likely that the banding and 'salt and pepper' patterns in the sandstone were derived from the same parent material-weathered biotite in both cases. The quarryman's term 'salt and pepper' refers to the numerous small (less than 1mm) patches or spots of darker brown limonitic material which in some instances represents up to 25% of the stone. Fluids migrating through the rock take into solution iron oxides (goethite and hematite), the products of weathered biotite and, due to pH changes, redeposit them elsewhere in the formation as concentric darker coloured liesegang bands or along joint surfaces. Jointing appears to be an important mechanism in the process. If there is insufficient migrating fluid, these oxides remain *in situ* and thereby develop the 'salt and pepper' pattern. Generally, bedding has not influenced the deposition of liesegang bands.

For well over a hundred years, fine to medium-grained sandstone of this unit has been quarried as either 'Helidon

Sandstone' or 'freestone' for construction purposes. The stone is widely used as a facing stone in many of the State's historic Government and commercial buildings, as well as in the University of Queensland, St Lucia. Monumental stone is also sourced from this unit.

All 'Helidon Sandstone' quarries appear to be located in the same stratigraphic unit (Carmichael, 1987), a massive medium-grained sandstone which occurs towards the top of the unit. This stone's colour varies from the sought after light brown to pink, mauve, white and light grey. In the Murphys Creek area to the northwest, a much paler and coarser variety of this medium-grained stone - *(Murphys Creek Sandstone)* appears to represent the stratigraphically uppermost section of the Helidon Sandstone. The sandstone is white to light grey, and the concentric liesegang banding is absent (Willmott, 1987). Previously, it had been quarried for building stone between the 1870s and 1900, but all quarries were abandoned for many years until the recent demand for sandstone generated local interest in possible reopening of several quarries.

The earliest documented report on the Helidon quarries is that of the Select Committee (Anon, 1888). Later reports by Richards (1918) and Wolff (1957) reviewed the stone industry and described the physical properties of the Helidon Sandstone. Further, there have been many reports by Government geologists on specific quarries and resources in the Helidon area including those by Dunstan (1923), Morton (1927, 1928a), and Denmead (1943, 1945). The detailed study by Willmott (1987) not only updated the earlier work of Zahawi (1979) and O'Flynn (1980), but also outlined the extent of sandstone resources in the area for future planning purposes. A comparison of Australian sandstones, including Helidon Sandstone, was published by Spry (1983).

In the past two years, most sandstone quarrying companies in the Helidon area have expanded their quarries and modernised their processing facilities. The major producers are described below.

In 1988, **J.H. Wagner and Sons Pty Ltd** invested $2.8 million on new machinery including large diameter diamond block saws and profiling machines for its Toowoomba based operations. Only last year, the Company outlayed a further $400 000 for a custom-made crawler-type trenching machine to increase production from its Helidon quarry (previously the old Wright's quarry), probably the largest quarry (Figure 2) in the district and operated by this company since 1963. The large 8t blocks are cut from several benches using trenching machines and transported to Toowoomba for processing. Sandstone tiles (minimum thickness 30mm), pavers, blocks (75mm), furniture, benchtops, landscaping rocks, and monumental stone are manufactured as well as a wide range of granite and marble products using other Australian or imported stones. Helidon Sandstone has been supplied by this company for Jupiters Casino (Surfers Paradise), Hayman Island Resort, Bond University (Gold Coast) and St. Stephens Cathedral restoration work. Richards (1918) describes many of the Brisbane buildings constructed on stone from this quarry. Large resources are present on the company's land, and extend into adjacent State Forest (Willmott, 1987).

The **Helidon Sandstone Company Pty Ltd** purchased Spratt's quarry (formerly Jude's, University and in part the old State quarries) in the latter part of 1987. Initially, the 4t blocks cut using leased trenching machines were sent to the company's processing plant at Bethania (south of Brisbane) where a range of floor and cladding tiles (15 to 50mm thick), slabs, crazy pavers (offcuts from the tile plant), blocks and furniture were manufactured.

The stone was marketed nationally and overseas by Helidon Hogg Sandstone Co, Sydney, with interest shown by U.S., New Zealand, Japan, Singapore and Hong Kong distributors. Examples of local

developments using this stone include Sheraton Mirage Resort (Port Douglas) and The Boardwalk (Breakfast Creek). In late 1989, the company was sold to a Sydney based group but retained the name Helidon Sandstone Company. A new plant was opened at Wacol producing a range of tiles and pavers (minimum thickness 30mm), stair treads and furniture in banded brown, brown, or mauve sandstone. Export sales to Japan, U.S.A. and New Zealand have been made. At full production, the plant will process about 100t of sandstone per week. Resources are large (Willmott, 1987).

In 1985, Mr. T. Comerford of **Comerford Sandstone** purchased the southern of two properties owned by Mr Spratt (Portion 85, Helidon) on which were situated large sandstone resources (Willmott, 1987) and the old Millers, Jude's and State quarries (part only). Initially, wide-cut trenching machines with associated high wastage were used to obtain blocks up to 20t. Brown, mauve, white and 'salt and pepper' sandstone is sawn and milled on site to manufacture tiles (20 to 35mm), table tops, blocks and landscaping materials (Figure 3). Recently, the company has installed larger capacity diamond saws. In April 1990, the Company made its first shipment of sandstone tiles to Japan, where domestic construction industry is increasing and there is a preference to use natural stone. Locally, it has found use in the Port Douglas Sheraton Mirage, shopping centres (Canberra), Townsville TAFE, and restoration of Dutton Park cemetery.

Mr W. Corrigan's company, **Lockyer Sandstone**, developed three small quarry faces in Helidon Sandstone on his property, 4km northeast of Helidon. Sandstone occurs in a thin bed (less than 4m thick) between coarse-grained sandstone and conglomeratic sandstone. Willmott (1987) reported small to moderate resources in the deposit. Blocks were transported to a processing plant at Gatton where they were sawn (diamond block saw) into tiles, thin slabs, blocks, crazy paving and monumental stone. The coarser and conglomeratic material is hydraulically split into 'colonial blocks' with a slight pebble texture.

In May 1989, the company was purchased by **Australian Stone Consultants Pty Ltd**. The name Lockyer Sandstone has been retained, and the company has relocated to near Helidon and substantially upgraded its processing plant. In the long term, the company plans to increase tile production from the current 800m^2/week to 3 000m^2/week, of which over 90% will be exported to New Zealand, Singapore and America.

Stanwell

The Stanwell quarry, 3 km south of Stanwell, is one of several old quarries worked in this area between 1883 and 1916 for use in many important Rockhampton buildings (Richards, 1918; Wolff, 1957). Willmott (1976) reported production by F.M. Allan & Co and , after a period of disuse, **Stone Products Pty Ltd** reopened the quarry in 1988.

The quarry is situated in a cliff-bounded outlier of the Early Jurassic *Razorback beds*. The lower sequences are dominated by quartzose sandstone with minor conglomerate, mudstone and siltstone; cross-stratification is rare (Kirkegaard & others, 1970). The sandstone is medium-grained and light brown, with a silica cement. Discontinuous thin bands of haematite concretions occur in the upper quarry faces. Immediately west of the quarry, cross-stratified sandstones of the upper sequences can be observed. Silty interbeds and claystone laminae occur throughout this upper sandstone, negating its use as a building stone.

The stone, marketed as 'Capricorn Sandstone', is worked from several benches in the quarry face (Figure 4). Blocks are cut from the face along a series of vertical and horizontal percussion holes, using feathers and wedges to break the blocks free. The blocks (2.2 x 1.2 x 1 m) weighing up to 7t are transported to Parkhurst

(Rockhampton) for processing. Here, a gangsaw with 22 blades reduces the blocks into 25 to 50mm thick slabs which are then passed through a diamond block saw to produce building blocks and tiles. Blocks currently being produced are 110mm x 300mm, with random lengths. Until recently, a large proportion of uncut blocks was sent to the Sydney and Gosford plants of Melocco Ltd for cutting. This stone is used for monumental and restoration work.

Two types of stone are obtained from this quarry: brown stripe from the upper quarry and light beige from lower levels. The stone works well, weathers cleanly and takes a fair arris. The average grain size is about 0.5mm but grains up to 1mm are observed. The clast to matrix ratio is approximately 80:20, and is dominated by quartz (40 - 50%) and lithic fragments (40%); muscovite, feldspar, garnet, apatite and haematite account for the remainder.

The large resource of sandstone in the vicinity of the quarry will maintain anticipated production rates for the medium to long term.

Granite

In scientific terms, granitic rocks are relatively coarse-grained, intrusive, igneous rocks normally composed of quartz, two feldspars (alkali feldspar and plagioclase), and mica which have crystallised from molten material. They include 'true granite', adamellite and granodiorite (Streckeisen, 1973). Terms indicating the absolute range of grain size (crystal diameter) are:

Pegmatitic .....**> 30mm**

Coarse-grained ..... **5 to 30mm**

Medium-grained ..... **1 to 5mm**

Fine-grained ..... **< 1mm**

Some petrologists also refer to very fine-grained rocks (< 0.05mm). Porphyries consist of a fine-grained groundmass containing larger crystals of one or more minerals.

In commercial applications, the term 'granite' may also include gneiss - a foliated, crystalline rock - and the dark, granular igneous rocks (basalt, dolerite, gabbro, diorite, anorthosite and norite) commonly referred to as 'black granite' (ASTM C119; 1983b); The latter are not true granites as they contain little or no quartz and alkali feldspar, but are composed largely of calcic-plagioclase and one or more dark rock forming minerals such as biotite, hornblende and pyroxene. The characteristics and physical requirements for the selection of granite for building and structural purposes are outlined in ASTM C615, and parts of this standard are reproduced in Table 2. Commercial classifications (Diamant Boart S.A.) are based on Shore's hardness value and quartz content. **Group I** granites (Rustenburg and African black) are low-quartz bearing materials with hardness less than 95; **Group II** have hardness values between 95 and 105; **Group III** are the high-quartz bearing granites (Rosa Sardo & Balmoral) with hardness greater than 105. They have been adopted by several Australian producers.

For all applications, the granite must be sound, durable, and free of defects or imperfections such as joints, veins, cracks and microcracks (in larger crystals) which would impair its structural integrity (reduced flexural and compressive strengths) or allow transmission of fluids (increased permeability). The stone should be relatively free of deleterious minerals such as secondary minerals resulting in dimensional instability and sulphides causing discolouration and instability. The maximum acceptable sulphide content varies from 2% (Spry, 1988) to 3% (I. Wallace, personal communication, 1988).

Colour, texture and pattern are the most important criteria for selection of granite. The presence of dark, basic xenoliths or bedrock inclusions are not

acceptable, even though such materials may have no effect on the stone's strength or durability. Worldwide, there appear to be two distinct market categories for granite, based solely on colour. The first or premium grade granites are the so called 'exotic' stones - the black, dark red, blue, and coloured granites (yellow, green and brown) which display depth of colour, take good polish and exhibit the desired durability. Stone from this group is priced at up to $1000/m^2$. The second category includes the more common and readily available grey and pink granites (granodiorite, adamellite, alkali granite) which retail at between $300 and $600/m^2$ in highly competitive markets.

Many of the patterned granites are finding greater use in architecture because of their random and unique patterns; they include orbicular gabbros (Figure 5), rapakivi textures, porphyries, migmatites, and gneissic granites.

There has been a marked increase in exploration activity for granite resources throughout eastern Queensland and in the Mount Isa region. Several companies are proposing to establish new quarries, and feasibility studies are progressing for multi-million dollar processing facilities in eastern Queensland, with production anticipated by the mid 1990s. A promising future is forecast for the quarrying and processing of granite, both for domestic use and for export.

Granitic intrusions are widespread in eastern Queensland, ranging over many thousands of square kilometres. Their distribution is depicted on the Queensland geological map, and the units are described by Day & others, (1983), a comprehensive companion volume to this map. Most 'granitic' rock types are represented in the State.

The Australian demand for granite products has grown to over 400 000m^2 per annum, with domestic supply still meeting less than 50% of this demand (Flynn, 1988a,b). In addition, potential export markets to Taiwan, Japan, U.S.A. and Italy exist for granite blocks and possibly tiles, slabs and billets.

In Queensland, granite is quarried in small quantities at Gracemere, Pozieres, Mount Surprise and Mount Isa. Previously, granite has been quarried from locations near Brisbane, Ipswich, Greymare (via Warwick), Crows Nest, Blackbutt and Townsville. These sources were briefly described by Ball (1905), Richards (1918) and Wolff (1957); some may still be available for exploitation.

The major granite producers in Queensland are reviewed below; historical sources and those resources not yet developed but for which a permit or quarry sale has been issued are listed in Appendix 2.

Brisbane

The widespread distribution of granitic intrusions in the Brisbane region is outlined on the Moreton Geology 1:500 000 map. These granitic rocks display considerable variation in rock type and degree of weathering.

In the past, granite has been quarried northwest of Brisbane at Ashgrove, Camp Mountain, Samford and Cedar Creek (O'Flynn & others, 1983). However, it is unlikely that these sources could be reopened because of environmental constraints and urban development. The Ashgrove quarry is within a residential area of Brisbane and is now abandoned. The Samford, Camp Mountain and Cedar Creek quarries are within rural-residential areas of the Pine Rivers Shire and it is the policy of the local authority to prohibit the establishment of extractive industries in these areas.

The granite quarry previously worked in the Kholo Creek area (via Ipswich) is within a large granite deposit of future potential for quarrying for aggregate (Willmott & others, 1979). Most of this area is owned by either BMG Resources Ltd or Pioneer Concrete (Queensland) Pty Ltd, leaving little if any for the development of an independent quarry.

Crows Nest

In the Crows Nest area, stone has been previously quarried from the *Eskdale Granodiorite* (Anduramba quarry) and *Crows Nest Granite* (Ravensbourne or Ulam Carrara quarry) for building and monumental stone (Dimmick, 1949; Wolff, 1957; O'Flynn, 1980).

Over the past two years, there has been a considerable amount of exploration for possible granite resources in the large Permian to Triassic granite batholiths represented by the Crows Nest Granite and Eskdale Granodiorite.

In late 1988, **Jalsign Pty Ltd** obtained extractive industry permits to commence quarries at Bluff Mountain (a Tertiary dolerite intrusion) and on Austin's property (Portion 71V, Djuan) covering a small area of Eskdale Granodiorite. Although sample material of 'Austin Red', (a coarse-grained, dark pink granite) was forwarded interstate (to Granites of Australia and Melocco) and overseas for assessment, no quarrying or production was recorded. More recently an extractive industry permit has been issued to **Lachlan Valley Granite**, a New South Wales based company with considerable expertise in granite quarrying for the building stone industry. Production is expected to commence in the mid 1990s; the bulk of the blocks will be transported to Sydney for processing by Melocco.

Potential granite deposits in the Crows Nest Granite, 2 to 3km east of Crows Nest (Portion 22V, Crows Nest) were described by Dimmick (1949). These were found to outcrop well, as large exfoliated sheets of fresh to moderately weathered, medium to coarse-grained biotite granite. However, the stone is closely jointed, (in some outcrops, joint spacings are less than 10cm) and therefore of little or no use as building stone.

In May 1989, **Marlborough Gold Mines Limited** and **Pavstar Pty Ltd** entered into a licence agreement with **Nknda Pty Ltd** granting rights to quarry and market black granite building stone from the Nukinenda deposit, some 25km north of Crows Nest. The medium-grained, black, porphyritic quartz gabbro occurs in a dyke in the marginal or contact zone of the Eskdale Granodiorite. The company is planning to quarry 6t blocks initially, but blocks from 10 to 20t will be extracted later using closed-spaced drilling methods, and either feathers and wedges, hydraulic rock splitters or detonating cord. Waste rock will be dry crushed and screened to produce concrete and road aggregate. Feasibility studies have been completed and the company is now seeking expressions of interest to invest in the proposal, thereby enabling an expanded operation and wider market distribution of the stone.

Gracemere

Two granite quarries have been worked in the Gracemere area, west of Rockhampton. The earliest by F.M. Allan & Co. commenced in the early 1920s. A second quarry under Mining Lease No. 480 (Rockhampton) has been intermittently worked initially by F.M. Allan and Co. and more recently by West Moreton Industries Pty Ltd. Early operations are described by Ball (1927); Richards (1926) described the petrology and physical characteristics of the stone. Wolff (1957), Trezise (1989) and Trezise & others (1983) also have reported on the resource.

The quarries are situated in the *Bouldercombe Complex*, a Permian to Triassic batholith of moderate size extending east-northeast from Westwood to Gracemere and forming low undulating country. The rocks are deeply weathered and exposures are poor, but large rounded tors of fresh rock are found in places. The dominant rock type is a medium-grained granodiorite, but tonalite, gabbro and quartz gabbro are recorded from near the margins of the Complex. The quartz gabbro is quarried for monumental and building stone purposes near Gracemere and similar quartz gabbro crops out on the slopes of Table Mountain.

Allan's old quarry was commenced in 1922 by F.M. Allan, a stone mason of

Rockhampton. The site was originally chosen for the occurrence of large tors and exfoliated rock surfaces in this area. In 1958, the quarry was held under Mining Lease No. 308 (Rockhampton) by Charles Allan; in 1971 it was transferred to Capricornia Quarries Pty Ltd, later known as Capricornia Concrete Pty Ltd. The quarry was disused at the time of Willmott's (1976) inspection and the lease expired in 1980.

Exploratory drilling by F.M. Allan and Co. intersected fresh to slightly weathered rock below 3m. The rock, a quartz gabbro, is medium grained, dark speckled bluish grey, becoming darker on polishing. Plagioclase grains display a schiller effect or play of colour on polished surfaces (Richards, 1926). Basic segregations (xenoliths) are absent as are pyrite and lighter coloured veins. Joints are rare and indistinct. Blocks were split from the quarry face by feather and wedge along aligned drill holes. A steam-driven crane with a steel lattice girder 26m long was installed to lift blocks from the quarry floor. Sections of this crane remain near the now abandoned quarry. Blocks were transported to the F.M. Allan and Co. works in Rockhampton where they were cut into slabs of various thickness by a six-blade, steel-shot gangsaw for later polishing. Many of the smaller blocks (2 to 5t) were used for monumental purposes. The stone has been widely used throughout Queensland and can be seen in the bases of a number of Brisbane buildings (Wolff, 1957). Richards (1926) considered the Gracemere stone to be of very high quality, relatively free of defects, non-porous, and resistant to weathering.

A medium to large volume of rock remains to the east of the quarry for possible future exploitation. However, rural-residential developments in the Gracemere area may spread over the deposit in the near future, thus preventing stone extraction.

The **Lucas Street quarry** is situated on Mining Lease No. 480 (Rockhampton), which was applied for in 1970 by Charles Allan, but transferred to Capricornia Quarries Pty Ltd in 1971. It was sub-leased to P.J. Lowther Pty Ltd for 2 years from June 1974. In 1981, Sellars Quarries (Rockhampton) Pty Ltd (formerly Capricornia Quarries Pty Ltd) transferred the lease to **West Moreton Industries Pty Ltd**, a subsidiary of C.S.R. Ltd.

The quarry has been excavated to a depth of 10m in decomposed quartz gabbro. Large boulders and tors are supported by this softer material. The fresh stone in the large boulders is drilled and split to produce rectangular blocks (Figure 6) which are transported to Monumental & Masonry Supplies, Brisbane, where they are cut and polished. The stone finds use in monumental work and bench tops.

The smaller boulders are also used for landscaping purposes and the decomposed material is a convenient source of fill and road surfacing materials (Trezise & others, 1983).

The volume of remaining rock suitable for building stone is small; many of the boulders are below the minimum dimensions ($2m^3$) required to produce a rectangular block for processing. Adjacent areas are more weathered and therefore generally unprospective for building stone; substantial quantities of fill materials have been obtained from the neighbouring quarries to the east and south. Rural-residential developments in the Gracemere area will further limit stone extraction.

Deposits of dark green to dark grey gabbroic rocks in the Table Mountain area, some 11km southwest of Gracemere, are held by **Central Mining** under quarry sale from Queensland Forest Service. Reconnaissance drilling and sampling of the northern slopes by R.G.C. Exploration Pty Ltd was completed in early 1990 under an agreement with Central Mining. Carpentaria Exploration Company Pty Ltd is reported to also have interests in this area.

Mount Garnet

Southwest of Mount Garnet in the Sundown Road area, two trial quarries

were established in the *Herbert River Granite* by **Australian Facia Stone Quarries**, a company established by the late Mr. A. H. Pitt, initially in joint venture with Emidex Pty Ltd but in 1989 with Granite Resources Limited. The new operating company is **Sherpan Pty Ltd**. Closed-spaced drilling and cordex were used to produce 7 to 10t granite blocks (Figure 7). 'Sundown Pink' (a coarse-grained, pink adamellite) and 'Down Grey' (a coarse-grained, pink granodiorite), crop out as large tors supported by decomposed granite; little or no massive rock crops out in this area. However, moderate to large resources are present in these tors, although basic xenoliths in the granodiorite increase the wastage factor. Orders and sales for 'Sundown Pink' and 'Down Grey' have been negotiated.

In the same area, but further west on Sundown Road, the Sydney based stone-mason and fixing company **Volpato Design Group Pty Ltd** has applied for a quarry sale for granite. This company is proposing to process the stone in Canberra (A.C.T.).

Mount Isa

In the Mount Isa region, extensive areas of the Proterozoic *Sybella Granite* and the *Lunch Creek Gabbro* (Blake, 1987), as well as numerous dolerite, metadolerite and amphibolite bodies (east towards Cloncurry) have attracted many companies to this region in search of textured granites and black granite.

In the Sybella Creek area of Mount Guide Holding, some 30km southwest of Mount Isa, the Sybella Granite consisting of coarse-grained, porphyritic or porphyroblastic 'granite' (or gniess) has been quarried by several companies. The stone features large phenocrysts or augen of pink feldspar (to 50mm) set in a strongly foliated biotite-rich groundmass. **Talflag Holdings Pty Ltd** has produced blocks of its 'Orbit Black' from this area (Figure 8), but the quarry is not being worked at present as the company is concentrating its activities to the Mount Surprise-Georgetown-Forsayth area.

Dacca Pty Ltd, a subsidiary of Montes Marble, Sydney (a Division of Taresti Pty Ltd), has previously engaged quarry contractors Viscon Pty Ltd and Foschi Enterprises to extract several 8 to 10t blocks of Sybella Granite which were road-transported to Sydney for processing. A red granite has also been produced from this area by Dacca Pty Ltd. Full-scale quarry production has not yet commenced, but the company has recently commissioned a finishing plant at Maroochydore and a granite processing plant at West Euri Creek, Bowen. In late 1987, Mr G. Hamilton obtained Department of Forestry consent to test stone from the Mount Guide Holding.

Northwest of Mount Isa, gneissic rocks of the Sybella Granite are under investigation by Granite Resources Limited and others.

Mount Surprise

In 1989, the Mount Surprise quarry of **Talflag Holdings Pty Ltd** commenced producing granite blocks from the Late Carboniferous to Early Permian *Elizabeth Creek Granite*, about 40km northwest of Mount Surprise. 'Surprise Red' or 'Queensland Rose' is a pink to pink-brown medium-grained granite (Figure 9). Granite is cut from several large exfoliated sheets using close-spaced drilling and thermal lance; detonating cord or non-explosive expanding compounds break 7 to 20 tonne blocks free from the quarry face. Under an agreement with TTS Transport Pty Ltd, the stone is transported to Townsville and Brisbane for shipment overseas (Belgium), or to Melbourne for processing into polished granite slabs and tiles. Talflag Holdings Pty Ltd is undertaking feasibility studies into the construction of a granite processing facility in Townsville, to treat its stone from Mount Surprise, Forsayth, Georgetown and Mount Isa (Orbit Black).

Nanango

The *Boondooma Igneous Complex* was intruded into the Yarraman Block in

mid-Permian time, and now crops out over a very large area from Tarong to Boondooma, covering several thousands of square kilometres. The Complex comprises a variety of rock types including granodiorite, adamellite, granite (some rapakivi granite), tonalite, quartz diorite and gabbro. Much of this unit is deeply weathered and has laterite and silcrete profiles; elsewhere, it is overlain by extensive sheets of the Tertiary Main Range Volcanics.

In the Nanango-Maidenwell area, **Granite Resources Limited** has been investigating two 'granite' deposits within the Boondooma Igneous Complex, and has lodged applications for extractive industry permits. The attractive 'Nanango Peach' is a medium-grained, pink-grey adamellite (Figure 10) which crops out well with little overburden and widely-spaced joint sets. A trial quarry has been opened in this large resource. Less than a kilometre to the northeast, a narrow dolerite dyke has intruded the adamellite. Drilling and subsequent testing of sample blocks from a small trial quarry indicated the highly jointed nature of the deposit (Maiden Black) and its unsuitability as a source of building stone. The company is continuing further regional investigations to locate additional granite deposits in the Kingaroy area.

Further to the east, the Permian to Triassic *Taromeo Tonalite* crops out over a wide area from Nanango south to Blackbutt and Emu Creek, and comprises many rock types including tonalite, adamellite, leucocratic granodiorite and porphyritic hornblende diorite. During the 1950s, the Taromeo Tonalite was an important source of building and monumental stone (Wolff, 1957; Martin & Neville, 1981). Boulders or tors of dark grey, medium-grained tonalite were quarried in several areas north of Blackbutt and in the Emu Creek area. The latter deposit was investigated by **Granite Resources Limited** in 1988. Core from two diamond drill holes indicated high sulphide content in the matrix and as joint coatings (10%). Overburden depths of up to 4m were recorded. No further development is being undertaken in this area.

A significant deposit of medium-grained, leucocratic granodiorite occurs in 'The Boulders' area 6km southwest of Nanango. Although the deposit was drilled and sample blocks extracted and tested for **Granite Resources Limited**, a quarrying proposal was abandoned as these geological features are a local scenic attraction.

Stanthorpe, Pozieres

The Triassic *Stanthorpe Adamellite* is the largest granite batholith to crop out in the Stanthorpe area. Generally, it occurs as a massive, medium-grained pink adamellite with few, if any, basic xenoliths. There is little or no alignment of feldspar crystals, but some varieties display porphyritic texture with large euhedral feldspar or quartz phenocrysts (Robertson, 1972).

Small quantities of Stanthorpe Adamellite were quarried by Messrs Edwards and Roberts from near the Stanthorpe railway station (Annual Report of the Department of Mines, 1915 and 1916). This red granite took an excellent polish, and was considered to be of satisfactory quality and durability.In 1973-74, **Consolidated Mining Industries Limited** applied for Mining Leases over potential granite deposits in the *Ruby Creek Granite* west of Dalveen (MLs 57 and 58, Warwick) and in The Summit area (MLA 451, Stanthorpe), but no mining was carried out.

In the Donnelly's Castle Road area, near Pozieres, **South Queensland Granite** completed reconnaissance drilling of a large granite boss (part of the Stanthorpe Adamellite) and has commenced production (Figures 11 and 12). This holocrystalline granite has a uniform, medium to coarse-grained texture, and grades from yellow to pink-beige vertically. Vertical joint sets are well spaced and will be an advantage in quarry design. Simultaneous multiple drilling (in vertical or horizontal planes)

will be used for block extraction. All processing into tiles and slabs will be carried out in New South Wales. Interest in this stone has been shown by Australasian Stone Products, Melocco and Lachlan Valley Granites.

In early 1990, South Queensland Granite and New England Granites (a company with granite interests in the Tenterfield-Warwick area), entered into a joint venture agreement to quarry and market granite from this area under the company name **Dimension Granite Pty Ltd.**

Granite Resources Limited also is reported to have granite interests in the Stanthorpe area.

During 1987-88, **Emidex Pty Ltd** investigated a dyke and small pluton of gabbroic material in the Wallangarra area as possible sources of 'black granite' facing stone. This medium-grained, dark grey gabbro was found to be highly weathered to a considerable depth; the remaining tors or boulders were too small to quarry.

Warwick

Medium-grained, leucocratic granodiorite *(Greymare Granodiorite)* from the Greymare area, west of Warwick, has been used in buildings in Warwick and Brisbane (Richards, 1918; Wolff, 1957), but this boulder source is virtually depleted. Elsewhere, granitic rocks in the Warwick-Stanthorpe area offer some potential for quarrying (O'Flynn, 1983); large boulders and tors near the western margin of the Greymare Granodiorite in the Buckhurst-Glengariffe-Evandale area may offer some potential as a source of stone and warrant further investigation.

Marble and Limestone

By definition, marble is a granular metamorphic rock, composed of calcite or dolomite, which has formed by the recrystallisation of calcareous sediments (limestone or dolomite), through a combination of high temperature and pressure (ASTM C119: 1983b).

In contrast, commercial marbles encompass any crystalline rock composed of calcite, dolomite or serpentine capable of taking a polish; it includes many crystalline rocks: limestone, dolomite, travertine and the basic igneous rock - serpentinite. Travertine is a dense, often banded rock produced by the precipitation of calcite through evaporation in springs, caves, and from water near geysers and hot springs. Typically, travertine displays vesicular openings arranged in layers. 'Onyx' marble (a trade name) is a microcrystalline carbonate precipitate; true onyx is a hard, silicate similar to agate. 'Verde antique' is massive serpentinite which takes a good polish.

Generally, marble is cut to the required shape and size, and polished for use mainly in architecture (cladding, tiles, panels, pavers: minimum thickness 20mm), also for monumental and statuary purposes. It is rarely used in rough or 'rock' face form, although some limestone ashlars are produced in South Australia (Mount Gambier) and Western Australia (Carabooda Limestone). Final selection of marble, and therefore their classification is based upon colour, texture and structure.

Pure marble, composed entirely of calcite, is white, but the presence of other minerals or impurities can produce a wide variety of colours as evident in some of the Chillagoe marble, where colours include grey, silver, blue, green or black; black marble and limestone have a high carbonaceous content. Premium-grade marbles, sought worldwide, include coloured marble as well as fine-grained, white marble similar to 'Carrara' marble. Textures and structures evident in some Queensland

stone include banding (bedding, foliation, or other mineral and rock laminations), breccia, fossils, ooliths, saccharoidal texture and veining. The grain-size classification of Spry (1986) is followed in this study:

coarse (1 to 5mm),

medium (0.5 to 1mm) and

fine-grained (0.1 to 0.5mm);

very fine-grained (cryptocrystalline) marble has grains < 0.1mm.

Marble and limestone for dimension stone are required to be sound, durable and free of visible defects or concentrations (spalls, microfractures, cavities and seams) that cause any appreciable loss of strength, durability or appearance (staining). Standard specification ASTM C503: 1989 addresses the criteria for the selection of marble (for exterior use) in all four classes, based on composition; namely calcite, dolomite, travertine and serpentinite (Table 2).

Minimum values for exterior marble are specified for density (2.59t/m^3), compressive strength (52MPa) and modulus of rupture (12MPa). Abrasion resistance values should be > 10 for marble stairways, floors and platforms subjected to high pedestrian levels. Abrasion resistance values for some saccharoidal Chillagoe marble is below this figure (10) and their use is restricted to internal walls or low wear areas (Spry, 1986). The thermal properties of marble, particularly the co-efficient of thermal expansion, is of considerable importance as many types of marble have dimensional instability. In some external applications, when extreme environmental conditions occur, the shape and size of the material may change through repeated cycles of wetting and drying, and temperature fluctuations. These effects on marble are further discussed in some detail by Spry (1986, 1988, 1989). No specific limits have been set down for the maximum values of co-efficient of thermal expansion. In all exterior applications, marble is very susceptible to solution from rain water (and weak carbonic acid) and attack by other atmospheric pollutants (acid rain) and organic acids (biological processes).

Limestones for dimensional stone use are classified according to their densities (ASTM C568: 1979b): low density (1.76 to 2.16t/m^3, medium density (2.16 to 2.56t/m^3) and high density limestone (over 2.56t/m^3). Specified limits for absorption, modulus of rupture and compressive strength are presented in Table 2.

Since the early 1980s, marble has been quarried from the Chillagoe district in north Queensland for both domestic use and export. Between 1987 to 1989 a total of 26 680t of marble was extracted (valued at $7.8 million) but only a small quantity of this material was exported. The major producers are Queensland Marble Limited, Carrington Marble and Cairns Marble (a marble tile manufacturer). In southeast Queensland, limestone and marble chips for terrazzo are produced from quarries at Elbow Valley and Limevale. Feasibility studies into development of marble resources in the Gladstone region are currently being undertaken by several companies.

Bracewell

In the Bracewell - East End area, southwest of Mount Larcom, Krosch (1981) identified three significant limestone deposits within the Mount Holly beds. Within the central deposit, high-grade limestone crops out over a distance of some 3.5km and has an average width of 500m.

Northwest of Jacobs Creek, **Mining Lease No. 411 (Gladstone)** which covers part of the central deposit was issued to O. Howden and R. and K. Savage. It was transferred to A. and E. Zarb (1974) and Bracewell Marble Pty Ltd (1980).

Recrystallised, medium to coarse-grained marble is restricted to a prominent hill in the northeast corner of the lease. Colour varies from white, cream, light grey to red. Limestone breccia with a red ferruginous matrix is present. Departmental drilling (LS 23-27, Bracewell) proved an extension of the deposit to 90m, with minor interbeds of

siltstone and greywacke and andesitic dykes (Krosch, 1981).

The deposit is reported to be suitable for marble blocks and slabs. By-products comprise terrazzo chips, marble dust, burnt lime, road base and aggregate screenings. To date, no mining has been carried out, but block production for export markets is planned and joint venture negotiations are proceeding. On the basis of outcrop dimensions, estimated limestone reserves are in the order of 1 million tonnes per vertical metre, or 4.75 million tonnes per vertical metre if continuity of the deposit is assumed.

Cecilwood area - Marble Mountain and Cedric Mountain

The *Capella Creek beds* (Kirkegaard & others, 1970) form the deeply dissected and rugged country of the Dee Range and Calliope Range to the west of the Mount Holly beds. Recrystallisation associated with regional metamorphism has not affected these beds to the same degree as it has the Mount Holly beds. Within the Capella Creek beds, limestone and marble deposits occur as discontinuous, narrow lenses in the Cecilwood area, south of Bajool.

The **Marble Mountain** deposit has been under investigation by Rioace Pty Ltd, a subsidiary of Steamships Trading Company. The company was granted Mining Leases Nos. 805 and 813 (Gladstone) over these deposits but to date no mining has been carried out. The sale of all leases and their transfer to Elderlodge Pty Ltd was recorded in early 1990. The marble is generally fine to medium grained, but in the eastern section of the deposit, it is coarser grained, grading to saccharoidal. The outcrops are narrow, lenticular, and appear to form the limbs of a tightly folded synform. The colour is quite variable - grey, white, cream, pink, red and brown. The highly fractured sections of the deposit will pose some difficulties in production of blocks of the required size (up to 23t).

A small trial pit southeast of Marble Mountain was excavated and sample marble blocks were cut and polished for further testing. Diamond drilling was undertaken to assess the suitability for selected first-grade blocks for export, as well as for locally produced polished slabs and tiles. Waste materials will be crushed for terrazzo chips, screenings and crusher dust for other industrial purposes. It is planned to process the stone at the proposed plant of Heritage Holdings Pty Ltd which has extensive limestone and marble interests in the Mount Larcom area.

Rioace Pty Ltd has submitted Mining Lease Application No. 804 (Gladstone) over the **Cedric Mountain** deposits, previously held by Peko-Wallsend Operations Pty Ltd (1982-83). The limestone deposits are reported to be very similar to the Marble Mountain deposits; traces of fossils (crinoids) are present (Krosch, 1981). The potential for development of the Cedric Mountain deposits will be limited by the narrow, lenticular nature of the limestone, poor access and distance to markets.

Chillagoe

The development of the marble industry in north Queensland has been hindered by lack of detailed knowledge of the resources and distance from markets. In the late 1950s and 1960s, reconnaissance geological mapping of the Chillagoe area was undertaken by joint Bureau of Mineral Resources and Geological Survey of Queensland field parties. The area's mineral resources were described by de Keyser & Wolff (1964). Remapping of the Atherton 1:250 000 Sheet area to update this earlier work was commenced in 1982 by the Geological Survey of Queensland (Bultitude & others, 1985). Connah (1958) briefly described the large high-grade limestone deposits in the Chillagoe and Palmerville areas. The quality and volume of these limestone resources (Chillagoe Formation) were assessed by Ishaq (1977) and Willmott (1979).

The potential for marble production from deposits in the Chillagoe district of north Queensland was recognised in the early 1980s. Subsequent quarry developments and the establishment of stone processing plants at Cairns and Chillagoe led to sales of marble blocks, slabs, billets, and tiles to both the domestic and overseas markets. Initial exports were to Italy but, more recently, additional blocks have been exported to Taiwan for processing. A comparison of Australian marbles, including the Chillagoe marble of Anroma Pty Ltd, was published by Spry (1986) to aid in selection, use and marketing. Continued strong interest has been shown by the American, Japanese and other European markets. Total production for the period 1987-89 was 26 680t valued at $7.8 million (Table 7) but of this tonnage, only a small quantity was exported (Tables 5 and 6).

Over the past 8 years, the development of the north Queensland marble industry has been erratic; several companies are in liquidation and others are investing capital to further develop these resources. The major producers are Queensland Marble Limited and Carrington Marble (formerly Austcorp Marble), while companies such as Granite Merchants Australia Pty Ltd, Australian Transpacific Marble, Gori Terrazzo Tiles and Quemeg Pty Ltd are yet to develop quarries on their respective mining leases.

The late Silurian to Early Devonian *Chillagoe Formation* the westernmost unit of the Hodgkinson Basin, contains important limestone and marble resources in a north trending belt of rocks between Almaden and the Palmer River. To the west, it abuts the Precambrian crystalline rocks of the Dargalong Inlier along the Palmerville Fault.

The formation is a diverse sedimentary sequence comprising interbedded arenite, greywacke, siltstone, conglomerate, limestone, chert and basalt, which were deposited on a shallow continental shelf or sloping ramp. Most beds are lenticular and cannot be traced over any distance. Many of the fossiliferous limestone lenses appear to have slumped as allochthonous blocks into deeper water east of this shelf. By the Late Devonian to Early Carboniferous, sedimentation had ceased and these rocks underwent regional deformation causing intense folding, faulting and slight recrystallisation. The limestones were hardened and beds steeply inclined. The older Proterozoic rocks were thrust eastwards over the younger sediments of the Chillagoe Formation.

Generally, the medium to dark grey limestones are hard, granular, and fine-grained. They occur as massive or thin beds, lenses, and blocks or fragments which have slumped into other sediments. Fossils including corals, crinoids, brachiopods and bivalves are common. The solubility of the limestone has given rise to the spectacular jagged bluffs (tower karsts) and large cave systems, a noted feature of the Chillagoe area.

The Chillagoe Formation has been intruded by several large granitic plutons of Late Carboniferous to Permian age. Also at this time, thick sheets of acidic ignimbrite (Redcap Volcanics & Featherbed Volcanics) were erupted and now cover parts of the Chillagoe Formation. Limestones in areas adjacent to these intrusive bodies were recrystallised to varying degrees depending on distance from the intrusion. The resultant marble deposits are massive and for the most part, evenly textured. The coarse to very coarse-grained, saccharoidal marbles are commonly the coloured varieties (cream, gold, pink, silver-blue and blue). Only the white marble (Bianca quarry) and dark grey to black limestones are fine grained. Relict bedding features, foliations, strain cracks and joints are common linear defects.

In 1984, **Anroma Pty Ltd** (formed by Mr V. Bellino and partners in 1982) commenced quarrying southeast of Chillagoe from Marble Sales Agreement

Areas (T.C. 48/82 & 117/82) issued by the Department of Forestry. These agreements remained in force until the end of 1987, although marble in the Chillagoe Mining Field had been declared a mineral under the Mining Act in March 1985. Mining Leases Nos. 3970-3976 and 4216 (Mareeba) were granted over the quarries which were continued to be worked to produce blocks for export until the company went into liquidation in 1985. The marble was generally coarse to very coarse-grained and colours included pink (ML 3971), pale blue, blue-green and blue-grey (ML 3974), and dark pink to red breccia (ML 3972). Medium-grained, white marble (Bianco Neve and Ciocho D'Oro) was quarried from the Bianca quarries (ML 3970). The resource potential of the marble sales agreement areas was evaluated by Stevens (1983). Spry (1986) tested the Chillagoe marble for comparison with other Australian marbles. Its average bulk density is 2.69t/m^3. Its resistance to abrasion is low for marble; the Taber Index value ranging from 7 to 12, less than that of Wombeyan (New South Wales) and Angaston marble (South Australia). The stone's low compressive strength (average: dry 69MPa, soaked 75MPa) and modulus of rupture (average: dry 5.6MPa, soaked 8.7MPa) together with the coarse grain and inherent weakness along grain boundaries, restrict its use to internal situations only, as wall cladding. In addition, the abrasion resistance is too low for internal commercial paving applications (high density pedestrian traffic).

Queensland Marble Limited (formerly Jinkinous Limited) acquired Mining Leases Nos. 3970-3976 (Mareeba) from Elders Finance & Investment Company (as mortgagee) consequent to the demise of Anroma Pty Ltd. This acquisition was financed by the proceeds of a loan by Campaign Holdings Limited, which also purchased the marble processing plant in Cairns from the mortgagee, NatWest Finance. Five additional mining leases (Nos. 4213-4216 and 4268, Mareeba) have been granted to QML; Zapata Pty Ltd, a subsidiary company, successfully applied for Mining Leases Nos. 4242-4245 (Mareeba), but to date no mining has occurred except for the excavation of a small pit on the black marble deposit (MLA 4216, Mareeba). Queensland Marble Limited, in a $13.75 million joint venture, was listed on the stock exchange in August 1988 after successful completion of a $3.75 million public float. Thiess Contractors Ltd was contracted to extract marble blocks between 10 and 20t each.

Marble production by the joint venture was centered on the Bianca north (ML 3970), Chillagoe Rose (ML 3971), Aquamarina (ML 3974) and Cobra (ML 3975) marble deposits (Figures 13 to 16). A small trial pit was excavated in the White Crystal deposit (ML 3976). Initially, blocks were produced using wire saw cutting techniques. Korfmann saws played a major role in more recent operations. First-grade blocks were sent to Cairns and Townsville for shipment; second-grade blocks were processed at the company's tile factory in Cairns, where a Mordenti tile polishing line and Hensel finishing line had been installed. Anticipated annual production of 60 000t comprised 20 000t/year of high-grade stone and 40 000t/year from billet and tile manufacture in Cairns. QML proposed to upgrade this facility by construction of a new plant in Mareeba; crushing facilities to reduce waste materials to marble extenders and fillers were planned for Chillagoe. However, in the first full year of production, the company sustained a loss of $2 million for the half year ending December, 1988.

Towards the later part of 1988, sales agreements for the supply of blue Chillagoe marble were entered into with World Amtai Inc., for processing of marble in Taiwan and sales to the U.S. through World Amtai Inc's distribution network. As a result of these agreements, quarry operations at Chillagoe were reduced to production of blue marble

only, the Cairns processing plant was sold, and QML terminated its mining contract with Thiess Contractors Pty Ltd. With the failure of this agreement in 1989, Coopers & Lybrand, as Mortgagee and possession for Campaign Holdings Pty Ltd has been advertising nationally seeking expressions of interest in QML's mining operations.

In late 1984, **Global Marble Pty Ltd** and **N.Q. Marble Tiles Pty Ltd** were established (both wholly owned by V. & R. Bellino). Early in 1985, operations were commenced in the Greenfields quarry (ML 3990, Mareeba), just west of Chillagoe. An associated company, **Pacific Quarries Australia Pty Ltd**, controlled all mining interests in respect to building stones other than marble - mainly granite and volcanic rocks.

In August, 1985, Global Marble Pty Ltd also commenced working Rankines Enterprise (ML 1376, Mareeba), under tribute to D.H. and C. Rankine, for the production of white and pink marble. Large volumes of similar coloured but coarser-grained marble were extracted from the medium to large, multi-benched Global Marble quarry (ML 4033, Mareeba) under Sales Agreement TC 112/84 (See cover photo). The smaller NQMT No. 1 and 2 quarries (MLs 4125, 4126, and 4139, Mareeba) were later opened to supply medium to coarse-grained grey, white, cream and yellow marble. Seven additional applications for mining leases (MLs 4150-4153, 4160-4162) were lodged but no mining occurred within these leases. Marble blocks up to 22t, produced by Korfmann saws and pneumatic block drills, were transported to the Chillagoe plant of **Australasian Transpacific Marble Pty Ltd** (formerly Exville Pty Ltd) for cutting and slabbing. In mid-1987, a 30% equity ($2 million) held in Global Marble by Homely Pty Ltd, enabled the company to fill export sales agreements of 24 000t/year with M+Q Graniti AG, European Granites Company and Parotti A.s.r.l.

Global Marble had proposed to build a $3 million tile-processing plant at either Dimbulah or Mareeba in 1988, but financial difficulties resulted in the sale, in August 1988, of the company's assets to **Austcorp Marble (Operations) Pty Ltd**. In 1989, Austcorp Marble centred its operations on extraction of marble from Chillagoe Rose quarry (ML 4033), white crystal pit (ML 4139) and 'black ice' pit (ML 4125); it also applied for two additional mining leases (MLs 4321 and 4322, Mareeba) but they have not been granted or worked to date. First or A-grade blocks had standard size and shape, few defects and an even colour; B-grade blocks displayed uneven colour, some structural defects and the irregular shape (overcome by trimming with a Monolama single blade saw). Broken pieces and boulders were classed as C-grade material. The company's mining operations were sold to Carrington Marble in January 1990.

Limevale

Large resources of high-grade limestone and marble suitable for most industrial purposes including building stone are present in the Limevale area, 9km north of Texas. Building and monumental stone, reported to be of good quality (Wolff, 1957), has been quarried intermittently from the Limevale area - the earliest mining operations by Mr. A.G. White commenced in 1919. Mapping and drilling of these deposits were undertaken by Siemon (1973); the resources and mining activities were reviewed by Krosch (1985, 1990) and Denaro (1989). The coralline limestones occur within the Late Devonian to Early Carboniferous *Texas beds*, a volcaniclastic flysch-type sequence of greywacke, mudstone, slate, chert and intraformational andesitic volcanics (Day & others, 1983). The limestones were deposited either in shallow-marine environments at this time or they may represent allochthonous blocks from a shelf area to the west. The entire sequence was strongly folded by pre-Permian deformation involving thrusting or gravity sliding.

In the Pipersleigh-Limevale to Magee Creek area, the limestone crops out as discontinuous, often narrow lenses, commonly with interbedded micaceous sediments (slate and phyllite) and altered volcanics; elsewhere, the limestone occurs as isolated large pods or blocks (Limevale and Lime Products quarries). The uniformly fine-grained limestone is mainly white or light to dark grey; thinly banded light to dark grey limestone is common. Some white, blue-grey and black materials have been quarried from Mining Lease No. 267 (Stanthorpe).

The only current mining activity is the quarrying of marble and limestone at the Limevale quarry (Mining Leases Nos. 275, 426, 518 and 520, Stanthorpe) by **Lime Products**, a division of T.N.T. Australia Pty Ltd. This company, which acquired these leases and processing plant in late 1989 from Lime Products Pty Ltd, a subsidiary of Allied Minerals Pty Ltd, has similar mining and processing interests in the Elbow Valley area, near Warwick. Two medium-sized quarries are selectively worked to supply marble and limestone to a small crushing and screening plant on the lease. Marble dust and chips, of various sizes up to 10mm, are supplied for stockfeed, exposed aggregate (swimming pools), terrazzo, crushed lime and burnt lime. Estimated reserves in the Limevale quarry deposit exceed 900 000t/vertical metre (Siemon, 1973); additional large resources remain in the vicinity of the abandoned Marble Queen quarry and west of Limevale (Magee Creek marble deposit).

No mining activities are currently undertaken on the company's Mining Lease No. 267 (Stanthorpe), which covers the Lime Products or Inglewood Quarry No. 2, about 5km northeast of the Limevale quarry. Inferred resources of 465 000t/vertical metre are present in the vicinity of these old workings (Siemon, 1973; Denaro, 1989).

The Pipersleigh marble deposit, situated 4km south of Limevale, is being developed by **Australian Dimensional Stone Industries Pty Ltd** as a source of marble chips and blocks. Sample blocks of banded (light to dark grey) marble have been excavated from two trial pits for further testing. The stone is highly jointed, and bands of altered phyllitic shales and volcanics are common in both pits. The company is currently seeking a buyer for the deposit.

Mount Larcom

Australian Quality Marble Pty Ltd has extracted marble from the **Mount Larcom quarry** situated some 9km south of Mount Larcom. In late 1985, the quarry was commenced on Portion 9, Nolan and was later extended east into Portion 538, Mount Larcom. The marble is variegated and includes white, grey, blue, pink, deep red and black. Initially, the company had planned to export blocks for processing and to establish a processing plant at Mount Larcom but financial problems prevented this development.

However, during 1986-89, stone was trucked to a crushing plant on Mr. Popenia's property, north of Mount Larcom, where marble chips of mainly -10mm, but occasionally -12mm and -20mm size were produced. Smaller chips (-6mm) were supplied for use as exposed aggregate for Cathedral Square, Brisbane. The plant is limited to small blocks for crushing and in late 1986, the production rate was about 40t/week. Terrazzo chips were supplied to Marble Tile Co. (Brisbane) and R. Rolfe and Co Pty Ltd (Townsville). The crusher fines represent a possible source of stock feed additive, agricultural lime and marble dust for coal mines.

In 1987, the company obtained extractive industry permits to quarry marble from Shaw's property, Mount Larcom and Elliott's property, Bracewell but the quarries were never commenced and the company has ceased operations. Heritage Holdings Pty Ltd subsequently was granted a permit over Shaw's property. Mr. Popenia continued to obtain stone from the Mount Larcom quarry until late 1989 when the land owner, Mr. Schultz, was granted title to

the quarry but to date no further stone has been produced.

The **Touch-Stone marble project** 7km southwest of Mount Larcom, is to be developed by Heritage Holdings Pty Ltd, which is currently negotiating the sale of Shaw's property (Portions 71 and 121, Langmorn). A prospectus seeking capital investment via limited partnerships is currently before the Corporate Affairs Commission. In 1987, this area was held under an extractive industry permit by Australian Quality Marble, but the quarry was not commenced and title was transferred to Heritage Holdings Pty Ltd.

These recrystallised limestones, part of the Mount Holly beds, are fine to coarse grained and multicoloured, mainly grey-white, grey, pink, red and orange (Krosch, 1981). Traces of fossils (crinoids and corals) are rare. The limestones are brecciated in parts with minor ferruginous banding. Between 1974 and 1979, Dampier Mining Company Limited, (a subsidiary of B.H.P. Company Limited) undertook reconnaissance mapping, drilling and sampling of the limestone deposit. The estimated limestone resource was in excess of 40 million tonnes, adequate for most industrial purposes.

In 1987, AQM commissioned Unisearch Limited (NSW) to undertake mechanical testing of drill core, based on ASTM C568 using modified procedures due to small sample size. The stone was classified as Grade 111 - high density limestone, with a bulk density of 2.70t/m^3, and average modulus of rupture of 14.8MPa and compressive strength of 116.8 MPa.

At a cut-off depth of 15m, the extractable resource is estimated to be in the order of 10.5 million tonnes (Heritage Holdings Pty Ltd, personal communication, 1990). Conservative estimates put recovery at about 50%. A processing plant for slab and tile production is being planned for construction in either Gladstone or Brisbane; waste stone will be further processed (crushed and milled) for terrazzo chips, exposed aggregate, road pavement gravel, and other industrial uses. It is anticipated, that the bulk of the output will be exported and that some marble will be sold on the smaller Australian market.

South Ulam

In the South Ulam area, west of Gladstone, marble has been intermittently quarried since 1917; these blocks were sawn, trimmed and polished to supply white marble for monumental use (Australian War Graves Commission) and as interior cladding. The first assessment of limestone and marble deposits in the Gladstone hinterland was completed by Ball (1904). The white marble deposits at South Ulam were described by Saint-Smith (1917, 1920, 1921a,b) and Morton (1928b, 1930). A summary of all available data on limestone and marble deposits of the Gladstone region was prepared by Connah (1958). During the 1970s, detailed regional surveys of limestone resources undertaken by the Geological Survey of Queensland (Krosch & Kay, 1977; Krosch, 1981) demonstrated the availability of large limestone deposits of suitable size and grade to supply industrial requirements; several of these offer potential as possible sources of building stone. More recently, limestone and marble resources in the region have been reviewed by Krosch (1985, 1990).

Marble has been intermittently quarried from the Early to Middle Devonian *Mount Holly beds* at South Ulam and Mount Larcom. The Mount Holly beds consist dominantly of acid to intermediate volcanics including abundant ash-flow tuff, and minor limestone and clastic sediments. These particularly pure limestones are lenticular. Fine recrystallisation has resulted from widespread regional metamorphism, but southwest of Marmor and in the South Ulam area several granodiorite to adamellite bodies have intruded these beds during the Late Permian. The resultant contact metamorphism has recrystallised these limestones to coarse-grained

saccharoidal marble; the impure limestones were transformed to skarn and marble containing various calc-silicate minerals.

The South Ulam quarries are located in a large pear-shaped marble lens which extends for some 2km south from Mount Kelly; the maximum width is about 800m. The majority of the early building stone quarries are within Mining Lease No. 750 (Gladstone), but are not currently worked. Leases on the southwest flanks of Mount Kelly are held by Omya-Southern Pty Ltd from which marble is extracted and pulverised for agricultural and chemical use.

The wider, southern section of this marble deposit is partly within **Mining Lease No. 750 (Gladstone)**, 17km south of Bajool, which is held by Mr. J.A. Wells, of Wells Lime Works, Marmor. Formerly, A. and C. Packers had interests in this lease from 1981 to 1983. The lease covers a succession of previous mining leases dating back to 1917.

Prior to 1974, several quarries including the old Ulam Carrara marble, Carrara and Ulam quarries were worked for statuary and monumental stone, interior cladding and terrazzo chips. Total production during 1917-1974 was over 6700t (Krosch, 1981). The bulk of the stone produced since 1974 has been used for agricultural and chemical purposes. At present, marble is extracted from the small, unbenched quarry in the northeast section of the lease for processing at Marmor. Agricultural dust, quick lime and stock additive is produced. The material is reported to be too coarse and soft for terrazzo chips.

There are three large marble block quarries and several smaller pits within the lease. The largest quarry has five levels from which marble blocks were cut using percussion guttering machines, feathers and wedges. This white marble with a distinct dark green to grey flashing is even textured and coarse grained. Individual grains of marble, though coarse, are tightly cemented and locked together, forming a resistant rock that cuts well and takes a good polish. It is reported to have been easily worked, but care was necessary with regard to arris (Wolff, 1957).

South Ulam marble has been used extensively for monumental work and as interior cladding for numerous buildings. The State and Commonwealth Governments, and the Commonwealth War Graves Commission were major users. Wolff (1957) listed Queensland buildings in which this marble could be seen.

Although marble is not currently worked for building or monumental purposes, a large volume of stone remains on this and adjacent areas held under mining lease.

Another lease in this area, **Mining Lease No. 985 (Rockhampton)**, abuts the southern boundary of Wells' lease (ML 750) and covers the southwestern part of the South Ulam marble deposit. Originally, it was granted to M.F. Partridge in 1978, but was transferred to K. MacDonald in 1984 and in 1988 to R. McClintock of Five Way Seeds Pty Ltd.

The white marble which crops out well in the eastern part of the lease is coarse to very coarse grained, saccharoidal and relatively joint free. It is similar to and is an extension of the marble deposit on Mining Lease No. 750. Skarn minerals - garnet and epidote - are common and may pose problems during cutting and polishing. No mining has occurred to date, but exploration involving diamond drilling and testing is planned.

Warwick-Elbow Valley

Early Devonian limestone deposits of the *Rosenthal Creek Formation* in the Elbow Valley area, southeast of Warwick, are the largest deposits in the Warwick district (Siemon, 1973). Saint-Smith (1922), Wolff (1957), Connah (1958), Siemon (1973), and O'Flynn (1983) have described these deposits, past mining activities and potential resources.

The white, cream to yellow marble occurs in discontinuous lenses and varies in grain size from fine to coarse, with some saccharoidal material. Laminated light to

dark grey marble is present in O'Dea's quarry. Thin bands of altered basic volcanic rocks are interbedded with the marble.

Marble mining commenced in this are during the early 1930s. Several companies have intermittently quarried a number of mining leases (Appendix 3) as a source of crushed screenings (marble chips) for stockfeed and terrazzo. Some of the material was used for monumental and building purposes (Wolff, 1957); small blocks (1 to 2m^3) were drilled and broken free with feathers and wedges for processing by The Marberete Company Pty Ltd at Geebung in Brisbane. Recorded production from 1932 to 1977 was 17 480t.

The medium-sized O'Dea's quarry is the only quarry currently worked by **Lime Products** (a division of T.N.T. Australia Pty Ltd), which purchased these leases and crushing plant from Warwick Lime and Marble in late 1989. The marble is hauled a short distance to a processing plant on nearby Mining Lease No. 8 (Warwick) where it is put through a primary and secondary crusher, hammer mill and screens to produce various aggregates for use as stockfeed (-1mm), agricultural lime and variously sized terrazzo chips (from 5 to 25mm). The estimated annual production for 1988-89 was about 20 000m^3 of which some 2 000m^3 was for terrazzo chips. The company also has marble mining and processing facilities at Limevale, near Texas. No mining is currently being undertaken from Mining Leases Nos. 8 and 26 (Warwick) adjacent to the processing plant.

Medium to large limestone/marble deposits remain in this area, with an inferred resource in the order of 20 000t/vertical metre (Siemon, 1973). However, the varied texture and colour, as well as interbedded volcanic rocks and highly fractured zones will make block production difficult to achieve.

Slate

Slate is a microcrystalline rock produced by the metamorphism of fine-grained sedimentary materials (clay and shale), resulting in the layering of flat, micaceous minerals in parallel planes. This gives rise to slaty cleavage. Relic bedding is an undesirable feature, but certain varieties of 'slate' - metasiltstone - display fine laminations which may part easily and are termed 'ribbon' slate or 'ribbon' stone.

Slate has been widely used as roofing material, damp-proof courses, stair treads and risers. In modern times, it is commonly used as a paving stone - tiles, random pavers and crazy pavers, and as facing or pitching stone.

Standard specifications are set out for roofing slate (ASTM C406: 1984) and building stone (ASTM C629: 1980b; BS 5534, 1985) and are listed in Table 2. Specific test procedures are outlined for determining flexural strength (ASTM C120: 1981e), water absorption (ASTM C121: 1981a) and weather resistance (ASTM C217: 1981).

The Queensland slate industry is small, the bulk of our requirements being met by imported slates of greater variety and generally better quality. Production is estimated to be less than 2000t/year but accurate figures are not available. The majority of the currently worked quarries at Warwick, Gympie, Cairns, and Maitland Downs (via Mount Molloy) supply stone for local consumption, but recent developments in the Forsayth-Gilberton area may see the establishment of export markets for our 'slate'.

Many of these slates are not true slates but cleaved mudstones (Hodgkinson Formation, Neranleigh-Fernvale beds, Texas beds) and siltstones (Amamor beds), phyllitic shales (Kin Kin beds, Rannes beds) and mica schist (Corbett Formation). Generally, they are quarried by drilling and blasting. Processing may

involve further splitting and manual grading, followed by cutting, hydraulic splitting and milling if tile products or slabs are required. Random and crazy pavers, facing or pitching stone, and landscaping materials require little or no processing.

Forsayth and Gilberton Areas

Since the mid-1970s, mica schist and multicoloured siltstones and mudstones of the Early Proterozoic *Corbett Formation* have been intermittently quarried as 'slate' in the North Head station to Gilberton station area, southwest of Forsayth. In the late 1970s, similar materials were quarried by Mr.R.Story from the Percy River for use as random pavers.

Blackwell's slate deposit (Figures 18 and 19) is located on the Gilbert River, 48km southwest of Forsayth. It is a hard, fine-grained, grey to grey-green mica schist which exhibits a closely spaced (12mm) prominent cleavage, but at depth the cleavage is less pronounced (O'Flynn, 1988). The original **Gilbert River quarry** was established by Mr. I.K. Pike who also quarried slate from the Robertson River, some 15km to the northeast. In 1986, Mining Leases Nos. 1062 and 1063 (Georgetown) were transferred to Mr. J.W. Grievson of **Cairns Slate**, which was recently granted an additional lease (ML 1625). A pilot plant comprising small block saws or trimming saws, grinding and honing machines was built at Ravenshoe to produce a range of slate products including cut tiles, random pavers and furniture. Preliminary testing (O'Flynn, 1988) indicated that the stone is resistant to delamination and deterioration from chemical weathering. Inferred resources (ML 1062 & 1063) are in the order of 500 000m^3. At present, the company is seeking joint venture capital.

In May 1989, **Gilbert River Quarries** announced plans to extract banded, multicoloured siltstone and mudstone (Corbett Formation) from deposits on the Gilbert River (Rungulla holding), 26km northwest of Gilberton station. The $4 million joint-venture proposes annual quarry production of over 80 000 tonnes of siltstone, to be processed into slabs and tiles at a plant to be built on the Atherton Tableland; commissioning of both the quarry and plant is about 18 months away. Tile production is expected to reach 400 000m^2/year, the bulk of which will be marketed and exported as 'Ribbon Slate'. The company is currently upgrading access roads to the proposed quarry site, via Agate Creek.

Queensland Stone Constructions and Contractors Pty Ltd is developing a new quarry in multicoloured 'slate' (Corbett Formation) on the Gilbert River, 4km south of the Gilbert River quarries. Access to the deposit is being constructed along the river and east to Kidston, via Ortona station. The company plans to process the stone in Cairns using hydraulic rock splitter and multi-blade diamond saw to manufacture tiles, pavers and slabs for local and Japanese markets.

Gympie

Northeast of Gympie, in the Gunalda - Anderleigh area, several small slate quarries have been worked in the Early Triassic *Kin Kin beds*, a widespread sequence of regionally metamorphosed (lower greenschist facies) sediments. The unit comprises slate, phyllite, phyllitic shale, shale and minor silty arenite. Intense deformation of the beds resulted in the development of a prominent slaty cleavage. Slate quarries in this area have been inspected by Krosch (1972), O'Flynn (1976) and O'Flynn & Graham (1987).

Anderleigh Quarries is the only remaining slate producer in the Gunalda-Anderleigh area, and operates a medium-sized quarry (Figure 20) in thinly layered, very fine-grained phyllitic shale (Figure 21). The fresher darker grey to blue-grey slate grades to a khaki green to fawn colour in the upper moderately to highly weathered sections of the quarry. The cleavage is generally uneven, and dips at a low angle to the northeast; parting widths vary from 5 to 50mm. The stone is drilled and loosened with the use of explosives. It is manually graded; two trimming saws are used to

manufacture tiles. First grade stone has a uniform cleavage and thickness of 20mm; seconds have rough surfaces, jointing and discolouration. Performance of these materials in outdoor environments has revealed no major problems with exfoliation, although earlier testing indicated that the material may exfoliate (Krosch, 1972; O'Flynn, 1976). The material is largely used as facing stone and paving material (tiles and crazy paving).

In the Yabba Creek Road area, west of Imbil, **Mary Valley State** has opened up several faces in the poorly cleaved rocks of the Carboniferous to Permian *Amamoor beds*. Small quantities of this multicoloured (grey, blue-grey, mauve, green, brown and black) metasiltstone (slate) have been marketed locally as random pavers and stone for landscaping, inclusing use in walls.

Maitland Downs, via Mount Molloy

In recent years, a number of small-scaled 'slate' quarries or pits have been developed between the St. George River and the Palmer River, on Maitland Downs northwest of Mount Molloy. The slate, a strongly cleaved mudstone, occurs within the Silurian to Devonian *Hodgkinson Formation* which is extensive in north Queensland. This formation consists of deep-water flysch-type sediments (mudstone, siltstone, greywacke and minor limestone and altered volcanics). Several periods of intense deformation towards the end of the Devonian resulted in the development of tight (isoclinal) northwest trending folds and associated steep axial-plane cleavage, and widespread shearing. The strongly cleaved mudstones (slate) are now steeply inclined.

Most quarries are worked intermittently due to poor access in the wet season; the larger operators include **Mr. R.D Joseph, River of Gold Slate Company, Rogina Stone and Slate, and Palmer River Slate.** This fine-grained stone commonly has a phyllitic sheen and is brown to dark grey; yellow to dark red colouration is common in the more highly weathered surface deposits. The total annual production from the region is less than 1000m^3, which is largely marketed in the Cairns area as random and crazy pavers, and for landscaping. High overheads associated with remote location and generally lower quality stone reduce its competiveness with many cheaper imported slates.

Similar materials (in the Hodgkinson Formation) have been previously quarried at Ellis Beach and Mellow Mountain (Julatten) near Cairns.

Warwick

Slate resources occur in the Late Devonian to Early Carboniferous *Texas beds*, a marine sequence of volcaniclastic flysch-type sediments which crops out over a wide area west of Warwick between the Leyburn-Pratten area and south to the Queensland-New South Wales border.

For over 20 years, slate has been quarried from a series of shallow pits within Mining Leases Nos. 31 and 32 (Warwick). Following the removal of the shallow overburden, gunpowder is used to break the stone loose to enable excavation by backhoes. Grading is done by hand. The lessees, **W. & J. Voss,** market this material to the Toowoomba-Warwick-Brisbane areas as 'Leyburn Slate', which finds use as paving material (random paving), cut tiles (processed in Toowoomba), pitching and landscaping stone (O'Flynn, 1983). This relatively hard slate has a well developed cleavage parallel to the steeply dipping beds. Colour varies from mainly blue-grey to silver, green-grey and khaki. Total production for the period 1968-89 was 2610 t.

Volcanic rocks (porphyry, welded tuffs and volcanic flows)

Vast areas of eastern Queensland are underlain by considerable thicknesses of pyroclastics, of mainly rhyolitic to rhyodacitic compositions, and volcanic flows (basalt). In southeast Queensland, the Brisbane Tuff (a welded tuff or porphyry) was quarried for building stone. Some of these quarries were the earliest hard-rock quarries in the State to be developed. Access to known deposits is now limited by extensive urban development and these materials are now in short supply.

Quarries in similar welded tuffs of the Featherbed Volcanics in the Herberton region have been recently opened to supply flagging stone. Only small quantities have been produced to date.

West of Brisbane, basalt flows (bluestone) of the Main Range Volcanics have been intermittently quarried since the turn of the century for building stone, guttering and kerbing; only small amounts of basalt for these purposes are still quarried.

There are no standards or specifications set down for the use of volcanic rocks. However, as many of these extrusive rocks are chemically and mineralogically similar to coarser intrusive igneous rocks - rhyolite (granite), dacite (diorite), and basalt (gabbro) - the standard for granitic rocks (ASTM 615: 1980c) may be applicable and provide a guide to their use.

Sources of volcanic rocks for building stone are briefly described below; all known quarries are tabulated in Appendix 5.

Brisbane

During late Triassic times, violent volcanic eruptions ejected massive clouds of volcanic ash, steam and other gases in the Brisbane region. This super-heated material was subsequently deposited in a sequence of rhyolitic pyroclastics, mainly tuff, welded tuff or ignimbrite and agglomerate, collectively known as the *Brisbane Tuff*. This unit crops out in a narrow belt extending from the Aspley - Chermside area southeast into the central business district of Brisbane, Newstead and Kangaroo Point (O'Flynn & others, 1983). Welded tuff or 'porphyry', as it was sometimes referred, has been widely used throughout Brisbane for building purposes, kerbing, road-pavement gravels and in training walls for port and river developments.

The welded tuffs are unsuited to polishing and were generally rough-dressed for building purposes. The colour was variable - white to yellow, brown, green and mauve; rock fragments including shale clasts from the Neranleigh - Fernvale beds are common. Important quarries were worked at Kangaroo Point, Spring Hill and O'Connelltown; other quarries at Herston, the Exhibition Grounds, Fortitude Valley, Lutwyche and Stafford also produced building stone in the early years, but were later sources of road-pavement gravels. The history of these early tuff quarries and availability of remaining resources have been reviewed by Richards (1918), Wolff (1957), Houston (1967) and O'Flynn & others (1983).

The Kangaroo Point quarry, one of the earliest hard-rock quarries to be opened in Queensland, was intermittently worked from circa.1825 until 1976, by which time available resources had been exhausted and the quarry was closed. Originally, stone was punted across the Brisbane River to the 'stone wharf' near the Edward Street ferry landing. The Commissariat Store and surrounding walls is the oldest remaining structure built of this stone.

The Spring Hill quarry was worked from circa.1858 until 1900, by various contractors employed to construct several churches and Government buildings in Brisbane. This stone was found to be extremely hard and tough, and it was difficult to cut and dress. However, it was widely used, particularly as foundation stones, and in most instances

the stone has performed well for over a century.

Stone from the O'Connelltown or Windsor quarry found use as a base course in many Brisbane buildings including the Treasury Building (1887-89), Government Printing Office (1912), St John's Cathedral (1909), and St Paul's Presbyterian Church (1912).

At present there are no currently operating quarries in Brisbane Tuff and this material is now in short supply for construction purposes, and restoration works in particular. Small quantities of welded tuff have been obtained from building-demolition sites throughout the city but this has not been able to meet the demand for this stone. Several construction and masonry companies have been investigating alternative sources including foundation excavations for high-rise buildings, widening of road cuttings and from the proposed railway tunnels through this unit. South of Brisbane, additional resources of tuff may be present in the Triassic *Chillingham Volcanics*, an acid pyroclastic unit (similar to the Brisbane Tuff) extending from the North Tamborine area, south into New South Wales. The *Aranbanga beds* in the Gayndah area may contain deposits of similar welded tuffs.

Herberton

Rhyolitic to rhyodacitic welded tuffs or ignimbrite of the Carboniferous *Featherbed Volcanics* cover vast areas of northeastern Queensland, and these volcanics are intermittently quarried from several quarries adjacent to the Herberton-Petford road, west of Herberton. Two small quarries - Chinaman Creek and 'BZ' quarries - are occasionally worked by **Mr M. Rogina**, a Cairns based stone mason. This cleaved, grey to light green ignimbrite is split along its cleavage producing a flagstone (20 to 60mm thick) for use as pavers, facing stone and construction of stone walls. Very little processing is carried out, apart from hand or hydraulic splitting.

The Flagstaff quarry within Mining Lease No. 6832 (Herberton) is worked by **Queensland Stone Construction Pty Ltd** under an agreement with the lessees - G.J. and K.F. Bendon. This dark grey, crystal-rich rhyolitic to rhyodacitic ignimbrite is highly fractured with parting between fractures of 40 to 100mm. Flagstone pavers, and facing stone are currently produced from this quarry. The company is looking to establish a processing facility, possibly in Cairns, with multi-bladed diamond saws and hydraulic rock splitters to make 50mm cubes or setts for floor paving. Eventually, it hopes to export these products.

Toowoomba

Olivine basalt flows of the Tertiary *Main Range Volcanics* have been previously quarried from several sources (Richards, 1918; Wolff, 1957; O'Flynn, 1980). The Bridge Street quarry of the **Toowoomba City Council** is now the only quarry from which small quantities of building stone is still occasionally supplied. The stone has been widely used for guttering and kerbing throughout Toowoomba, as well as for structural use in many buildings - St Luke's Anglican Cathedral, Downlands College and Smithfield homestead. However, the bulk of this stone is crushed for road and concrete aggregates; only small quantities find use as building stone. Large resources remain accessible in the existing quarry benches and floor (O'Flynn, 1980), but the encroachment of residential development will limit futher expansion of this quarry.

AUSTRALIAN INDUSTRY AND TRADE

The Australian dimension stone industry is still small by world standards. Australia remains an import rather than export nation, despite long established and new processing plants in the southern States and a somewhat improved competitive position in international trade in recent times.

Commonwealth Legislation, Controls and Assistance

Legislation affecting foreign trade in stone includes the Customs Act 1901, the Customs Tariff Act 1987 and the Customs Tariff (Anti-dumping) Act 1975.

The **Customs Act 1901** was originally intended to protect Australian industries from import competition but, more recently, the Government's view is that industries must be capable of operating under lower levels of protection. The Australian Custom's Service provides import and export documentation to the Australian Bureau of Statistics for compilation of foreign trade reviews and statistics.

The **Custom's Tariff Act 1987** provides statutory authority for imposing rates of duty; customs collections are a major source of revenue. This act has three classes of rates:

- general rates apply to all goods from all countries that do not qualify for Special or Concessional rates of duty;
- special rates apply to goods from specific countries as set out in Schedule 3;
- concessional rates (Schedules 4 and 5 of the Act) apply to sources with particular ownership or for goods subject to tariff quotas.

The **Customs Tariff (Anti-dumping) Act 1975** provides protection for Australian industry against unfair trading.

Import Controls

In the early 1970s, import controls were introduced in response to worldwide recession. Imports of certain excavation and materials handling equipment are subject to import licensing controls based on recommendations of the Industry Commission. Import duty for monumental and building stone, mosaic cubes and chippings fell by 1% from 1st July, 1989. The general rate is now 13% and special rate 8%; a further reduction of 1% in these rates will take effect from 1st July, 1990. The general rate for diamond tipped cutting equipment is 19%; special rate 14%.

Australian Trade Commission (Austrade)

In 1986 Austrade was formed to improve export performance, to facilitate export marketing and to advocate an improved environment for export. It provides direct loans to overseas borrowers for the purchase of Australian capital goods and services. Insurance services are provided to cover Australian exporters against non-payment and unfair bonds and guarantees.

Export incentives include (cash) grants based on proven expenditure for overseas market research and participation in Trade Fairs.

Foreign Investment Policy

The Government's policy recognises the contribution that foreign investment makes to development of Australia's industries and resources. The Department of the Treasury (1989) has published a guide to Australia's foreign investment policy.

The Australian Government's foreign investment policy encompasses the **Foreign Acquisitions and Takeovers Act 1975** and the Foreign Investment Review Board assists the Treasurer in administration of this policy. The Board's main functions are to examine proposals by foreign interests for investment in Australia, to advise the Government on foreign investment matters, to foster awareness of Government policy and to provide guidance to investors on aspects of their proposals.

The Australian Government expects the following categories of proposals by

foreign interests to be submitted for assessment before implementation:

- acquisitions of share holdings of 15% or more in Australian companies that have total assets of $5 million or more;
- takeovers of Australian companies and businesses whose assets exceed $5 million by means other than acquisition of shares; and
- takeovers of off-shore companies that have Australian subsidiaries valued at half the global assets, or assets valued at $20 million or more.

Investment proposals not coming under the Act are:

- proposals to start a new business (one which is not operating in Australia) where total investment is $10 million or more; and
- direct investment by foreign governments or their agencies.

Expansion of existing Australian activities of foreign interests are not subject to examination under this policy.

The Australian Government considers that Australians should have adequate opportunities to participate in development of Australia's industries and natural resources. Specific guidelines are set down for new mining projects. A proposal for a new mining business or project involving total investment of $10 million or more will, as a general rule, be allowed if it has a minimum 50 % of voting strength on the board or controlling body (exploration expenditure is not taken into account).

Foreign Trade

Australian foreign trade statistics (imports and exports) were obtained from the Australian Bureau of Statistics (ABS). This data was compiled from documentation submitted to the Australian Customs' Service as required by the Customs Act 1901. All currency values are in Australian dollars. The import commodity groupings are slate, marble and a third group comprising granite, porphyry, basalt, sandstone and other monumental stones. Prior to 1988, there was no such breakdown of commodities within the export grouping and only total quantity and value statistics were recorded.

However, international implementation of the Harmonised Commodity Description and Coding System, introduced in January 1988, provides a more detailed breakdown of commodity types and differentiates between crude or roughly trimmed blocks and merely cut stone. Comparison of earlier data with post-1988 figures is still possible. Australian import statistics for building and monumental stone which are processed no further than roughly split, squared, or squared by sawing into blocks or slabs are listed in Table 3 and worked dimension stone in Table 4; export statistics for both unprocessed and processed stone are presented in Tables 5 and 6 respectively.

In 1988/89, dimension stone imports were valued at $19.2 million, representing an 80% increase in value over the previous year and far exceeding the 1982/83 value of over $6 million. By comparison, imports of worked dimension stone (cut and finished stone) for the same period rose significantly from just over $5.2 million (1982/83) to nearly $64.5 million (1988/89), and of this figure $9.3 million worth of stone was imported into Queensland. The bulk of these imports were represented by worked articles of marble and granite. These figures represent the value of stone to the delivery point in Australia; some industry sources have indicated that the final total value of both imported blocks (processed in Australia) and imported processed stone would probably exceed $200 million, indicating a considerable value-added component achieved through processing and fixing of the stone.

Exports of Australian stone were much lower in both quantity and value. In the 1986/87 period, stone exports peaked (blocks and slabs) at 3860t valued at

TABLE 3: IMPORTS OF DIMENSION STONE (1983-1989); BY COMMODITY, COUNTRY OF ORIGIN, QUANTITY & VALUE

	1982/83		1983/84		1984/85		1985/86		1986/87		1987/88		1988/89	
	m^2	$(A)	m^2	$(A)	m^2	$(A)	m^2	$(A)	m^2	$(A)	m^2	$(A)	m^2	$(A)
SLATE														
A.B.S. Code 2514.00 (273.11.01 prior to 1st July, 1988)														
China (excl Taiwan)	163 403	831 477	227 824	1 183 037	226 493	1 274 946	313 046	2 129 936	288 267	1 729 074	251 601	1 540 317	707 957	4 272 496
India	310 844	1 623 516	368 065	1 929 153	616 889	3 467 983	458 886	2 916 604	473 778	3 031 492	354 869	2 225 573	1 015 068	5 428 770
Portugal	-	-	-	-	881	4 153	2 600	13 931	9 812	59 508	11 775	73 239	41 698	235 761
South Africa, Rep.	200 847	1 969 763	208 884	2 118 445	351 788	3 318 920	335 121	2 941 059	398 531	3 259 969	137 357	1 421 607	336 146	3 724 104
Other countries	13 470	109 988	10 378	96 366	13 874	106 777	21 237	218 774	21 895	207 978	10 199	159 128	38 213	361 551
Total imports (slate)														
Australia	688 564	4 534 744	815 151	5 327 001	1 209 925	8 172 779	1 130 890	8 220 304	1 192 283	8 288 021	765 801	5 419 864	2 139 082	14 022 682
Queensland	141 732	850 351	153 849	877 612	181 458	1 156 784	191 934	1 301 109	207 282	1 246 257	126 609	764 982	290 044	1 662 790
MARBLE & TRAVERTINE														
A.B.S. Code 2515.11 & 2515.12 (273.12.01 prior to 1st July, 1988)														
	t	$(A)	t	$(A)	t	$(A)	t	$(A)	t	$(A)	t	$(A)	t	$(A)
Greece	46	30 522	73	36 896	135	72 197	213	127 712	74	62 631	12	7 574	139	93 495
Italy	1 968	989 997	2 006	1 087 400	2 026	1 402 054	2 527	2 101 601	1 660	1 857 728	984	946 769	2 343	1 772 722
Yugoslava	17	13 030	18	5 434	17	8 034	-	-	-	-	-	-	35	24 895
Other Countries	165	97 555	201	136 249	218	140 584	104	81 529	42	62 629	86	90 152	171	167 013
Total imports (marble & travertine)														
Australia	2 196	1 131 104	2 298	1 265 979	2 396	1 622 869	2 844	2 310 842	1 776	1 982 988	1 082	1 044 495	2 688	2 058 125
Queensland	414	242 297	416	296 069	373	276 134	532	359 818	306	359 342	146	230 833	199	190 092
GRANITE, PORPHYRY, BASALT, SANDSTONE & OTHER MONUMENTAL STONES														
A.B.S. Code 2516.11 & 2516.12 (granite); 2516.21 & 2516.22 (sandstone); 2516.90 (other monumental stone); (273.13.00 prior to 1st July, 1988)														
	t	$(A)	t	$(A)	t	$(A)	t	$(A)	t	$(A)	t	$(A)	t	$(A)
Finland	404	56 208	697	108 766	544	79 779	476	107 345	417	90 982	200	46 600	594	139 367
India	582	82 369	232	29 162	460	81 308	174	32 466	345	74 157	100	17 725	379	107 392
Italy	144	121 428	242	175 857	1 600	1 258 332	1 371	1 296 796	898	1 156 777	343	545 459	887	1 333 612
Norway	140	45 932	195	49 840	313	92 523	339	118 454	208	91 638	125	67 500	793	335 114
South Africa, Rep.	453	71 204	696	105 292	1 332	161 919	721	132 168	605	137 800	204	53 541	726	275 928
Sweden	112	30 186	27	3 733	55	16 629	107	38 150	212	115 638	148	93 354	174	82 543
Other countries	158	12 968	32	11 565	56	72 187	89	35 873	147	226 181	35	21 313	160	146 115
Total imports (granite, etc.)														
Australia	1 993	420 295	2 121	484 215	4 360	1 762 677	3 277	1 761 252	2 832	1 893 173	1 155	845 492	3 713	2 420 071
Queensland	165	61 048	43	15 501	1 134	787 270	900	818 025	144	168 345	167	180 450	341	460 687
Total value of imports ($A)	**6 086 143**		**7 077 195**		**11 558 325**		**12 292 398**		**12 164 182**		**7 309 851**		**18 500 878**	

(Source: Australian Bureau of Statistics: Overseas Trade Statistics)

nearly $1.7 million; exports of worked stone products (1988/89) were valued at $1.3 million.

Imported Slates

The bulk of slate imported into Australia comes from India, China and South Africa. These slates are used for flooring, paving materials and roofing tiles. Imports between 1983 and 1985 increased from nearly 670 000m^2 to 1.2million m^2 but recorded a slight decline in 1986/87. In 1988, the level of imports was almost back to 1983 levels in 1988 at 766,000m^2. However, recently released figures show a marked increase of 180% in slate imports for 1988/89, to over 2.1 million m^2 valued at nearly $14million. Analysis of 1988/89 imports indicated that India supplied over 47% of slate imports, followed by China (35%) and South Africa (16%). Imports of slate and articles of slate were valued at $2.9 million (1988/89).

Since the mid-1970s, India has made an impact on international markets with its slates and dark to black granites. Indian slate imports into Australia have increased significantly from 310 000m^2 in 1982/83 to 1 million m^2 last year. The unit value for this material is $5.34/$m^2$, well below Australian production costs.

Imports of Chinese slate have increased from 163 000m^2 (1982/83) to over 700 000m^2 (1988/89), representing a 330 % increase. Similarly, imports of South African slate have steadily increased over the 1983-89 period, having increased from 200 000m^2 to over 300 000m^2.

Potential slate resources in Brazil are large but are not fully developed. In 1988/89, Australia imported over 14,000m^2 of Brazilian slate and it is anticipated that this figure will continue to increase.

Imported Granites (& other stones)

Prior to 1988, import statistics for granite, porphyry, basalt, sandstone and other monumental stones were aggregated as a total figure only. It was not until acceptance of the HCDC system in January 1988, that a detailed break down of specific commodity types became available. It is considered that a large component of this broader commodity group comprises granite.

Granite imports from the Scandinavian countries trebled from 473t (1987/88) to over 1 500t (1988/89) which represent 44% of total granite imports, and was valued at nearly $580 000. Finish stones 'Balmoral' and 'Baltic' brown are widely used as is 'larvikite' or pearl-type granites - a well known Norwegian stone with pronounced adularescence or 'moonstone' schiller in the alkali feldspars.

The Italian dimension stone industry is changing emphasis to a greater reliance on imported stone - mainly granite, as traditional sources (Sardinia & Piemonte) become depleted. Many of these granites are processed and re-export to countries like Australia, where in 1988/89 some 25% (887t) of our total granite imports originated from Italy. In 1985/86, 40% of granite imports were from Italy and this decrease in market share is reflected by strong performance by Scandinavian imports.

South African granite imports, mainly black granite have remained constant at about 20% of Australia's total granite imports. Granite imports rose steadily from 453t (1983) to a peak value of 1332t in 1985, but gradually fell to a five year low of 204t in 1988. This decline in imports has now reversed, and in 1989 over 700t of South African granite was imported into Australia.

The value of imported worked granite (1988/89) was $8.43 million; a breakdown of this figure and comparison with previous years is not possible as ABS did not record these statistics.

Marble and travertine imports

The bulk of the marble and travertine imports into Australia over the last five years originated from Italy. In the last financial year (1988/89), over 87% of marble imports valued at $1.8 million came from Italy in finished form. The unit value was $670/t. The total value of

TABLE 4: IMPORTS OF WORKED DIMENSION STONE (1983-1989): BY COMMODITY & VALUE

COMMODITY	HTICC	SITC	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88[1]	1988/89
Natural stone (excl. slate) setts, curbstones, & flagstones		661.31	8 875	5 625	4 821	73 331	31 799	-	80 000
Blocks, sheets, slabs, polished on any face, edge or end		661.32	4 664 017	6 411 840	10 112 281	19 567 372	25 747 982	-	-
Natural stone tiles, cubes & the like (less than 7cm)		661.33	617 802	620 616	958 744	1 134 249	1 444 393	511 758	1 076 834
Marble, travertine, alabaster (cut or sawn)		661.34						4 791 794	11 093 481
Monumental or building stone (cut or sawn)		661.35							7 773 000
Other calcareous stone (cut or sawn)	6802.22.0004							47 599	75 721
Granite (cut or sawn)	6802.23.0005							3 524 480	7 310 590
Other stone (cut or sawn)	6802.29.0006							52 408	347 064
Worked articles marble, travertine, alabaster	6802.91.0007	661.36						6 256 153	19 822 387
Worked articles monumental or building stone		661.39							11 975 000
Worked articles, other calcareous stone	6802.92.0008							8 589	28 808
Worked articles, granite	6802.93.0009							3 733 529	1 121 925
Worked articles, other stone	6802.99.0010							325 028	730 622
Worked slate & articles of slate	6803.00.0011							1 113 018	2 906 260
Total Value - Australia			**5 287 694**	**7 038 808**	**11 075 846**	**20 774 952**	**27 224 174**	-	**64 341 692**
- Queensland			n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	**9 309 085**

Note: 1. Statistics for 1987/88 were recorded for period January to June, 1988; no figures were recorded for previous six months.
2. Worked stone refers to simply cut or sawn, moulded, turned, polished, decorated or carved natural stone.

Abbreviations: n.a. - not available
HTICC - Harmonised Trade, Import Commodity Classification.
SITC - Standard International Trade Classification.

(Source: Australian Bureau of Statistics)

TABLE 5: EXPORTS OF DIMENSION STONE (1983-1988), BY STATE, COUNTRY OF DESTINATION, QUANTITY & VALUE

	1982/83		1983/84		1984/85		1985/86		1986/87		1987/88	
	(t)	$(A)	(t)	$(A)	(t)	$(A)	(t)	$(A)	(t)	$(A)	(t)	$(A)
STATE												
ABS Codes 2514.00, 2515.12, 2516.22, 2516.90 (273.10. prior to 1st July, 1988)												
New South Wales	*	360	650	1 004 891	151	114 221	2	5 634	145	67 755	-	-
Queensland	79	15 350	1 315	379 182	4 213	940 462	2 846	715 164	3 370	1 374 113	168	117 800
South Australia	4	3 532	13	1 379	-	-	41	7 883	6	524	1	276
Tasmania	-	-	-	-	3	1 100	19	10 551	-	-	-	-
Victoria	23	11 502	-	-	5	1 312	50	46 582	87	70 167	2	3 880
Western Australia	-	-	-	-	7	6 420	2	4 000	44	15 188	-	-
Re-exports	16	7 558	22	14 676	39	40 307	140	80 792	208	137 598	63	31 638
Australian total	**122**	**38 302**	**2 001**	**1 400 128**	**4 417**	**1 103 822**	**3 129**	**877 495**	**3 860**	**1 665 365**	**234**	**153 594**
	(* Less than 1t)											
COUNTRY OF DESTINATION												
Canada	-	-	-	-	-	-	-	-	40	29 718	-	-
China, Taiwan Province	-	-	148	238 029	-	-	-	-	-	-	-	-
Germany, Fed. Rep.	-	-	-	-	-	-	-	-	83	26 623	-	-
Indonesia	-	-	154	252 068	116	23 446	-	-	-	-	-	-
Italy	75	15 000	1 295	376 146	4 087	912 795	2 877	714 135	3 328	1 342 745	123	78 394
Japan	-	-	344	506 419	145	99 543	10	9 500	-	-	6	7 800
Malaysia	-	-	-	-	-	-	-	-	41	34 027	-	-
New Zealand	6	4 085	13	1 829	15	9 441	67	51 209	93	57 497	84	48 194
Singapore, Rep. of	21	11 309	-	-	4	10 700	-	-	45	29 907	-	-
United Kingdom	-	-	21	3 036	-	-	-	-	-	-	-	-
Others	20	7 908	26	22 601	50	47 897	175	102 651	230	144 848	21	19 206

(Source: Australian Bureau of Statistics: Foreign Trade Statistics)

TABLE 6: EXPORTS OF WORKED AUSTRALIAN DIMENSION STONE (1988/89); BY QUANTITY AND VALUE

ABS Code			1988/89
6802.10		m2	4 190
		$A	79 545
Worked stone, simply cut or sawn			
6802.21	Marble, travertine, alabaster	m2	2 206
		$A	230 167
6802.22	Other calaceous stone	m2	755
		$A	102 042
6802.23	Granite	m2	12 654
		$A	472 617
6802.29	Other Stone	m2	345
		$A	53 819
Worked stone, cut, sawn and finished			
6802.91	Marble, travertine, alabaster	m2	680
		$A	56 329
6802.93	Granite	m2	10 724
		$A	295 659
6802.99	Other stone	m2	145
		$A	36 283
6803.00	Worked slate	m2	5 292
		$A	51 121
	Total Quantity	m2	36 991
	Value	$A	1 377 582

(Source: Australian Burueau of Statistics)
Note: There are no recorded statistics for the period prior to 1988/89.

imported worked marble and articles of marble exceeded $20 million (Table 4).

During 1988/89, smaller quantities (50 -150t) of marble were imported from Greece and Malaysia; Portuguese marble imports have shown a steady decrease since 1984.

Australian Exports

The Australian Bureau of Statistics has not recorded specific commodity export statistics prior to 1988, and therefore only total export figures can be compared.

Between 1983/84 and 1986/87, there was a sustain period of export orientated production in Australia with an annual average of 3 350 tonnes of stone exported, valued at nearly $1.3 million. However, export figures fell to a 5 year low in 1987/88 of 234t with a value of $153,594 due largely to the decline in production of marble from Chillagoe (Queensland) and granite from the Kimberley region (Western Australia). The total value of all worked stone exported was $1.37 million, representing nearly 37,000m^2 of stone products. The bulk of these materials were made up of granite products - 23 378m^2 (Table 6).

The Australian dimension stone industry has the potential resources for satisfying sections of the domestic market (import substitution) and for establishing export markets.

In recent years, dimension stone production in Japan and Italy has placed greater emphasis on imported stone sources due to a scarcity of domestic resources and environmental constraints. In particular, Japan's vast stone processing industry and materials for its construction industry are, to a degree, reliant on imported stone and this situation is unlikely to change. The quantity of stone imported to Japan has steadily increased at 18% per annum since 1980, with 1988 granite imports exceeding 1.1 million tonnes, mainly from Republic of Korea (26%), China (19%), India (16%) and South Africa (nearly 10%).

Therefore, the Asia-Pacific region is likely to dominate as the most important export market for Australian raw materials and products (including dimension stone) well into the 1990s, with

Japan expected to be the major growth market. Other Pacific-Rim markets such as the Republic of Korea, Taiwan, Singapore, and New Zealand continue to grow and may offer long-term opportunities for Australian exports.

Domestic Trade and Outlook

Domestic dimension stone production figures for 1982/83 to 1987/88 were collated from Annual Reports for each State's Department of Mines. Annual totals for specific commodities are not possible due to differences in units (quantities), fiscal or calendar year and in some States the figures cited do not represent the total production figures. Production figures on a State basis are presented in Table 7. The value of worked stone has increased from $34 million in 1982/83 to over $62 million in 1986/87 (Table 8); figures for 1988-1989 were not recorded.

In 1987/88, sandstone production in both Queensland and New South Wales increased by over 45% on the previous year, to exceed 38 000t. This is a result of the strong demand for a natural and traditional material by the construction industry. A slight increase in sandstone production was recorded in Victoria, but production fell in Tasmania and Western Australia.

Demand for granite is increasing and this has resulted in record production from New South Wales and South Australian quarries; some 19 000t were produced in 1987/88 which was valued at over $3.2 million. Further, it has led to intensive exploration for granite resources throughout Australia, with proposals to develop new quarries and processing facilities in Queensland, Western Australia, South Australia and the Northern Territory.

Marble production in Australia peaked in 1986/87 at the time of major developments in Chillagoe (Queensland), but production has declined since. It is considered likely that domestic demand will continue to be met by cheaper imports even though many Australian marbles are comparable in quality, and display a wide range of colours and textures.

In recent years, basalt or bluestone production has increased significantly in Victoria; only minor quantities are quarried in other States.

The bulk of slate produced in Australia is extracted from South Australian quarries; smaller production is recorded in New South Wales, Queensland and Victoria.

Queensland

In Queensland, renewed interest in dimension stone by architects and the construction industry has led to increased exploration for stone resources, redevelopment of several historic sources, and several proposals to establish new quarries and processing facilities in eastern Queensland by the mid 1990s. The Department of Resource Industries has commenced a comprehensive review of the dimension stone industry in this State to provide technical advice on all aspects of the industry, including those areas where resources may be located and an industry established.

Dimension stone production figures for Queensland are incomplete; those figures presented in Table 7 represent production from Mining Leases and gazetted quarries. The annual total production figures would be higher.

Whilst sandstone has the highest production, followed by marble and slate, there is increasing interest in the State's granite resources and its production is anticipated to rise within the next few years. The Queensland industry has the potential to satisfy significant sections of the domestic market and for establishing export markets.

TABLE 7: AUSTRALIAN DIMENSION STONE PRODUCTION (1983-1988), BY STATE, QUANTITY & VALUE

	1983/84		1984/85		1985/86		1986/87		1987/88	
QUEENSLAND (1)	(t)	($)	(t)	($)	(t)	($)	(t)	($)	(t)	($)
Marble							14 000	5 600 000	12 280	1 703 776
Sandstone	1 120	81 400	3 220	177 600	-	-	1 380	93 013	2 129	138 245
Slate	82	8 005	63	6 410	-	-	71	7 299	88	32 931
Sub-total	**1 202**	**89 405**	**3 283**	**184 010**	**-**	**-**	**15 451**	**5 700 312**	**14 497**	**1 874 952**

(Note 1: Queensland figures are understated as they represent production from Mining Leases and gazetted quarries only).

NEW SOUTH WALES										
Granite	4 245	649 259	5 218	654 131	6 601	893 871	8 688	1 095 521	(2) 9 019	1 653 795
Marble & limestone	1 664	153 733	1 591	151 474	718	48 880	1 030	61 760	1 586	95 460
Sandstone & quartzite	12 602	873 751	9 329	782 395	13 026	1 640 052	12 263	1 991 954	20 170	3 157 507
Other	3 113	272 493	888	100 818	870	99 161	410	41 369	1 435	270 690
Sub-total	**24 624**	**1 949 236**	**17 026**	**1 688 818**	**21 215**	**1 788 986**	**22 391**	**3 190 514**	**32 210**	**5 177 452**

(Note 2: Granite production is probably higher than figure stated, as two quarries have been omitted from statistical collection; Ray, 1988).

NORTHERN TERRITORY	(m^2)	($)	(t)	($)	(t)	($)	(t)	($)	(t)	($)
Slate	(3) 485	8 350	61	8 750	108	27 284	-	-	-	-
Other	-	-	-	-	-		-	-	-	-
Sub-total	**485**	**8 350**	**61**	**8 750**	**108**	**27 284**	**-**	**-**	**-**	**-**

(Note 3: Source - Australian Mineral Industry Review for 1986)

	(1984)		(1985)		(1986)		(1987)		(1988)	
SOUTH AUSTRALIA (4)	(t)	($)	(t)	($)	(t)	($)	(t)	($)	(t)	($)
Bluestone	400	21 000	230	17 000	240	7 000	176	2 360	440	4 400
Granite	4 655	647 000	5 876	896 000	9 410	1 367 000	9 724	1 394 197	10 002	1 564 708
Dolomite & limestone	18 247	373 000	16 682	327 000	9 705	227 000	11 604	264 934	11 976	289 742
Quartz & sandstone	1 911	52 000	783	35 000	1 919	84 000	1 961	120 042	1 355	81 675
Slate	9 979	583 000	10 775	724 000	9 749	1 020 000	7 049	1 039 130	10 444	1 403 466
Sub-total	**35 192**	**1 676 000**	**34 346**	**1 999 000**	**32 023**	**2 705 000**	**30 514**	**2 821 663**	**34 217**	**3 343 991**

(Note 4: South Australian figures are recorded for each calendar year)

TASMANIA	1983/84 (m^3)	1983/84 ($)	1984/85 (m^3)	1984/85 ($)	1985/86 (m^3)	1985/86 ($)	1986/87 (m^3)	1986/87 ($)	1987/88 (m^3)	1987/88 ($)
Freestone	233	7 580	295	23 810	556	8 019	1 130	6 030	226	7 126
Granite		-	6 768	41 340	4 040	40 400	455	34 333	925	210 900
Granite (red)	504	3 240	-	-	-	-				
Other	54	25 550	63	40 560	2 540	41 940	8 760	62 820	2 083	14 373
Sub-total	**791**	**36 370**	**7 126**	**105 710**	**7 136**	**90 359**	**10 345**	**103 183**	**3 234**	**232 399**

VICTORIA	1983/84 (t)	1983/84 ($)	1984/85 (t)	1984/85 ($)	1985/86 (t)	1985/86 ($)	1986/87 (t)	1986/87 ($)	1987/88 (t)	1987/88 ($)
Basalt	*	*	*	*	1 800	750 000	28 600	866 700	n.a.	n.a.
Granite	*	*	*	*	2 300	430 200	2 500	295 000	n.a.	n.a.
Sandstone	*	*	*	*	800	12 400	14 200	70 500	n.a.	n.a.
Other	*	*	*	*	14 200	313 900	700	336 100	n.a.	n.a.
Sub-total (t)	**17 814**	**623 234**	**28 400**	**1 342 900**	**19 100**	**1 469 500**	**46 000**	**1 586 300**	n.a.	n.a.

(* Individual production figures for basalt, granite, sandstone and other stone are not available for the period 1983-85, Victoria).

WESTERN AUSTRALIA	1984 (m^3)	1984 ($)	1984/85 (m^3)	1984/85 ($)	1985/86 (m^3)	1985/86 ($)	1986/87 (m^3)	1986/87 ($)	1987/88 (m^3)	1987/88 ($)
Quartz	2 272	102 224	2 644	118 980	2 233	100 481	1 861	83 755	294	13 210
Quartzite	160	2 880	-	-	-	-	-	-	-	-
Black granite	-	-	-	-	145	45 000	585	50 000	-	-
Sub-total	**2 432**	**105 104**	**2 644**	**118 980**	**2 378**	**145 481**	**2 446**	**133 755**	**294**	**13 210**

(Western Australian figures for 1984 are based on a calendar year, later figures are based on fiscal year in line with most other).

New South Wales

Strong demand for natural stone by the construction industry resulted in a resources assessment program by the New South Wales Department of Mineral Resources. A comprehensive study of dimension stone was completed by Ray (1988) and updates earlier work by Wallace (1971). Production statistics are presented in the New South Wales Mineral Industry Annual Reviews and Annual Reports of the New South Wales Department of Mineral Resources.

Total dimension stone production, in particular granite, has increased steadily since 1985/86 from 21 215t to 32 310t last year. The value of this stone was over $5million. Much of this increased production is attributed to the improved efficiency of quarrying processing techniques, while sustained demand reflects a general trend to use natural stone as cladding in modern construction.

This strengthening of the domestic market is creating a base from which an export industry is beginning to develop although to date, exports have been small mainly to New Zealand, Pacific Island nations and the United States.

Over 80% of the State's sandstone production is centered in the Gosford-Somersby area of the Central Coast. Over the past decade, sandstone output has remained constant with an average annual total of 10 000t, until 1987/88 when it nearly doubled to 20,170t.

Granite production has rapidly increased with both higher tonnages and diversity of granite rock types available. Flynn (1988a,b) has reviewed the New South Wales granite building stone industry. Since 1983/84, granite production has increased from 4 245t to over 9 019t, with production probably higher than stated, as two quarries were omitted from the statistical collection (Ray,1988). The major granite sources are located at Eugowra, Mulyandry, Tocumwal, and several other quarries have been upgraded or recently developed. The largest producer is Melocco Limited, a subsidiary of the Boral Group, which, in May 1988, acquired Granites of Australia Limited based in Canberra. Other producers are listed in the Mineral Industry 1988 Review, and include Central West Granite Supplies (Eugowra), Martin's Granite Quarries, Lachlan Valley Granite Pty Ltd, and J.R. Martin. The Cullen family's company Australian Granodiorite Pty Ltd had proposed to build a plant at West Wyalong to process stone from its granite deposits, and feasibility studies are still continuing. Similarly, Western Granites Company Ltd, a subsidiary of Bathurst Bricks, has proposed to build a $20 million sawing and processing plant at Raglan, near Bathurst.

In 1986, Stonetile Pty Ltd, a subsidiary of Natural Stone (Holdings) Pty Ltd, commenced producing granite tiles (10mm) bench tops and other interior items from a wide range of Australian granites at the Company's Orange (NSW) plant. The company expects to export 80% of its product with exports to U.S.A., Hong Kong, Japan, Canada and New Zealand. A new processing plant has recently been commissioned at St.

TABLE 8: VALUE OF WORKED BUILDING & MONUMENTAL STONE IN AUSTRALIA (1983-1989)
SITC CODE: 980.13

Cut, shaped or polished natural stone or natural stone products; values of sales or transfers out ($A x million)

1982/83	34.644
1983/84	37.475
1984/85	41.957
1985/86	Note 1
1986/87	62.762
1987/88	Note 2
1988/89	Note 2

(Source: Australian Bureau of Statistics)

Note 1: There are no statistics available for 1985/86

Note 2: Statistics for 1987/88 and 1988/89 are not recorded separately, but are aggregated or compiled for the 3 years 1988 to 1990.

Marys (Sydney) by Australasian Stone Products.

Only four marble sources are exploited from quarries located at Wombeyan, Gocup, Orange and Caleula. In 1987/88, they produced only 1 586t valued at $95,000. Domestic demand is met mainly by cheaper imports.

Coloured slate for decorative purposes is extracted from a number of small quarries.

Northern Territory

There has been only minor dimension stone production in the Northern Territory, mainly flaggy sandstone, slate and granite. Coloured flaggy sandstone has been used for building purposes at Alice Springs and Ooramina sandstone is supplied by Stonecraft of Australia Limited. Production figures are not available, for these stones. Slate production between 1983 and 1986 totalled 654t but has now ceased.

A quantity of sample blocks of 'Darwin brown' granite were quarried by Mitchell Drilling (Brisbane) during 1988 and early 1989. The bulk of this material was sent interstate (New South Wales) where tiles were produced for local and export markets. To date, there have been no stone exports.

South Australia

As South Australia is deficient in suitable construction timber, the early settlers turned to stone for building purposes and sources of stone in the State have been well documented (Jack, 1923; Spry 1975-81; Ludbrook, 1980; South Australian Department of Mines & Energy, 1983). Currently, a catalogue of building stones including test data is being prepared by the South Australian Department of Mines and Energy (Young, in preparation).

Annual total dimension stone production figures for the 1983-87 period reflected a steady decrease in tonnage from 35 192t to 30 514t, but at the same time a general increase in value from $1.67 million to $2.82 million. This decline in production is attributed to reduction in extraction of bluestone, dolomite, marble limestone, and slate. However, granite production has nearly doubled in tonnage from 4 655t to 9 724t during this period. In 1988, demand for granite continued to rise and is reflected by increased granite production to over 10 000t and mirrored by an accompanying increase in slate production to 10 444t. In 1988 the total value of dimension stone production was $3.34 million.

The major granite producers are Amatek Limited (formerly Monier Granite), Martins Granite Quarries Pty. Ltd. and Calca Granite Pty. Ltd. with operating quarries in the Black Hill norite (Imperial & Austral black granite), Kingston and Calca, near Streaky Bay (Calca red). Granite slabs with various finishes for both building and monumental purposes are produced in Adelaide by Amatek Limited and Martins Granite Quarries Pty. Ltd. Nelson (1989) reported that at least a dozen new quarry sites for granite are to be developed to supply the increased Australian demand for stone cladding, kerb stones and paving materials.

Slate or flagstone for use mainly in paving is obtained from Mintaro, Auburn, Jones Hill, Wistow, Wilunga, Spalding and Oladdie (Carrieton). 'Angaston marble' or 'Barossa white' marble has been quarried in the past from the Barossa region. Porous limestone is used for building purposes in the Mount Gambier area.

Tasmania

A review of Tasmania's building stone industry for the Tasmanian Development Authority is nearly completed (Sharples, 1990). Annual production figures for dimension stone were sourced from the Annual Reports of the Director of Mines, Tasmania for 1983/84 to 1987/88.

Total annual production increased significantly from 791m^3 (1983/84) to 10,345m^3 (1986/87), but fell sharply last year by nearly 70% to 3 234m^3 (1987/88). The bulk of this production was in granite from Coles Bay and sandstone or freestone from sources near Hobart,

Pontville (Etna Stone Pty Ltd), Cobbs Hill, Bothwell, Melton and Mowbray. Quarries are also located near Launceston at Nunamarra and Braemar.

Between 1984 to 1986, small quantities (< 25t) of stone were exported to Papua New Guinea and New Zealand, but there has been no stone exported since 1986.

Victoria

Over the past four years, total production of dimension stone has doubled in tonnage from 17,814t to 46,000t (1986/87), due to substantial increases in basalt and sandstone production (Table 7), which represents over 90% of State's total stone production. It's value has increased from $0.62 million to $1.6 million for the same period. As early as 1983/84, dimension stone producers were experiencing some difficulties in meeting the increased demand for stone .

In Victoria basalt or bluestone is in strong demand with production centred near Kyneton-Marmsbury area (Melocco) and from Port Fairy (D. Bartlett). Some basalt is also quarried from Footscray and Warrnambool.

Granite production which now represents about 5% of total stone production has remained relatively unchanged at about 2,500t/ year, although this figure is probably understated as not all granite quarries come under the Extractive Industries Act, 1966. Important granite sources occur in the Harcourt area where the producers are Harcourt Granite Pty Ltd and Johnstone Granite Quarrying Pty Ltd.

Slate is quarries in the Mansfield and Castlemaine areas. In 1988/89, slate was exported to New Zealand and Korea.

Marble is not currently quarried, but a proposal to extract blocks (for export) from the Bindi area has been submitted by Waring & Purdy.

Western Australia

The status of West Australian stone quarrying and processing industry is difficult to assess owing to the intermittent operations of many quarries (to only fulfill orders or restock) and the dual administrative arrangements for such quarries under either the Mining Act (for Crown land) or the Town Planning and Public Works Department Act (for freehold land). During the 1984 to 1987 period, total annual production has remained relatively steady at about 2,500 t/year (Table 7), but its value has increased slightly from $105,000 to $134,000. The earlier figures represent quartz (Mukinbudin) and quartzite (Toodyay) production, with the latter ceasing production in 1984/85.

In Western Australia, recent exploration and development efforts have concentrated on the black granite (dolerite) resources in the Napier Range of the Kimberley region, where granite production commenced in 1985/86; production was not recorded in 1987/88. The main producers include Black Granite Pty Ltd, a subsidiary of Hang Lung Development Co. Ltd, Kimberley Granite Resources Pty Ltd, Black Swan Pty Ltd and Austone Limited. Additional mining tenement holders in the Napier Range area include Kimberley Colourstone Industry Pty Ltd, Neve Heimat Pty Ltd, Kimwest Granite Co. Pty Ltd in association with Northwest Granite Pty Ltd, and Readymix Group (W.A.) Ltd (Kimberley pearl). Black Granite Pty Ltd has a small facility at Muchea for processing to supply both local and export markets but a new processing plant is to be commissioned in 1990. Granite has been exported to Japan and New Zealand, and in the past few months Austone Limited is reported to have made additional sales to Hong Kong, Singapore and Taiwan.

Southeast of Exmouth, various coloured granites including black granite are held by Australian Marble and Granite (Glenflorrie homestead) and Moroonah Marble and Granite Pty Ltd (Moroonah station). Orbicular granite in the Mount Magnet area east of Geraldton is held by Australian Orbicular Pty Ltd and previous tenements by York Granite Supplies which also has granite

interests in the southwest of the State at Jerramungup, Kwolyin and Namban. Australian Granite and Marble has title to a deposit of green-grey porphyritic granite in the Albany area. Maritana Gold NL is planning to develop quarries in the Fraser Range area, east of Perth. Other coloured granites have been found in this area.

Since the early 1900s, **sandstone** has been quarried from the Donnybrook area and is currently supplied by Donnybrook Stone and Rockspring Resources. Quartzite (Hardey Sandstone) for use as flagstone is won from Karratha by Pegardi Pty Ltd.

Soft, porous **Tamala Limestone** is quarried from near Wanneroo by Carabooda Limestone for use as blocks, pavers and cladding material (internal and external).

QUARRYING AND STONE PROCESSING TECHNIQUES

Most dimension stone quarries are of the open-cut type, but underground mining for limestone and marble has occurred overseas using a room-and-pillar pattern. The most important parameter for any quarry is economic efficiency. This is achieved by planned quarry development and design, extraction of premium-grade stones, preferably from several sources in a local area, and by minimizing transportation costs and stone wastage. The typical Australian operation has a 40% or higher wastage factor at the quarry. However, higher wastage rates are recorded in individual quarries from some of the major overseas producing countries such as Finland (85%) and the Republic of South Africa (90%).

Initially, soil cover and rock overburden are removed by bulldozers or other earth-moving machinery to expose the stone surface to be quarried. This may be either an exfoliated surface (Pozieres or Mount Surprise) or large boulder deposit (Gracemere or Sundown Road, near Mount Garnet). It may be necessary to remove overburden by drilling and blasting. Flat-lying deposits such as slate, laminated volcanics and thickly bedded sandstone, can be worked as either benched or shelf quarries into the hillside.

The initial development of a vertical quarry face is achieved by excavating a trench (often with the use of explosives) or by the removal of key blocks to relieve the inherent strain in the rock. Traditionally, fixed derrick cranes or gantry cranes were suitable for the deeper pit-type quarry, but this limited the surface extent of quarries to the length of the boom or arm. However, modern lifting and transportation equipment has overcome this limitation. Mobile cranes and front-end loaders capable of handling blocks weighing up to 25t are increasingly common in stepped quarries; loaders are particularly versatile in transporting blocks and removing waste materials.

The widely practised **Finnish quarrying method** involves four stages of quarry development following the initial removal of overburden. The primary stage requires a 300 to 4000m^3 **stope block** to be produced, which has been freed from the main rock mass by simultaneous blasting along vertical and horizontal drill lines. In the second stage, the stope block is drilled and split into a number of smaller blocks (up to 100m^3 per block) which are tilted or toppled from the quarry face onto a sand bed. This secondary block is further split into appropriate sized blocks, largely controlled by the capacity of the end loader or crane, and the minimum block size required by the processing facility. During the final stage, these blocks are squared by fixed single-blade saws (Monolama), diamond saws, or wire cutting methods such as diamond wire.

Dimension stone blocks are quarried by the following extraction techniques.

Drilling Techniques

Mechanized drilling combined with controlled blasting or expansive compounds is the most widely used technique for primary and secondary block production for granite and to a lesser extent for sandstone and marble. Hydraulically operated **in-line drilling equipment** is usually rail-mounted, but crawler-mounted rigs can also be used on flat terrain. Single or multiple drills with hole diameters ranging from 22 to 40mm simultaneously drill to the quarry floor or to depths of between 4.5 and 8m. Most modern drilling rigs have a 90° turnable head capable of drilling both vertical and horizontal holes. These drills can be mounted on extendable booms or arms enabling the drilling of parallel drill lines.

Drilling and broaching, a variation of the above technique, is a traditional method of cutting all types of stone. The drilling and broaching tools are mounted on a quarry bar and frame, along which they can slide and be locked into

position to permit drilling of closely spaced or overlapping holes. The intervening web of rock is removed by a spade-shaped broaching bar actuated by pneumatic drill.

The **close-spaced or stitch-drilling method** involves drilling a series of closely spaced holes, only a few centimetres apart, in a single plane. By using feathers and wedges, hydraulic splitters, explosives, expansive compounds or winches, a relatively clean break surface can be created.

The use of **channelling or guttering machines** is one of the oldest methods for cutting marble, limestone and sandstone, but it is now rarely used. Sets of chisel-edged steel bars are used to excavate a 50mm slot in the stone to the quarry floor. This technique is still used in Ziegler's quarry, Helidon.

Wire Saws

Wire saws are widely used for cutting marble and limestone, and still find use in some sandstone quarries (Gosford, N.S.W.). The wire, which acts as a guide for the abrasive compound, is passed over a system of pulleys around the perimeter the rock to be cut. It is then drawn through the rock under tension.

The **helicoidal wire cutting technique** incorporates a moving loop of steel wires up to 2000m in length, which is kept in constant contact with the rock surface by tension. For marble, limestone and sandstone, the cutting edge is a slurry of sand and water carried along the whole cut by the helicoidal wire - essentially three strands of wire wound in a spiral. The diameter of the wire varies from 4 to 6mm and has a surface speed of 4 to 8m/sec. A harder abrasive such as silicon carbide is used for granite. Compared to other cutting methods, it is labour intensive, and has slower cutting speeds, rapid cable wear and uneven distribution of abrasive, resulting in lower production rates. Stone wastage is minimal.

The **diamond wire cutting method** is an important technical innovation developed in the last few years. It consists of a small multi-strand steel cable, 20 to 80m long and 5mm in diameter, along which are inserted small cutting rings or beads (10mm in diameter) impregnated or coated in diamond. The loop or noose is passed around the perimeter of the area to be cut, achieved by drilling intersecting holes to complete the loop. It has been used successfully with Chillagoe marble but not yet with granites because of their hardness. The advantages of this system are the high cutting speeds (8 to 13m^2/hour).

Chain Cutters or Saws, and Trenching Machines

These machines (Figure 22) provide high cutting speeds and are quite effective in softer stones such as marble and sandstone. They are commonly used at Helidon (either the Hydrapower or Vermeer crawler trenching machine) and Chillagoe (Korfmann stone cutting machine). The cutter consists of a track or rail-mounted frame which supports an arm with an effective cutting depth of up to 5m. Along the entire length of this arm runs a linked chain to which are mounted teeth armoured with either tungsten carbide, diamond or other hardened materials. Single channels from 200mm to 400mm width are cut down to the quarry floor, and horizontal undercutting can also be achieved. At Helidon, rates of 30m/hour in sandstone have been achieved in cuts to 2.5m depth. The cutters are limited in their use by the length of the cutting arm. Early machines had a high wastage factor but recent models have a much narrower cut.

A relatively recent development is the **diamond belt saw or cutter** which substitutes the link chain with tough, mechanically driven belts of wear resistant plastic, cored by multiple steel wires and diamond studded inserts. Its main advantages over metal-linked chains are increased cutting speeds and more durable cutting inserts.

Both systems are restricted to flat terrains not exceeding 25% slope.

Circular Saws

The use of **diamond-bonded circular saws** in quarries has been limited by the shallow depth of cut, but they are in use overseas. In Queensland, their use is restricted to hand-held units suitable for sample blocks only.

Jet Piercing, Flame Cutting or Thermal Lance

This is a common method for producing large blocks from granitic masses, and is particularly effective in quartz-rich granites. A vertical channel or slot, 70 to 110mm wide and up to 10m deep, is produced by a high temperature jet flame (2000°C) fed by compressed air and fuel oil through a hand-held lance. As the flame passes over the rock, cutting results from a combination of differential expansion, partial fusion and thermal shock leading to thin flaking or spalling (5 to 7mm each pass). Horizontal holes are drilled at the base of the block and small charges are detonated to break the block loose from the quarry bed.

Hydraulic Piercing

Hydraulic piercing utilizes a very high pressure water jet and added abrasive to cut the rock. It is still in the development stages but has been used in granite quarries overseas (Patton, 1974) and promises to be more economical than jet piercing (Lock, 1989). This technique has not been used in Queensland.

Splitting by Explosives

Traditionally **gunpowder or black powder**, a mixture of potassium nitrate (oxidizer), charcoal and sulphur (combustibles), has been used in block production. It is a low-velocity or propellant type of explosive, but under extreme confinement the reaction proceeds at a rate similar to that of high explosives. In recent years, it has become more common to use **detonating cord** (Cordtex or Primacord) which is safer and more manageable than black powder. Detonating cord contains a core of high-velocity explosive PETN (pentaerythriol-tetranitrate) which detonates at speeds of up to 7000m/sec.

Controlled trial blasting is necessary to ascertain the optimal distance between drill holes, blast size and filling. High-velocity explosives are damaging to the stone and are not recommended for use in dimension stone quarries.

A recent development is the use of **K-pipecharge** by Oy Forcit AB. This product is a light charge of NG-explosive encased in a plastic tube, and is reported to be widely used overseas.

Splitting with Expansive Compounds

Non-explosive **expanding compounds** (Bristar or S-Mite), when mixed with water to form a slurry, expand and harden in drill holes transmitting a force in the order of 3000t/m^2. The time required for crack formation is 10 to 20 hours at 20°C. The drill-hole spacing is dependant on the physical properties of the rock, but generally is 7 to 10 times the preferred hole diameters of between 38mm and 50mm. This technique has the advantages of being simple and safe, and does not produce damaging stresses in the rock.

Stone Processing

In the past, building stone has been widely used in the form in which it was collected, either as field stone or as non-dressed stone directly from the quarry. Naturally fissile stones, such as slate, shale, siltstone and many fine-grained sandstones are a common source of field stones, and often represented a convenient source of **flagstone** for use in paving, dry-stacked and mortared walls and other landscaping purposes. Irregularly shaped and sized **rubble** or broken pieces of stone are still used in the rough construction of walls, in foundations, and as paving materials. Non-uniform sized, rectangular blocks of subgrade quarry stone can be squared by sawing or splitting to form ashlar which is randomly set into walls.

Traditionally, stone processing, (the shaping and application of surface

finishes) was carried out by skilled craftsmen - a time consuming, labour intensive and expensive process. Following the introduction of mechanized processing machinery in the 1930s, stone processing has progressed to the current fully automated plants achieving both high outputs (up to 150,000m^2/year) and higher tolerances in the finished product (≤ 0.5mm). The current Australian total production of granite slabs and tiles is estimated to be in the order of 40,000 to 50,000m^2/month (West, 1989), and of this figure 70% would be directed to architectural work with the remainder finding use as monumental stone. This trend to automation will continue into the future with developing technology.

Today, the bulk of the building stone produced throughout the world has been processed to some degree in a mill or plant to enhance the natural colour, texture and structure of the stone. Processing of stone - the cutting or slabbing, grinding and polishing stages - is a value-added industry in which the component value of the raw material (stone) is small by comparison with the value of the end product. The industry is still dominated by European processing countries, particularly Italy, Spain, Greece, and the Scandinavian countries. However, the technological developments witnessed in the past 20 years, have resulted in great expansion of the stone processing industry in Asia, particularly in Japan, Taiwan, Korea and India. In the mid 1980s, total annual world production was 23 million tonnes (West, 1989).

Although the world's stone usage for architectural purposes is large and demand is rapidly increasing, development of Australia's (and in particular, Queensland's) vast resources requires considerable capital investment and development of industry skills. However, few companies have sufficient capital resources or expertise to invest in expensive stone processing machines in fully automated plants having establishment costs exceeding $A6 million. Current high interest rates and cost of labour compared with our southeast Asian competitors, regulated labour market, taxation structure in the Austalian economy and disinclination of Australian investors to invest in new technology in no way encourages development of the industry. Adequate return from such high initial capital expenditure requires significant outputs which target both the domestic and overseas markets.

Accurate production figures for Australian processed stone are difficult to obtain, but a brief summary of the A.B.S. returns is presented in the earlier section on Domestic Trade. West (1989) has reviewed the Australian stone processing industry on the basis of a questionnaire sent to over 120 companies throughout Australia. The response to this survey was poor (only 15% of recipients replied), due largely to the secretive and individualistic nature of these companies which operate essentially as cottage-style industries. Therefore, detailed analysis was not feasible but some useful fundamental industry profiles were highlighted. It was found that all capital cities (except Darwin) have full processing facilities dedicated to either a single stone type, a range of materials or a fixing company.

Generally, the single-stone type processing has associated quarry operations. A wide range of sandstone products is locally manufactured from the *Helidon Sandstone* (Comerford Sandstone, Lockyer Sandstone, and J.H. Wagner and Sons Pty Ltd), the *Razorback beds* in the Stanwell area (Stone Products Pty Ltd) and from sandstone of the *Coffin Hill Member*, west of Georgetown (Ribbonstone Pty Ltd). Sandstone Emporium at Alberton south of Brisbane and Mr. R. Story of Ipswich have sandstone processing facilities but no quarries; rather, they obtain stone from existing producers in the Helidon area.

Dacca Pty Ltd has recently established a granite processing plant in the Euri

Creek area, west of Bowen. Feasibility studies of proposed granite processing plants in eastern Queensland are currently being investigated by Granite Resources Limited, Talflag Holdings Pty Ltd, and New England Granites Pty Ltd.

Australian Transpacific Marble (previously Exville Pty Ltd) and Cairns Marble process marble blocks from the Chillagoe region.

Invariably, the multiple stone processors are associated with monumental masonry businesses, and in Queensland these include:

Batstones Stone Masonry
Melrose & Fenwick (Mackay)
MMS Memorials
Gori Terrazzo Tiles (Cairns)
T. Wrafter & Sons
R.F. Rolfe & Co Pty Ltd (Townsville)
R.C. Ziegler Monumentals

Two major N.S.W. processing companies - Stonetiles Pty Ltd (Orange) and Australasian Stone Products (St. Marys) purchase all their stone requirements from various quarries throughout Australia, including several Queensland granites.

A large proportion of the actual stone fixing is performed by independent contractors, many of which have processing facilities. They include companies such as Dimastone (Strathpine), Faybrook Pty Ltd (Caboolture), CMS (Labrador), Domous Industries Pty Ltd (Burleigh Heads and Townsville), Marble Tile Co. (Eagle Farm) and John Petrie & Associates (Northgate). The increasing availability of stone tiles and slabs has facilitated development of this industry sector.

Further, there is an increasing number of relatively new firms specialising in the import of polished stone and secondary processing. Most of these operations are based in southeast Queensland.

Shaping of the mill blocks is achieved by a combination of various saws, while finishes range from rock face (an irregular, broken surface), to sawn, scabbled, exfoliated, etched, honed and polished surfaces. The stages of processing are determined by the product required.

Stone Products

Since the turn of the century, significant changes have occurred in architecture, particularly with respect to stone application and its use. During the 19th Century, stone (mainly sandstone, with lesser quantities of granite and marble) was used in Queensland architecture as structural or load bearing materials. Traditional masonry blocks were used for wall construction, stair treads and other structural units including lintels, sills, arches and mullions.

The use of structural stone members has been in decline for some time due to increasing competition from modern, less expensive building materials (reinforced concrete, steel, aluminium). Modern construction methods have seen the development of a skeletal frame, a combination of structural steel or reinforced concrete, as the load bearing unit and the use of stone as a non-load bearing cladding (veneer) or curtain wall. Increasingly, this has led to the use of thinner materials (in some cases less than 10mm) to reduce weight and costs, and some failures with their use have been documented in the United States (Spry, 1988). Generally, the stone is attached or anchored to the structural support system by either brackets, clamps, hooks, struts or pins. The minimum permissible thickness will always depend on the specified use, the strength, and other physical properties of the stone. Very thin stone (< 20mm) can be cast in reinforced concrete or backed by fibreglass to provide additional strength.

Perry & others (1989) refer to thick (60-100mm), moderate (40-60mm), thin (30-40mm), and very thin cladding (<30mm). Research and design by the Australian and U.S. building stone industry have resulted in a recommended minimum thickness of about 50mm for external cladding, in some cases 100mm thick cladding has been used by Monier Granite, now Amatek Pty Ltd.

Historically, slate and certain flagging stones have been used as **roofing tiles**, but generally Australian slates do not meet specifications for such use (ASTM C406-58).

Stone tiles manufactured from granite, marble and sandstone are becoming more widely used as floor (paving) and wall tiles (cladding) in both exterior and interior situations. Their acceptance by the construction industry has led to increased production of sandstone tiles in Queensland, and the recent commissioning of two new granite-tile processing plants in N.S.W. (Stonetile and Australasian Stone Products). Standard dimensions are 300mm x 300mm and 300mm x 600mm, but lengths of 1800mm can be manufactured; thickness is generally between 7 and 30mm. Tolerances are ≤ 0.5mm .

Fissile stones - slate, flagging stone and other slabbed stones (sawn or split) - can be used as a **paving material**, usually of irregular dimensions (random paving) or as non-dressed stone (crazy paving).

The demand for **monumental stone** is declining, largely due to the trend to cremations rather than burials. In Queensland, a large proportion of the monumental mason's work has been associated with domestic and commercial projects, including bench tops and cladding for shop fronts and foyers.

Crushed marble aggregate is still widely used to manufacture terrazzo - a very popular flooring material in the late 1950s and 1960s. Terrazzo, mainly for interior commercial applications such as floor tiles and wall panels, is still manufactured in Queensland by Ensat Building Services, Dimastone Co., Marble Tile, Marble Design, R.F. Rolfe & Co Pty Ltd (Townsville). Gori Terrazzo Tiles (Cairns) ceased manufacturing terrazzo in early 1989.

Polished reconstructed granite is manufactured by Precast Concrete Pty Ltd, Wacol (southeast Queensland). It has been successfully used for moulded exterior panels in several Brisbane buildings.

Benedict stone, developed by James Benedict, is a man-made stone composed of crushed Brisbane Tuff bound by coloured cement. Benedict stone was manufactured at Bowen Hills and can be seen in Newspaper House (Queen Street) and the old Shell House (301-307 Ann Street), now CPS Credit Union Centre.

Slabbing and Cutting

Slate and other fissile stone require only minimum processing, and are usually **hand split** using crowbars, hammers, wedges and chisels to produce the required thickness of sheet or tile. This method is widely used by the majority of this State's slate producers.

Slabbing and cutting of mill blocks depends to a large degree on the stone's physical properties of grain, rift (the direction in which it splits most readily), foliation and flexural strength. It is also dependent on the end product and type of stone to be processed (soft sandstone or hard granite). In the first stage of processing, all blocks are reduced to slabs or panels to any specified thickness by various cutting techniques such as frame or gangsaws, large diameter diamond saws, and multi-bladed diamond saws.

For efficient handling, the minimum block size is about $2m^3$ (or 2m x 1m x 1m) and blocks up to $9m^3$ (or 3m x 2m x 1.5m) are capable of being processed. Operating costs will increase directly with the use of smaller blocks and with production of thicker slabs. Rounded tors or boulders are not easily handled and require squaring. This is achieved by using either a single-blade saw (Carrington Marble, Chillagoe) or drilling and splitting of the tor (West Moreton Transport, Gracemere).

Frame saws or gangsaws are the most widely adopted method of slabbing stone blocks. The saw comprises a reciprocating frame holding up to 100 parallel steel blades which cut or wear away the stone using a mixture of water

and an abrasive such as sand, chert, cast iron, steel shot or silicon carbide. The supply of abrasive is maintained by recirculation and replacement of worn abrasive. The area of output/m^3 varies from about $30m^2$ for 20mm wide slabs to $50m^2$ for 10mm wide slabs. In conventional frame saws, the blades move in a horizontal plane cutting down into the fixed block. Systems using fixed blade and the upward movement of the block are rarely used in Australia, as are vertically mounted frame saws. **Diamond or tungsten-carbide toothed frame saws** have a straight-line blade action and are suitable for slabbing softer rocks, including Chillagoe marble (Australian Transpacific Marble Pty Ltd). The cut widths vary with each type of frame saw but usually fall between 5mm and 15mm. The 'cala' or downward cutting speed in granite using a conventional frame saw is about 2 to 5cm/hour; rates of about 10 to 40cms/hour are possible with marble but high speeds produce rougher surfaces requiring further grinding and honing.

Steel-shot fed gangsaws are incorporated in the processing plants of T. Wrafters & Sons (Brisbane), R. Story (Ipswich), Dacca Pty Ltd (Bowen), Stone Products Pty Ltd (Rockhampton) and Ribbonstone (Cairns).

Large diameter (to 4.0m) **circular block** saws with diamond or other abrasive inserts are applicable for all granite types, marble and sandstone (Figure 23). This system is widely used for slabbing in Queensland by sandstone product manufacturers (Comerford Sandstone, Lockyer Sandstone, J.H. Wagner and Sons Pty Ltd, Helidon Sandstone Co. and Sandstone Emporium) and monumental masons. Optimum cutting speeds (depending on rock type) range from 0.8 to $2m^2$/hour, and cut width from 12 to 15mm. The entire operation is usually computer controlled. The saw blade is guided by laser beam and can produce any thickness of slab with an excellent, sawn surface.

Smaller diameter (600 to 700mm) **single blade diamond saws** are used for longitudinal cutting of the slab into panels up to 2m long, for trimming, detailing (chamfering or bevelling), and for crosscutting of panels and blocks. They can be programmed to carry out detailed profiling for intricate architectural work; J.H. Wagner and Son Pty Ltd (Toowoomba) have such a machine.

At Stonetile's plant (N.S.W.) two **multi-bladed diamond saws** (with up to 20 parallel blades and horizontal docking saws are used to cut stone panels 300mm deep by 3m long for later crosscutting into tiles. Such cutting systems are proposed in the marble and granite plants in Queensland.

After cutting of the block into either slabs or panels and trimming to near final size, the stone progresses to the final finishing stages (honing, exfoliation, etching, or polishing).

Hydraulic shearing devices or guillotines incorporating a straight edge or articulated teeth produce a broken but fairly planar surface (rock-face finish) in thickly sawn slabs. Several sandstone producers in Queensland manufacture 'colonial blocks' using this technique (Lockyer Sandstone, Anderleigh Quarries, and the North Queensland slate producer - Queensland Stone Constructions and Contractors Pty Ltd). Hydraulic splitters are used to manufacture granite paving setts or blocks in some interstate plants.

Surface finishes

In some cases, the slabbed stone requires little or no further processing - sandstone often only requires surface grinding or milling to remove saw marks in the final product. Six common methods of surface finishing are described.

Bush hammering refers to a range of hand and mechanically produced surface textures or finishes and it is one of the oldest methods of surface treatment for exterior stone still in use. Pointed chisels, picks, scabbling hammers and

routing tools are used to produce surface effects such as fine to coarse scabbling (pitted surfaces), striations (batted), prominent tool marks and other surface finishes.

Honed surfaces have basically undergone the first stage of the polishing process, in which grinding has removed any surface imperfections (saw marks) and has reduced the slab to the required thickness for further processing. This finish is achieved by using either rotating discs or rollers with abrasive segments fitted or impregnating the cutting surface. The resultant surface is smooth and flat, with a matt or semi-gloss finish.

The final or **polishing process** creates a near perfectly flat surface with an extremely high gloss. Coarse to fine abrasives (including silicon carbide, aluminium oxide, and other materials) hone the surface to a level, semi-gloss finish. The final mirror-like surface is achieved by buffing with a circular disc fitted with pads and fed with tin oxide or other finishing compounds. Oxalic acid is used for marble. The stone's natural colours are darkened and the contrast enhanced by polishing.

Essentially, there are three types of polishing machines. One of the oldest types and most widely used by Queensland's monumental masons is the 'Jenny Lind' type polisher which has a bridge or arm-mounted polishing disc moving over the fixed stone slab. The cycle is discontinued for each change of disc to a finer abrasive.

The other two polishing systems are fully automated with a series of coarse through to fine discs moving in a horizontal reciprocal motion over the slab. They differ only in that whereas one system has the slab fixed to a concrete bed, the other has a conveyor system where slabs move continuously on rollers through the fixed polishing line (an integrated honing and buffing system). The number of polishing discs may vary from 5 (marble) to 12 (granite). The standard automatic polishing line can work with widths of up to 2m, and has rates of 100 to 120m^2/day. Polished stone is susceptible to scratching, scuffing and dulling, and is extremely slippery and dangerous when wet. A number of surface finishes have been developed to overcome these problems in floor areas of high pedestrian traffic.

Flame, scorching or exfoliation is restricted to use with quartz-rich stones, usually granite. This surface finish is achieved through thermal shock from passing a high-temperature flame (a mixture of oxygen and acetylene) over the surface, followed by immediate quenching. This causes spalling or small flakes to break from the surface thus creating a rough, non-slip surface of vitreous appearance, suitable for floor tiles in areas of high pedestrian use.

Etched or grit blasted finishes, using sand or other abrasive materials to roughen the cut surface, are primarily applied to granites to create intricate patterns of polished and etched stone, and non-slip floor tiles. In New South Wales, Stonetile and Australasian Stone Products use this technique to manufacture non-slip floor tiles. Acid etching of marble is sometimes used.

Specialised edge grinders, polishers and chamfering machines are required for monumental stone, tiles and some building stones. Drilling and grooving for fixing purposes are the last of the milling processes.

REFERENCES

A. & B. JOURNAL OF QUEENSLAND, 1932: Benedict Stone. Its popular use in Brisbane. *Architecture and Building Journal of Queensland, November, 1932*, 71-73.

A. & B. JOURNAL OF QUEENSLAND, 1934: The preservation of building stone. *Architecture and Building Journal of Queensland, July 1934*, 11-16.

ALLISON, P., 1984: Dimension stone - a rock steady market. Industrial Minerals, July 1984, 19-35.

ANONYMOUS, 1888: Progress report from the Select Committee on the sandstone quarries of the southern districts of the Colony; together with the Minutes of Evidence, the Proceedings of the Committee and Appendices. W.R. North (Chairman). Queensland Legislative Assembly, Session (iii), 1888, 1021-1044

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1978: Standard test method for flexural strength of natural building stone.*ASTM C880-78.*

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1979a: Standard specification for marble building stone (exterior). *ASTM C503-79.*

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1979b: Standard specification for limestone building stone. *ASTM C568-79.*

AMERICAN SOCIETY FOR TESTING AND MATERIAL, 1979c: Test method for unconfined compressive strength of intact rock core specimens. *ASTM D2938-79.*

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1980a: Standard specification for sandstone building stone. *ASTM C616-80.*

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1980b: Standard specification for slate building stone. *ASTM C629-80.*

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1980c: Standard specification for granite building stone. *ASTM C615-80.*

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1980d: Standard test method for elastic moduli of intact rock core specimens in uniaxial compression. *ASTM D3148-80.*

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1981a: Standard test method for water absorption of slate. *ASTM C121-48* (reapproved 1981).

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1981b: Standard test method for compressive strength of natural building stone. *ASTM C170-50* (Reapproved 1981).

AMERICAN SOCIETY FOR TESTING AND MATERIALS,1981c: Standard test method for abrasion resistance of stone subjected to foot traffic. *ASTM C241-51* (Reapproved 1981).

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1981d: Standard test method for modulus of rupture of natural building stone. *ASTM C99-52* (Reapproved 1981).

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1981e: Standard methods of flexure testing of slate (modulus of rupture, modulus of elasticity). *ASTM C120-52* (Reapproved 1981).

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1981f: Standard test method for weather resistance of natural slate. *ASTM C217-58* (Reapproved 1981).

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1983a: Standard test methods for absorption and bulk specific gravity of natural building stone. *ASTM Standard C97-47* (Reapproved 1983).

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1983b: Standard definitions of terms relating to natural building stones. *ASTM Standard C119-50* (Reapproved 1983).

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1983c: Standard method for laboratory determination of pulse velocities and ultrasonic elastic constants of rock. *ASTM D2845-83.*

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1984: Standard specification for roofing slate. *ASTM C406-84.*

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1985: 1985 *Annual book of ASTM Standards*, **Volume 04.08.** Standards relating to natural building stone; soil and rock.

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1988a: Standard strength of anchors in concrete and masonry elements. *ASTM 488-1988.*

AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1988b: Stone on precast or steel in wall design and construction. *ASTM STP 996-1988.*

AMOS, B.J., & DE KEYSER, F., 1964: Mossman, Queensland SE/55-1. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources, Australia.

BALL, L.C., 1904: Certain iron ore, manganese and limestone deposits in the Central and Southern districts of Queensland. *Geological Survey of Queensland, Publication* **194**.

BALL, L.C., 1905: Queensland stones for architectural and monumental purposes. *Queensland Government Mining Journal*, **6**,457.

BALL, L.C., 1913: Ambrose limestone quarry. *Queensland Government Mining Journal*, **14**, 532-533.

BALL, L.C., 1927: Notes on the Gracemere granite quarry.*Queensland Government Mining Journal*, **28**, 216-217.

BALL, L.C., 1932: Elbow Valley marble and Limevale marble.Geological Survey of Queensland, unpublished file report.

BALL, L.C., 1941: Kholo granite. Geological Survey of Queensland, unpublished file report.

BLAKE, D.H., 1987: Geology of the Mount Isa inlier and environs, Queensland and Northern Territory. *Bureau of Mineral Resources, Australia, Bulletin* **225.**

BEDWELL, E.P., 1961: Boonjie marble deposits. Regional Advisory Committee. Geological Survey of Queensland, unpublished file report.

BRITISH STANDARDS INSTITUTION,1957: Glossary of terms for stone used in building. *B.S. 2847: 1957.* BSI, London.

BRITISH STANDARDS INSTITUTION, 1972: Natural stone cladding.*B.S. Code of Practice, CP 298: 1972.*

BRITISH STANDARDS INSTITUTION, 1975: Dressed natural stone kerbs, channels, quadrants and setts. *B.S. 435: 1975.*

BRITISH STANDARDS INSTITUTION, 1983: Industries based on various processable materials. Stone Industry. *B.S. 1000(679): 1983.*

BRITISH STANDARDS INSTITUTION, 1984: Code of practice for stone masonry. *B.S. 5390:1976 (1984).*

BRITISH STANDARDS INSTITUTION, 1985: Code of practice for slating and tiling. *B.S. 5534: Part 1: 1978 (1985).*

BRITISH STANDARDS INSTITUTION, 1989: Standard code of practice for design and installation of natural stone cladding and lining. *BS 8298: 1989.*

BROOKS, J.H., SYVERET, J.N., & SAWERS, J.D., 1974: Mineral resources of the Kilkivan District. *Geological Survey of Queensland, Report* **60.**

BULTITUDE, R.J., CRANFIELD, L.C., HEGARTY, R.A., HALFPENNY, R.W., RIENKS, I.P., & DOMAGALA, J., 1985: Summary of the results of field work in the Mossman and Atherton 1:250 000 Sheet areas, 1984 field season. RGMP Progress Report. Geological Survey of Queensland, Record 1985/31 (unpublished).

CARMICHAEL, D.C., 1987: Sedimentology of the Helidon Sandstone University of Queensland, Department of Geology and Mineralogy, Geology Mapping Project GM 460 (unpublished).

CONNAH, T.H., 1958: Summary report, limestone resources of Queensland. *Queensland Government Mining Journal,* **59,** 636-653.

CRANFIELD, L.C., & HEGARTY, R., 1989: Geology of the Rumula 1:100 000 Sheet area (7964) Northeast Queensland -preliminary data. *Queensland Department of Mines, Record* **1989/20.**

CURRIER,L.W., 1960: Geologic Appraisal of Dimension Stone Deposits *Geological Survey Bulletin 1109.* U.S. Department of the Interior. United States Government Printing Office, Washington.

DAY, R.W., WHITAKER, W.G., MURRAY, C.G., WILSON, I.H., and GRIMES, K.G., 1983: Queensland Geology. A companion volume to the 1:250 000 scale geological map (1975). *Geological Survey of Queensland, Publication* **383.**

DE KEYSER, F. & WOLFF, K.W., 1964: The geology and mineral resources of the Chillagoe area. *Bureau of Mineral Resources, Australia, Bulletin* **70.**

DENARO, T.J., 1989: Mineral occurrences - Inglewood, Texas and Ashford 1:100 000 Sheet areas, Queensland. *Queensland Department of Mines, Record* **1989/32.**

DENMEAD, A.K., 1929: Report on recent visit to inspect a deposit of diorite at Maroochydore. Geological Survey of Queensland, unpublished file report.

DENMEAD, A.K., 1943: Sandstone deposit on Por.85, Helidon.Geological Survey of Queensland, unpublished file report.

DENMEAD, A.K., 1945: Helidon sandstone. Geological Survey of Queensland, unpublished file report.

DENMEAD, A.K., 1949: Mowbray River limestone. *Queensland Government Mining Journal,* **50,** 42-43.

DENMEAD, A.K., 1956: C.V. Petersen & Co. Geological Survey of Queensland, unpublished file report. (28.5.1956).

DEPARTMENT OF THE TREASURY, 1989: *Australia's Foreign Investment Policy. A Guide for Investors.* Australian Government Publishing Service, Canberra.

DEPUTY CHIEF GOVERNMENT GEOLOGIST, 1927: Report (notes) on the Gracemere Quarry. Geological Survey of Queensland, unpublished file report.

DIMMICK, T.D., 1949: Building stone and sand - Crows Nest District. Geological Survey of Queensland, unpublished file report 13.7.1949.

DOUTCH, H.F., 1972: Galilee, Queensland SF/55-10. *1:250 000 Geological Series, Explanatory Notes.* Bureau of Mineral Resources, Australia.

DOUTCH, H.F., 1977: Croydon, Queensland SE/54-11. *1:250 000 Geological Series Explanatory Notes.* Bureau of Mineral Resources.

DRAPER, J.J., 1978: Report on building stone from St. Stephen's Cathedral and the effect of cleaning fluid AC85 on the stone. Geological Survey of Queensland, Record 1978/35 (unpublished, Confidential).

DRAPER, J.J., 1983: Investigations of building stones conducted on behalf of the Department of Works: "The Mansions" and "Stockman's Hall of Fame". Geological Survey of Queensland, Record 1983/45 (unpublished).

DRIESSEN, A., 1987: Construction materials; in *Australian Mineral Industry Annual Review for 1984.* Bureau of Mineral Resources, Australia. Australian Government Publishing Service, Canberra, 113-114.

DRIESSEN, A., 1989: Construction materials; in *Australian Mineral Industry Annual Review for 1987.* Bureau of Mineral Resources Australia. Australian Government Publishing Service, Canberra, 93-97.

DUNSTAN, B., 1923: Sandstone quarries at Helidon. Geological Survey of Queensland, unpublished file report.

FLYNN, D., 1988a: *Granite - N.S.W. A Brief Review of the Industry.* Department of Industrial Development and Decentralisation, Orange, N.S.W.

FLYNN, D., 1988b: *Granite - N.S.W. A Brief Review of the Industry.* Business and Consumer Affairs Agency, Orange, N.S.W.

GEOLOGICAL SURVEY OF QUEENSLAND, 1978: Mineral resources of the Bowen Region. *Queensland Government Mining Journal,* **79,** 187- 208.

GEOLOGICAL SURVEY OF QUEENSLAND, 1981: Mineral resources of the Wide Bay-Burnett region. *Queensland Government Mining Journal,* **82,** 153-178.

HALFPENNY, R.W., DONCHAK, P.J.T., & HEGARTY, R.A., 1987: Geology of the Hodgkinson Formation in the Mount Mulligan 1:100 000 Sheet area. Geological Survey of Queensland, Record 1987/2 (unpublished).

HAWTHORNE, W.L., 1980: Proposed slate prospect, Beechmont Road. Geological Survey of Queensland, unpublished file report.

HEINLEIN, M., 1987: Selection, purchase and delivery of building stone - the obstacle course. American Society for Testing and Materials. *ASTM STP 887,* 47-51.

HOUSTON, B.R., 1967: Economic geology of the City of Brisbane. *Geological Survey of Queensland, Publication* **325.**

ISHAQ, S., 1977: Limestone resources of the Chillagoe area, north Queensland. Geological Survey of Queensland, Record 1977/26 (unpublished).

JACK, R.L., 1899: Report of R.L. Jack, Government Geologist; in *Annual Report for the Department of Mines, 1896-1898.*

JACK, R.L., 1923: The building stones of South Australia.Department of Mines, South Australia. *Geological Survey of South Australia, Bulletin* **10.**

JAPANESE EXTERNAL TRADE ORGANIZATION, 1986: Access to Japan's import market. Marbles & granites (2nd edition). *JETRO* **No. 20.**

JAUNCEY, W., 1965: Betoota, Queensland SG/5406. *1:250 000 Geological Series, Explanatory Notes.* Bureau of Mineral Resources, Australia.

JENSEN, H.I., 1918: Lee's limestone lease, near Raglan. *Queensland Government Mining Journal*, **19**, 9-10.

JENSEN, H.I. 1919: Mount Peter Goldfield. *Queensland Government Mining Journal*, **20**, 55-57.

KIRKEGAARD, A.G., SHAW, R.D., & MURRAY, C.G., 1970: Geology of the Rockhampton and Port Clinton 1:250 000 Sheet areas. *Geological Survey of Queensland, Report* **38.**

KROSCH, N.J., 1972: Inspection of slate quarry near Gunalda.Geological Survey of Queensland, unpublished file report.

KROSCH, N.J., 1979: A review of the limestone industry in Queensland with regard to resources surveys and the future of the industry. Geological Survey of Queensland, Record 1979/29 (unpublished).

KROSCH, N.J., 1981: Limestone resources of the Gladstone Region. *Geological Survey of Queensland, Report* **101.**

KROSCH, N.J., 1985: Limestone and marble in Queensland. *Queensland Government Mining Journal*, **86**, 65-70.

KROSCH, N.J., 1990: Queensland mineral commodity report. Limestone. *Queensland Government Mining Journal*, **91**, 93-102.

KROSCH, N.J., & KAY, J.R., 1977: Limestone resources of the Rockhampton Region. *Geological Survey of Queensland, Report* **98.**

LEVINGSTON, K.R., 1956: "Bartle Frere" marble deposit, Malanda. Geological Survey of Queensland, unpublished file report. 8.8.1956.

LEVINGSTON, K.R., 1958: Limestone deposits, Mareeba. *Queensland Government Mining Journal*, **59**, 371-372.

LEVINGSTON, K.R., 1961: Bartle Frere marble deposit, Malanda. Geological Survey of Queensland, unpublished file report. 20.6.1961.

LEVINGSTON, K.R., 1961: Black granite, Cairns. Geological Survey of Queensland, unpublished file report.

LOCK, D.E., 1989: *The Geology of Industrial Mineral Resources.* MRI Manual, Industrial Minerals course notes. MRI Publishers, Canberra.

LUCAS, K.G., & de KEYSER, F., 1965: Cooktown, Queensland SE/55-6. *1:250 000 Geological Series, Explanatory Notes.* Bureau of Mineral Resources, Australia.

LUDBROOK, N.H., 1980: *A Guide to the Geology and Mineral Resources of South Australia.* Department of Mines and Energy, South Australia.

MARKS, E.O., 1910: Report on coal measures of south-east Moreton. *Geological Survey of Queensland, Publication* **225**, 43.

MARTIN, J.E., 1981: Properties of Queensland aggregates. Geological Survey of Queensland, Record 1981/29 (unpublished).

MARTIN, J.E., & NEVILLE, B.J., 1981: Workings of construction materials in the South Burnett District. *Queensland Government Mining Journal*, **82**, 491 - 506.

MEADE, L., 1989: 1988 Industrial minerals review - dimension stone. *Mining Engineering*, **41**, 405.

MORTON, C.C., 1927: Helidon State quarries - proposed boring campaign. Geological Survey of Queensland, unpublished file report.

MORTON, C.C., 1928a: A report on Mr. D.D. Carrick's quarrying area in the Helidon district. Geological Survey of Queensland, unpublished file report.

MORTON, C.C., 1928b: Ulam marble. Geological Survey of Queensland, unpublished file report.

MORTON, C.C., 1930: South Ulam marble deposits, Rockhampton District. Geological Survey of Queensland, unpublished file report.

NELSON, R.G., 1989: Review and outlook for South Australia; *in Papers. National Minerals & Energy Outlook Conference, 1989.* Department of Primary Industries & Energy, Canberra, 91-92.

NEW SOUTH WALES DEPARTMENT OF MINERAL RESOURCES, 1988: Granite - a new export industry? *MINFO, New South Wales Mining & Exploration Quarterly*, **20**, 6-8.

NEWBIGIN, C.E., 1967: Testing of slate for suitability as a natural building stone. Bureau of Mineral Resources, Australia, Record 1967/145 (unpublished).

NOLAN, C., 1985: Granite - a position paper. Commonwealth Development Bank of Australia, unpublished report (confidential).

OCEANICS AUSTRALIA, 1975: Environmental impact study of proposed limestone quarries, Mount Larcom - Bracewell area. Amended report by Oceanics Australia, prepared for Darra Exploration Pty Ltd.

O'FLYNN, M.L., 1976: Inspection of slate quarry near Gunalda. Geological Survey of Queensland, unpublished file report.

O'FLYNN, M.L., 1980: Workings of construction materials in the Toowoomba district. *Queensland Government Mining Journal*, **81**, 447-461.

O'FLYNN, M.L., 1983: Workings of construction materials in the Warwick-Stanthorpe district. *Queensland Government Mining Journal*, **84** , 339-354.

O'FLYNN, M.L., 1988: Report on inspection of slate mine, North Head Station, Forsayth area (ML 1062, 1063 Georgetown - Mr. J.W. Grievson) Queensland Department of Mines, unpublished file report.

O'FLYNN, M.L., in preparation: Review of extractive materials, Eastern Moreton Region. Department of Resource Industries.

O'FLYNN, M.L., & GRAHAM, P.D., 1987: Workings of construction materials in Gympie district. *Queensland Government Mining Journal*, **88**, 240-256.

O'FLYNN, M.L., HOLMES, K.H., & TREZISE, D.L., 1983: Industrial rock and mineral resources of the Brisbane and Caboolture 1:100 000 Sheet areas. *Geological Survey of Queensland, Publication* **382.**

PATTON, J.B., 1974: Glossary of building stone and masonry terms. *Indiana Department of Natural Resources, Geological Survey Occasional Paper* **6.**

PERRY, J., SPRY, A.H., & WEST, D., 1989: *Stone in Modern Buildings: the State of the Art.* Seminar notes, Sydney, 23-24 October, 1989.

RANDS, W.H., 1890: The Brookfield, Pullenvale, and Moggill Districts. *Geological Survey of Queensland, Publication* **63**, 1,2.

RAY, H.N., 1988: Dimension stone in New South Wales. Geological Survey of New South Wales. *Department of Mineral Resources, Record* **GS1988/102.**

REID, J.H., 1919: Iron ore and limestone deposits of Mount Perry district. *Queensland Government Mining Journal*, **20**, 421.

REID, J.H., 1923: Mr. Whyte's marble deposit, Portion 6V Parish Aricia. Geological Survey of Queensland, unpublished file report.

REID, J.H., 1929: Particulars of marble deposits in Queensland. Geological Survey of Queensland, unpublished file report 8.3.1929.

REID, J.H., 1945: Limestone, Rockhampton. *Queensland Government Mining Journal*, **46**, 112.

RICHARDS, H.C., 1911: The building stones of St. John's Cathedral, Brisbane. *Proceedings of the Royal Society of Queensland*, **23**, 199.

RICHARDS, H.C., 1918: The building stones of Queensland. *Proceedings of the Royal Society of Queensland*, **30**, 97-157.

RICHARDS, H.C., 1921: Laboratory report on the samples of white calcite marble submitted by Ulam White Marble Co., Rockhampton. Geological Survey of Queensland, unpublished file report, 8.8.1921.

RICHARDS, H.C., 1926: Laboratory report on granite from Gracemere near Rockhampton as a building stone. Geological Survey of Queensland, unpublished file report.

ROBERTSON, A.D., 1972: The geological relationships of the New England batholith and the economic mineral deposits of the Stanthorpe district. *Geological Survey of Queensland, Report* **64.**

ROBERTSON, A.D., 1979: Suitability of granite boulders for monumental stone. Geological Survey of Queensland, unpublished file report, 26.11.1979.

ROBBINS, J., 1986a: Slate - sales hit the roof. *Industrial Minerals*, **224**, 23-40.

ROBBINS, J., 1986b: Italy's industrial minerals. *Industrial Minerals*, **231**, 19-50.

SAINT-SMITH, E.C., 1917: On the occurrence of white marble at South Ulam, Rockhampton District. *Queensland Government Mining Journal*, **18**, 596-600.

SAINT-SMITH, E.C., 1920: J.A. Mitchell's marble lease, South Ulam. *Queensland Government Mining Journal*, **21**, 154.

SAINT-SMITH, E.C., 1921a: Ulam Carrara marble syndicate's area, Ulam. *Queensland Government Mining Journal*, **22**, 185.

SAINT-SMITH, E.C., 1921b: Australian White Marble Company's leases - Ulam District. Geological Survey of Queensland, unpublished file report.

SAINT-SMITH, E.C., 1922: Marble occurrences at Elbow Valley, Warwick District. *Queensland Government Mining Journal*, **23**, 359.

SAWERS, J.D., & COOPER, W., 1985: Some Queensland industrial minerals. *Queensland Government Mining Journal*, **86**, 188-195.

SAWERS, J.D., SIEMON, J.E., & KROSCH, N.J., 1976: Limestone - Queensland; *in* Knight, C.L., (editor), *Economic Geology of Australia and Papua New Guinea*; (Part 4) Industrial minerals and rocks. Australasian Institute of Mining and Metallurgy, Melbourne, 175-181.

SENIOR, D.A., 1973: Jericho, Queensland SF/55-14. *1:250 000 Geological Series, Explanatory Notes.* Bureau of Mineral Resources, Australia.

SHARPLES, C., 1990: Building and ornamental stone resources of Tasmania. Report prepared for Tasmanian Development Authority and the Department of Resources and Energy (unpublished).

SHEPHERD, S.R.L., 1955: Limestone on Duke Islands - Broad Sound. *Queensland Government Mining Journal*, **56**, 926.

SIEMON, J.E., 1973: Limestone resources of the Warwick-Texas area. *Geological Survey of Queensland, Report* **80.**

SMITH, M., 1987: Dimensional stone blasting in Finland. *Mining Magazine*, October 1987, 312-317.

SOUTH AUSTRALIAN DEPARTMENT OF MINES & ENERGY, 1983: Building Stones of South Australia. *Department of Mines & Energy, Mineral Information Series.*

SPRY, A.H., 1975-1981: Building stones of South Australia. *Progress reports 1-14, Project 1/1/166 for South Australian Department of Mines and Energy.*

SPRY, A.H., 1983: Australian Building Sandstones. *AMDEL Report* **1502.**

SPRY, A.H., 1986: Australian building stones: Marble. *AMDEL Report* **1591.**

SPRY, A.H., 1988: *Building Stone Seminar.* Alan H. Spry & Associates, Adelaide, April 18-21, 1988.

SPRY, A.H., 1989: Stone testing : general; *In* Perry, J., Spry, A.H., & West, D., *Stone in Modern Buildings : the State of the Art.* Seminar notes, Sydney, 23-24 October, 1989, 45-57.

STANDARDS ASSOCIATION OF AUSTRALIA, 1985: Aggregates and rock for engineering purposes. Part 7* Building Stone. Australian Standard 2758. (in preparation).

STANDARDS ASSOCIATION OF AUSTRALIA, 1986: Damp-proof courses and flashings. *Australian Standard 2904-1986.*

STEVENS, M.R., 1983: Geological evaluation of marble quarry, Chillagoe. Unpublished report for Anroma Pty Ltd held by Queensland Department of Resource Industries as CR 12190 (Confidential).

STRECKEISEN, A.L., 1973: Plutonic rocks. Classification and nomenclature recommended by the IUGS Subcommision on the Systematics of Igneous rocks. *Geotimes*, **18**(10), 26-30.

TREZISE, D.L., 1982: Workings of construction materials in the Biloela and Mount Morgan area. *Queensland Government Mining Journal*, **83**, 364-376.

TREZISE, D.L., 1989: Building stone industry, Central Queensland; *in* Whitaker, W.G., (editor), *1989 Field Conference Rockhampton Region.* Geological Society of Australia, Queensland Division, Brisbane, 51-58.

TREZISE, D.L., & GRAHAM, P.D., 1984: Workings of construction materials in the Central Burnett District. *Queensland Government Mining Journal*, **85**, 167-192.

TREZISE, D.L., O'FLYNN, M.L., & WILLMOTT, W.F., 1983: Industrial rock and mineral resources of the Rockhampton Region 1:100 000 Sheet area. Geological Survey of Queensland, Record 1983/8 (unpublished).

VALLARI, F.L., 1982: *Italian Marble Technical Guide*, Volumes 1 & 2. Italian Institute for Foreign Trade, Rome.

VINE, R.R. & DOUTCH, H.F., 1972: Galilee, Queensland SF/55-10. *1:250 000 Geological Series, Explanatory Notes.* Bureau of Mineral Resources, Australia.

WALLACE, I., 1971: Studies of natural building stones of New South Wales, University of New South Wales, Sydney, Ph.D. Thesis (unpublished).

WEST, D., 1989: Australian stone processing; *in* Perry, J., Spry, A.H., & West, D., *Stone in Modern Buildings: the State of the Art.* Seminar notes, Sydney, 23-24 October, 1989, 149-151.

WHITAKER, W.G., & GREEN, P.M., 1980: *Moreton Geology, 1:500 000 Geology Map.* Geological Survey of Queensland.

WILLMOTT, W.F., 1976: Workings of extractive materials in the Rockhampton area. *Queensland Government Mining Journal*, **77**, 284-287.

WILLMOTT, W.F., 1979: Limestone resources of the Chillagoe Formation - Rookwood, Bellevue and Mitchell-Palmer areas. Geological Survey of Queensland, Record 1979/41 (unpublished).

WILLMOTT, W.F., 1987: Revision of industrial rock and mineral resources of Gatton Shire. Geological Survey of Queensland, Record 1987/30 (unpublished).

WILLMOTT, W.F., MARTIN, J.E., O'FLYNN, M.L., & COOPER, W., 1978: Industrial rock and mineral resources of the Beenleigh and Murwillumbah 1:100 000 Sheet areas. *Geological Survey of Queensland, Publication* **368.**

WILLMOTT, W.F., COOPER, W., & MARTIN, J.E., 1979: Industrial rock and mineral resources of the Ipswich 1:100 000 Sheet area. *Geological Survey of Queensland, Publication* **373.**

WILLMOTT, W.F., TREZISE, D.L., O'FLYNN, M.L., HOLMES, P.R., & HOFMANN, G.W., 1988: Cairns Region, Queensland. *1:100 000 Geological Map Commentary, Sheets 8064 8063(part).* Queensland Department of Mines.

WOLFF, K.W., 1957: Queensland building and monumental stones. *Geological Survey of Queensland, Publication* **287.**

WOLFF, K.W., 1976: Building stones - Queensland; *in* Knight, C.L., (editor), *Economic Geology of Australia and Papua New Guinea.Part 4, Industrial minerals and rocks.* The Australasian Institute of Mining and Metallurgy, Melbourne, 78-80.

YOUNG, D.A., in preparation: Physical testing of South Australian building stones. *South Ausralian Department of Minerals and Energy, Report.*

ZAHAWI, Z., 1979: Reconnaissance of extractive resources in the Gatton and Laidley Shires. Geological Survey of Queensland, Record 1974/4 (unpublished).

COLOUR PHOTOGRAPHS

Figure 2. Sandstone quarry, Helidon; J.H.Wagner and Sons Pty Ltd

Figure 3. Banded Helidon Sandstone, Comerford Sandstone

Figure 4. Stanwell sandstone quarry; Stone Products Pty Ltd

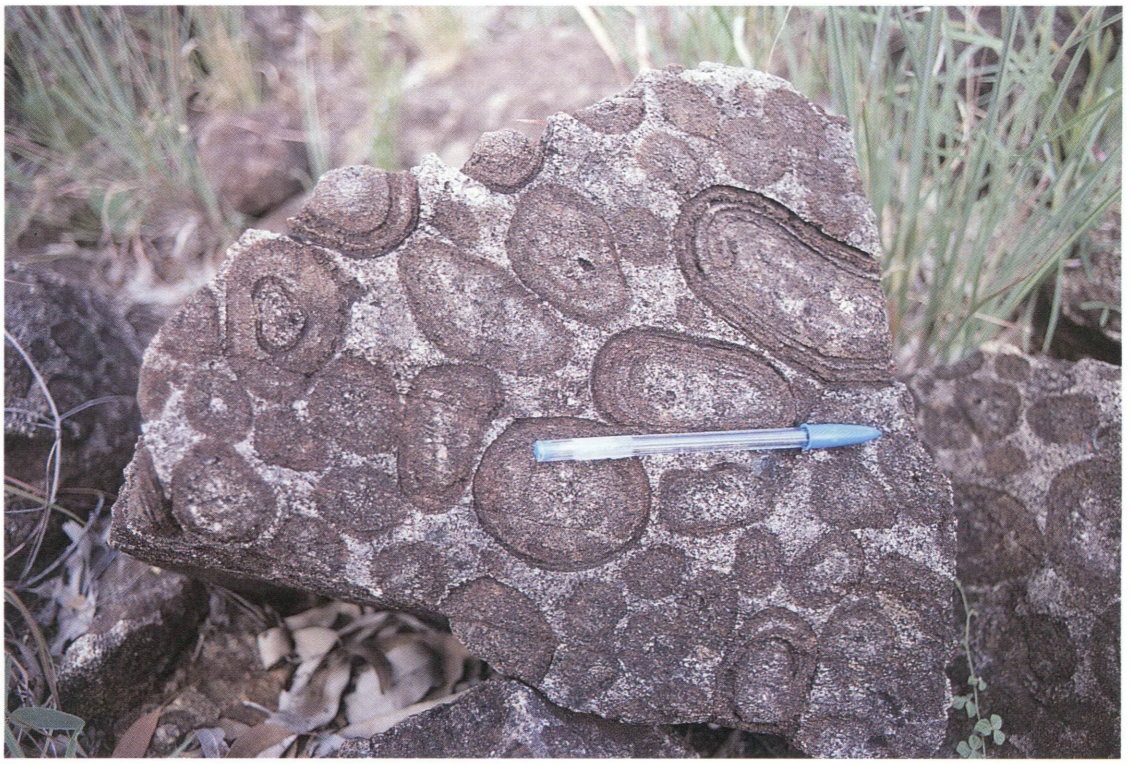

Figure 5. Orbicular Gabbro deposit, Ravenswood Granodiorite Complex; Charters Towers

Figure 6: Quartz-gabbro blocks and tors, Bouldercombe Complex; West Moreton Industries Pty Ltd

Figure 7: Block production, 'Sundown Pink', Herbert River Granite; Sherpan Pty Ltd

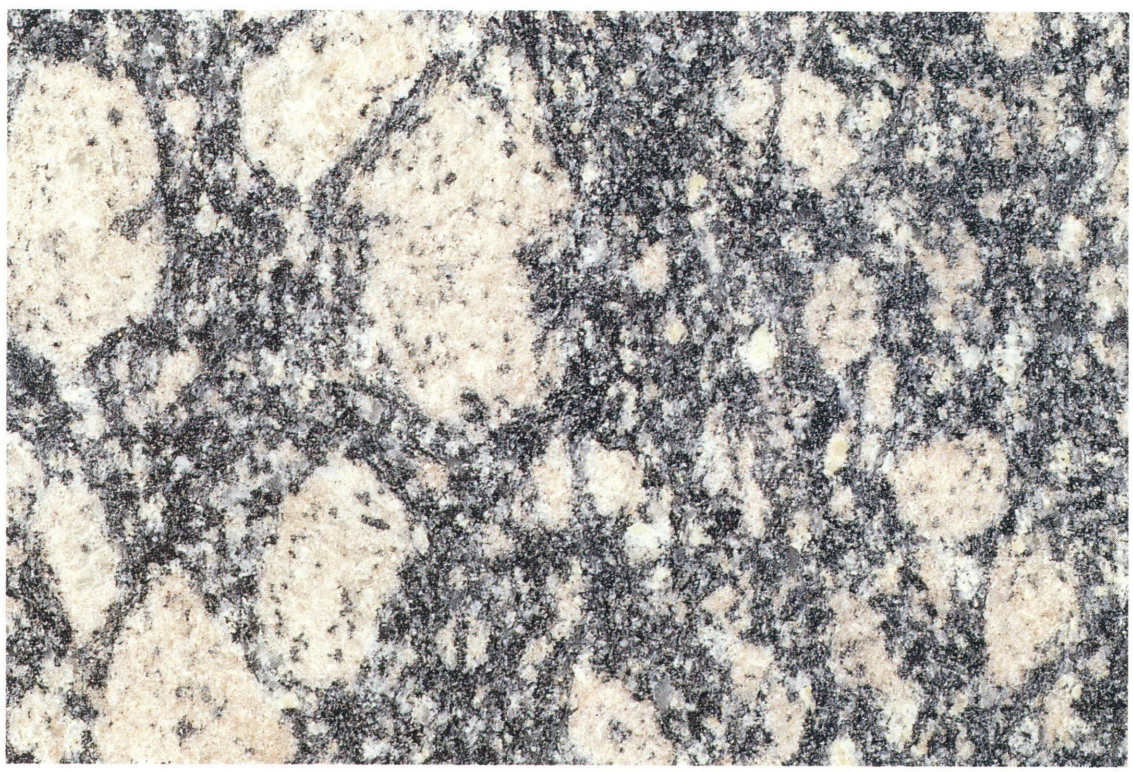

Figure 8: Sybella Granite (Orbit Black), Mount Isa, Taflag Holdings Pty Ltd

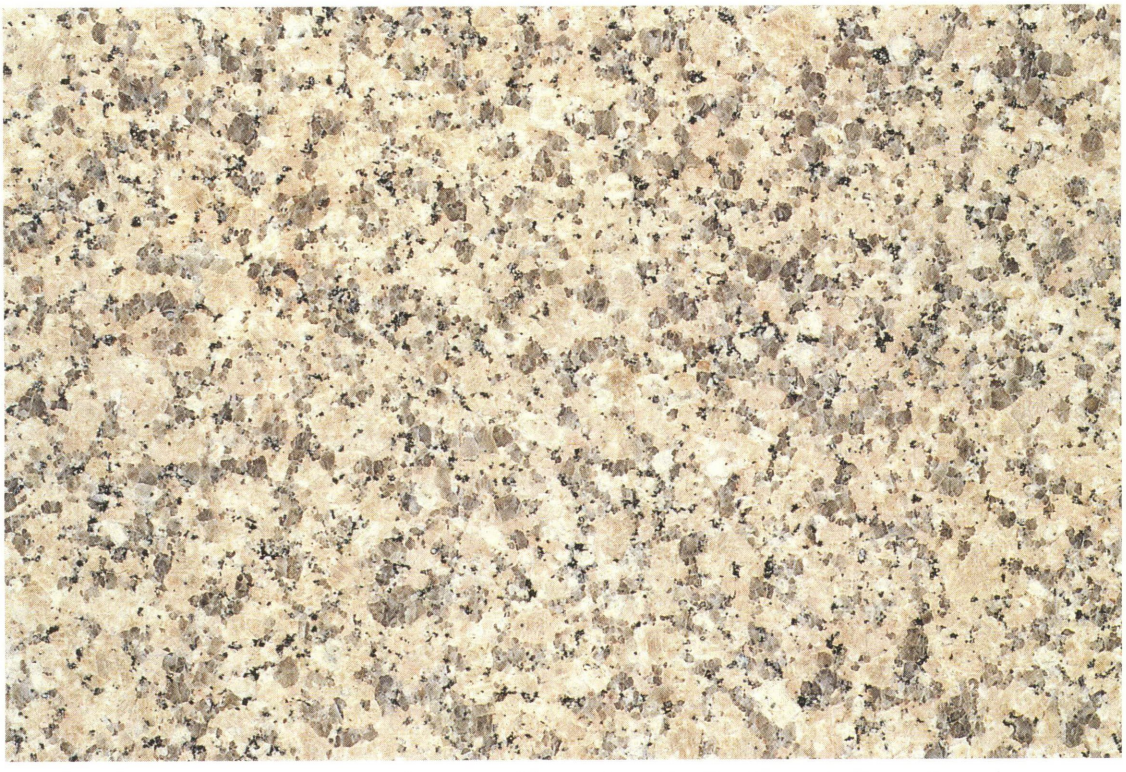

Figure 9: Elizabeth Creek Granite (Surprise Red), Mount Surprise, Taflag Holdings Pty Ltd

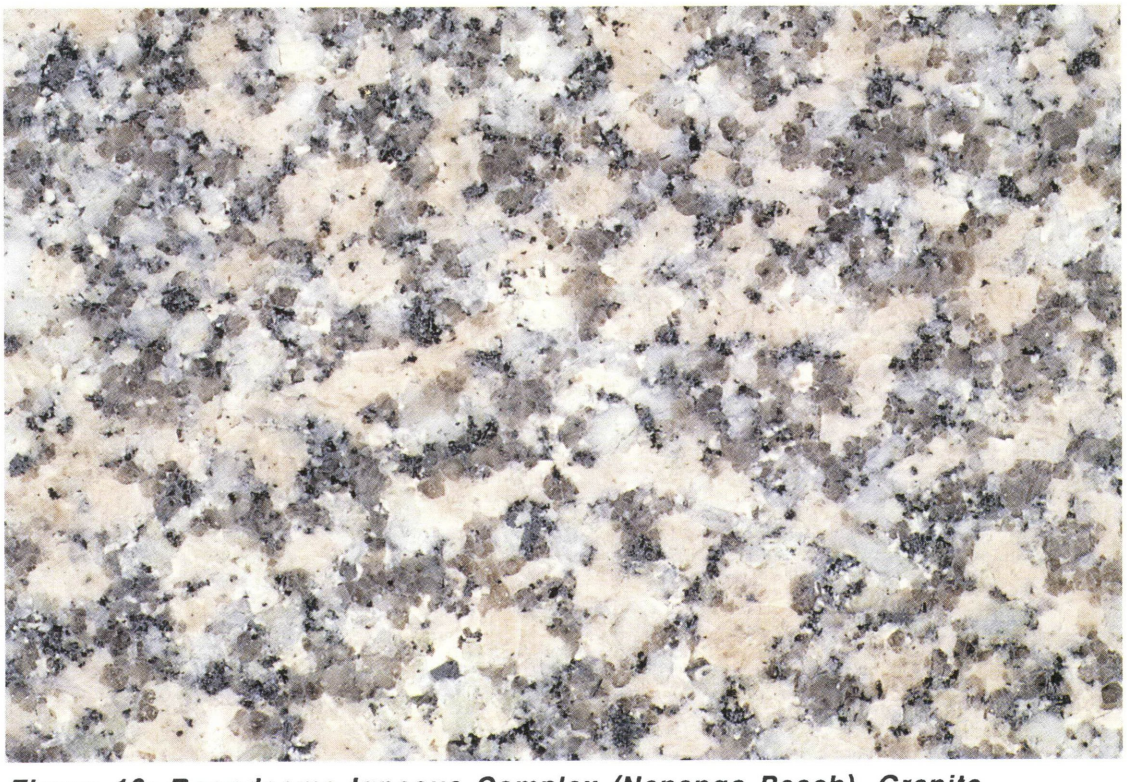

Figure 10: Boondooma Igneous Complex (Nanango Peach), Granite Resources Limited

Figure 11: Proposed granite quarry, Stanthorpe Adamellite; South Queensland Granite

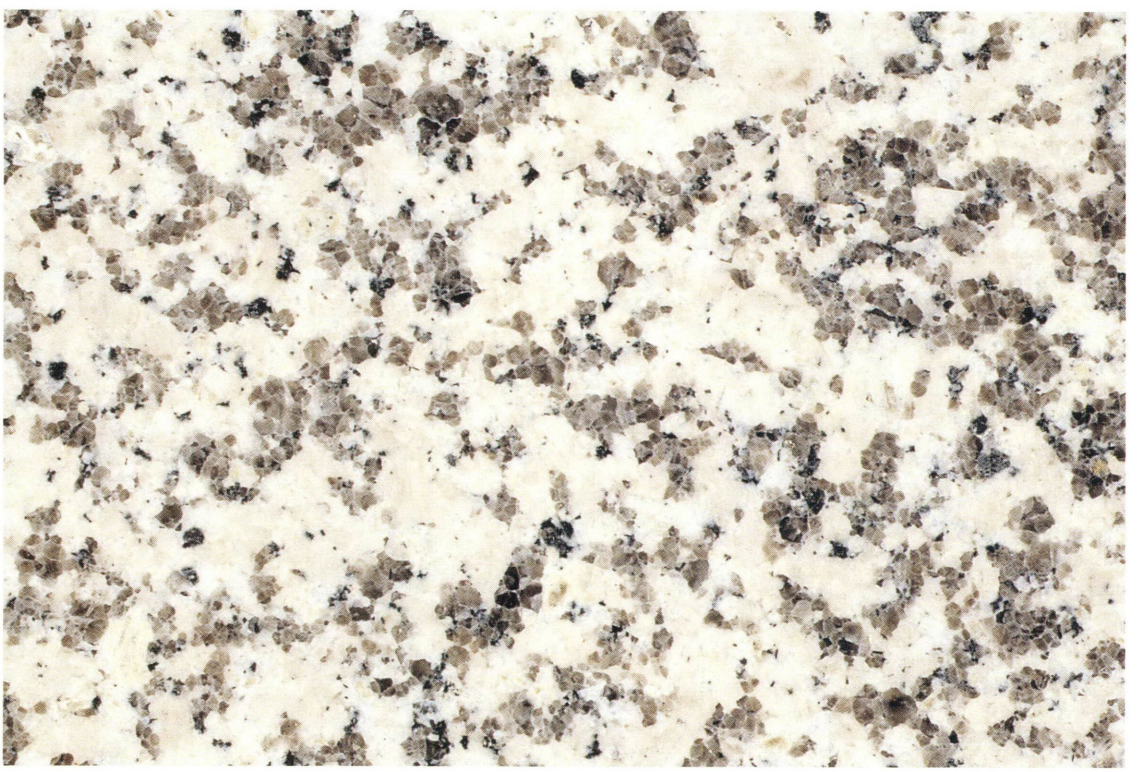

Figure 12: Stanthorpe Adamellite, South Queensland Granite

Figure 13: Bianca north marble quarry, Chillagoe Formation; Queensland Marble Limited

Figure 14: Aquamarina marble quarry, Chillagoe Formation; Queensland Marble Limited

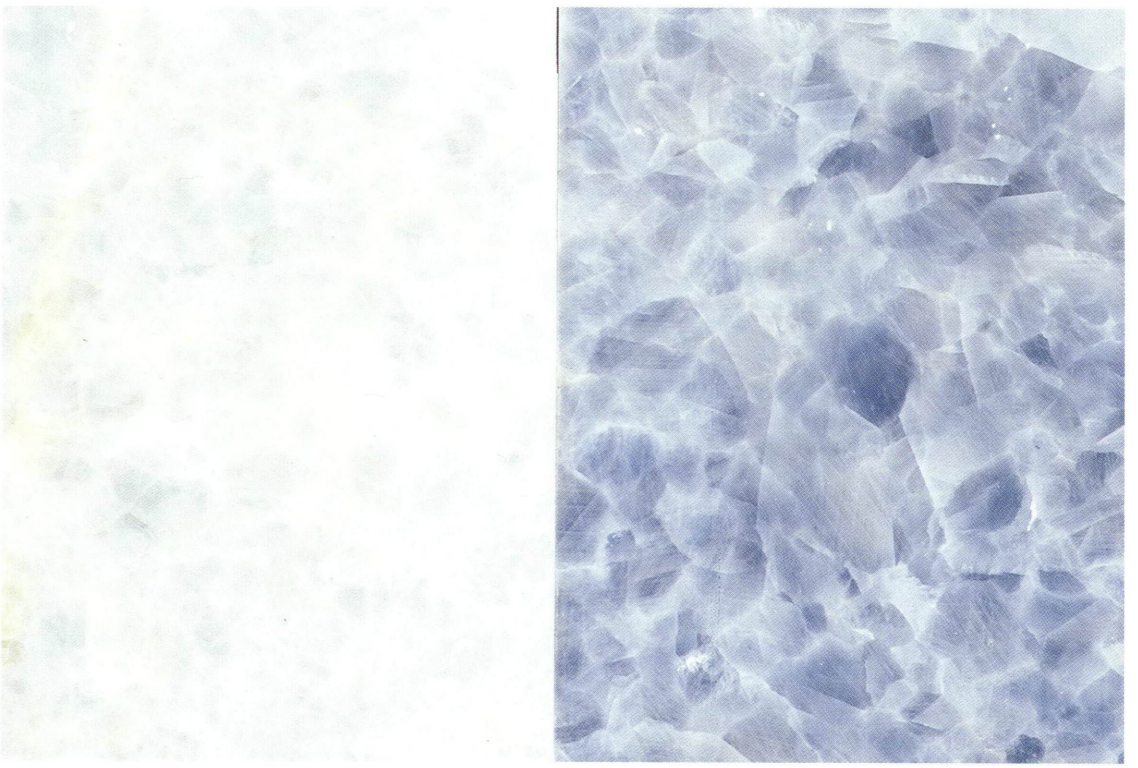

Figure 15: Chillagoe Formation (Silver and Light Blue Marble), Queensland Marble Limited

Figure 16: Chillagoe Formation (Pink Crystal), Queensland Marble Limited

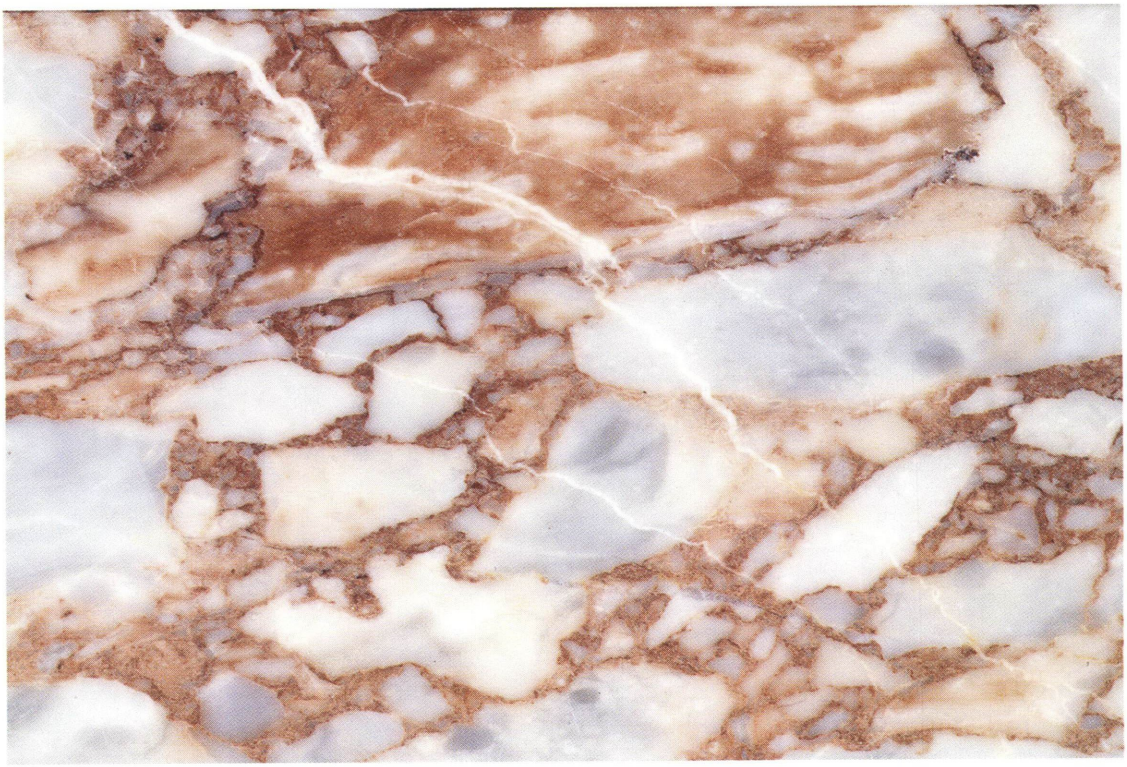

Figure 17: Mount Holly beds (Touch Stone Marble), Heritage Holdings Pty Ltd

Figure 18: Blackwell's slate deposit, Corbett Formation; Cairns Slate

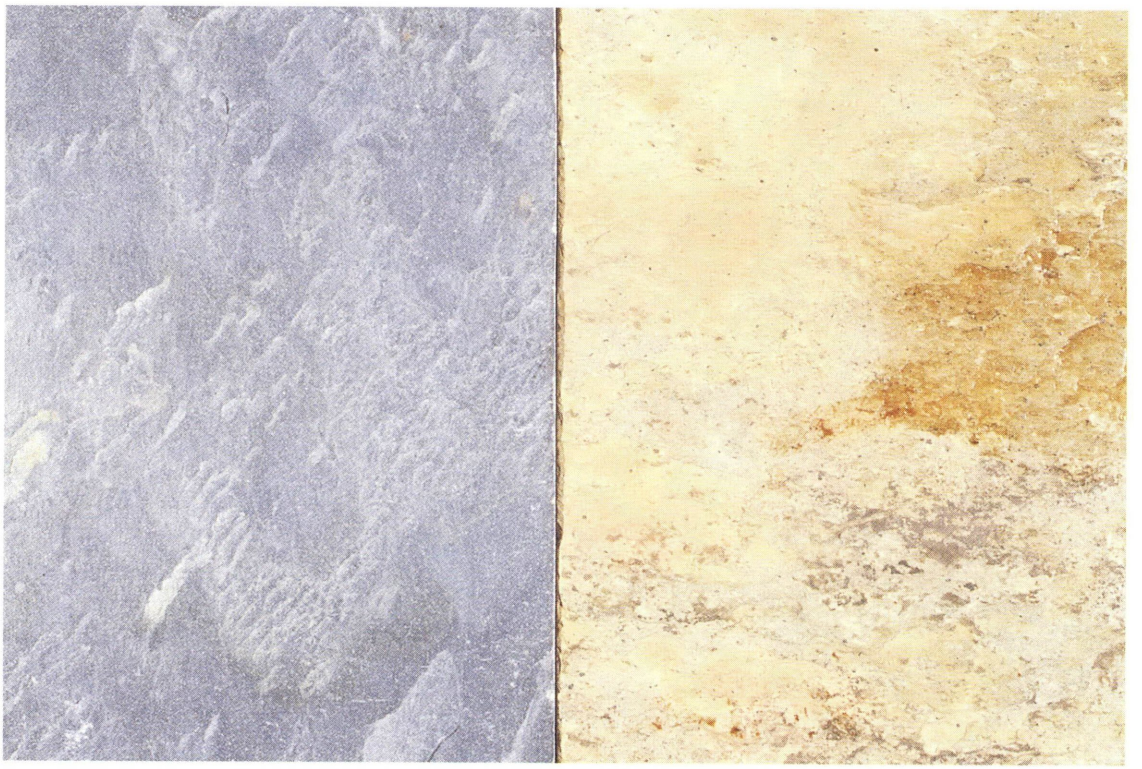

Figure 19: Corbett Formation (Blackwell's Slate), Cairns Slate

Figure 20: Anderleigh slate quarry, Kin Kin beds; Anderleigh Quarries

Figure 21: Anderleigh slate, Kin Kin beds; Anderleigh Quarries

Figure 22: Trenching machine, Helidon Sandstone quarry; J.H.Wagner and Sons Pty Ltd

Figure 23: Diamond-bladed block saw, Helidon Sandstone; Lockyer Sandstone Company

APPENDIX 1 : BUILDING STONE SOURCES - SANDSTONE

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Betoota	Betoota ?		? Daroo	Winton Formation: arkose, sandstone	Abandoned	?	Building stone	Betoota Hotel & Customs Post, built of locally quarried sandstone; Jauncey, 1965.
Beaudesert	Ipswich		69A	Walloon Coal Measures:	Abandoned	?	Monumental stone grindstones and gravestones	Quarry was not located; reported to be 6.5km west of Beaudesert; sandstone weathers easily; poor quality; Marks, 1910; Richards, 1918; Willmott & others, 1978.
Brisbane City								
Bryden's quarry (later Campbell's quarry)	Brisbane (042655)		(Enoggera)	Ipswich Coal Measures: grey-white, light brown coarse-grained sandstone, poorly cemented sandstone	Abandoned	James Campbell & Sons Pty Ltd	Building stone (Breakfast Creek sandstone)	Quarry was worked between 1860's & 1880's; site levelled and redeveloped for industrial use, Burdett Streets; Richards, 1918; Wolff 1957; Houston, 1967; O'Flynn & others, 1983; Spry, 1983.
Lyon's quarry	Ipswich (822501)		117 (Moggill)	Brassall Sub-Group: white to grey, brown fine-grained, poorly cemented sandstone	Abandoned	?	Building stone (Moggill sandstone)	Quarry operated prior to 1888; 20m long face, over 6m high; Anon, 1888; Richards 1918; Wolff 1957; Houston 1967; Willmott & others, 1979, Spry 1983.
Moggill quarries	Ipswich (856502) p.a.		109 (Moggill)	Brassall Sub-Group: white, medium-grained sandstone	Abandoned	?	Building stone (Moggill Sandstone)	Rands, 1890.
	Ipswich (855503)		110 (Moggill)	Brassall Sub-Group: white to grey, brown, fine-grained sandstone	Abandoned	?	Building stone (Moggill sandstone)	Quarry situated between Hawksbury Road & Brisbane River; Wolff, 1957; Houston, 1967; Willmott & others, 1979; Spry, 1983.
	Ipswich (855504) p.a.		111 (Moggill)	Brassall Sub-Group: white to grey, brown, fine-grained sandstone	Abandoned	?	Building stone (Moggill sandstone)	Wolff, 1957, Houston, 1967; Spry, 1983.
	Ipswich (854506) p.a.		112 (Moggill)	Brassall Sub-Group: grey, medium-grained sandstone	Abandoned	?	Building stone (Moggill sandstone)	Lugar's selection; stone reported to be easily worked, hardens on exposure; Rands, 1890.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Brisbane City								
	Ipswich (883486)		135 (Moggill)	Brassall Sub-Group: white to grey, brown, fine-grained sandstone	Abandoned	?	Building stone (Moggill sandstone)	Fraser's selection, quarry face developed in high bank on Brisbane River, stone was used in Parliament House; Rands, 1890; Wolff, 1957; Houston, 1967; Willmott & others, 1979; Spry, 1983.
Parliament House or Jeay's quarry	Ipswich		R.209	Brassall Sub-Group: light pink to brown, medium-grained sandstone	Abandoned	?	Building stone (Goodna sandstone)	Quarry was worked between 1860 and 1870, and abandoned by 1888; 4.5m bed worked below 18m of spoil; stone was used in Parliament House, and old Government House (now QUT); Anon, 1888; Richards, 1918; Wolff, 1957; Houston, 1967; Willmott & others, 1979; Spry, 1983.
Petrie's quarry	Brisbane (042655)		(Enoggera)	Ipswich Coal Measures: coarse-grained sandstone	Abandoned	Petrie	Building stone (Breakfast Creek sandstone)	Quarry was worked between 1860 and 1870; now site of residential development, Comus Crescent; stone used in St Stephen's Cathedral, Roma Street Railway Station, and old GPO, Brisbane; Richards, 1918, Wolff, 1957, Houston, 1967, O'Flynn & others, 1983; Spry, 1983.
Woogaroo quarry	Ipswich			Brassall Sub-Group: light pink to brown, medium-grained sandstone	Abandoned	Smith and Rees	Building stone (Goodna sandstone)	Two quarries situated on bank of Brisbane River, near Jeay's Quarry; stone used in St Paul's Presbyterian Church and walls of South Brisbane cemetary; Anon, 1888; Richards, 1918; Wolff, 1957; Houston, 1967; Willmott & others, 1979; Spry, 1983.
Calvert								
Beatty and Walsh's quarry	Helidon			Marburg Formation: brown, fine-grained sandstone	Abandoned	Beatty and Walsh	Building and monumental stone (Calvert sandstone)	Quarry location is no longer known; some stone used in Castlemaine Perkins Brewery; Anon, 1888; Richards, 1918; Wolff, 1957, Willmott & others, 1979; Spry, 1983.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Calvert Brodie's quarry	Helidon			Marburg Formation; brown, fine-grained sandstone	?	Brodie	Building and monumental stone (Calvert sandstone)	Quarry was worked between 1863 and 1878; 100m long face, 5.4m high, with railway siding, stone exhibited rapid disintegration; Anon, 1888; Richards, 1918, Wolff, 1957 Willmott & others, 1979; Spry, 1983.
Cooktown	Cooktown			? Battle Camp Formation glauconitic sandstone, shaly sandstone	Abandoned	?	Building stone (? Laura sandstone)	Quarry situated near Normandy Homestead; stone used in railway culverts, Cooktown - Laura railway line during 1890's; Lucas & de Keyser, 1965.
Croydon	Croydon			Mesozoic sandstone	?	?	Building stone	Doutch, 1977.
Galilee	Galilee			Clematis Sandstone and Dunda beds: flaggy sandstone	Abandoned	?	Building stone	Flaggy sandstone has been used in several local buildings; Vine & Doutch, 1972.
Georgetown Gilbert River quarry	Gilbert River (982882)		R.4 (Bumba)	Coffin Hill Member multi-coloured, fine-grained sandstone	Occasionally worked	Ribbonstone	Floor tiles, crazy paving, feature walls, stair treads furniture, ornaments	Stone is quarried from several shallow pits, east of the Gilbert River; blocks are sawn into slabs and tiles at company's plant, Cairns; some stone exported; appears to be large reserves remaining.
Rylestone 1 quarry	Gilbert River (972928) p.a.	Former ML 945 (Georgetown)	R.1 & 78 (Bumba)	Coffin Hill Member: sandstone	?	A. & S. Ryle, and W. Bell	? Sandstone tiles, and slabs	Quarry was not located; stone was reported to have been sawn on site (pers. comm. J. Warnick).
Grantham	Helidon			Marburg Formation: white to brown sandstone	Abandoned	?	Building stone columns, balusters, groins, and grindstones	Area also referred to as 'Jones' Siding' and 'Kettles paddock'; two quarries, not located Petrie and Co used stone on Government Printing Office, AMP building Toowoomba, and buildings Roma; Anon, 1888; Spry, 1983.
Gympie Anderleigh quarry	Gympie (603214)		92 (Curra)	Myrtle Creek Sandstone light grey, white, medium to coarse-grained sandstone	Worked	Anderleigh Quarries	Building stone, 'colonial' blocks	Small to medium sized quarry, 4 to 6m face; 3 beds of sandstone, upper bed is crossbedded; O'Flynn & Graham, 1987.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Gympie								
Heron Road quarry	Gympie (611982)		882 (King)	Myrtle Creek Sandstone light brown to cream, coarse-grained sandstone	Abandoned	J. Smith and Co.	Building stone	Small quarry, large reserves remaining, but coarse-grain size may be a problem; stone used in St Patricks Catholic Church (1887), Gympie; O'Flynn & Graham, 1987.
The Rocks quarry, cnr Heron and Long Roads	Gympie (610993)		882 (King)	Myrtle Creek Sandstone: medium to coarse-grained sandstone	Abandoned	?	Building stone	Small to medium sized quarry, large reserves to south formed by prominent cliff line, The Rocks: local scenic feature.
Scrubby Creek Widgee Road	Gympie			Myrtle Creek Sandstone	Abandoned	J. Smith and Co. (1883-87)	Building stone	Quarry was not located; stone used in St Patricks Catholic Church, Gympie.
Helidon								
Helidon quarry	Helidon (160544)		8v (Helidon)	Helidon Sandstone: white mauve, brown, sandstone fine to coarse-grained, conglomeratic sandstone	Trial quarries	Australian Dimensional Stone Industries Pty Ltd		Four shallow trial excavations, no production recorded to date.
Comeford's quarry (formerly Spratt's quarry)	Helidon (120565)		85 (Helidon)	Helidon Sandstone: white mauve, brown, fine-grained sandstone	Worked	Comeford Sandstone	Building stone blocks, slabs tiles, and table tops (Helidon Sandstone)	Several old quarries, including Miller's, Jude's and old State quarries are being worked; Anon, 1888; Richards, 1918, Dunstan, 1923 Morton, 1927; Denmead, 1943, 1945; Wolff, 1957, Zahawi, 1979; Spry, 1983; Willmott, 1987.
Helidon Sandstone Company	Helidon (120567)		50v (Helidon)	Helidon Sandstone: white mauve, salt & pepper, brown, fine-grained sandstone	Worked	Helidon Sandstone Company Pty Ltd	Tiles, blocks, slabs, crazy pavers, furniture (Helidon Sandstone)	Previously Spratt's, Jude's University and part of old State quarries; new faces are being developed, spoil removed for road construction purposes; Richards, 1918; Wolff, 1957; Zahawi, 1979, Spry, 1983; O'Flynn, 1980; Willmott, 1987.
Jude's quarries								Several quarries operated by Jude: refer to Comeford's and Helidon Sandstone Company quarries.
Lockyer Sandstone or Corrigan's quarry	Helidon (154550)		92 (Helidon)	Helidon Sandstone: light grey, mauve, brown, fine to medium sandstone.	Worked	Lockyer Sandstone	Blocks, slabs, tiles, furniture, bench tops, ornamental stone (Helidon Sandstone)	Several faces developed in single sandstone bed; grades into coarse sandstone, conglomeratic, above and below this bed; previously one of Pearson's quarries; Willmott, 1987.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Helidon								
Miller's quarry								See Comeford's quarry above.
Montgomery's quarry	Helidon		? (Helidon)	Helidon Sandstone	Abandoned	Montgomery, McLachlan and Sheddon	Building stone slabs, blocks (Helidon Sandstone)	Several small quarries near Ziegler's Quarries present working; blocks extracted using picks, feathers and wedges; gang saw behind Montgomery's home; Anon, 1888.
Old State quarries								Refer to Comeford's and Helidon Sandstone Company's quarries, see above.
Pearson's quarries	Helidon (166574)		(Helidon)	Helidon Sandstone	Abandoned	Pearson		See Lockyer Sandstone's quarry above.
Phippard's quarry	Helidon	?	? 3v (Helidon)	Helidon sandstone: white, fine-grained sandstone	Abandoned	Phippard	Building stone (Helidon Sandstone)	Quarry was not located, but believed to be N.E. of Wright's Quarry; stone used in Central Railway Station, Brisbane.
Stronach's quarry	Helidon		(Helidon)	Helidon Sandstone	Abandoned	Stronach	Building stone (Locker Creek Sandstone)	Quarry was not located; two quarries, height over 13m; Richards, 1918; Wolff, 1957; A.B. Journal (Qld), March 12, 1934 (p47), stone used in AMP building, now McArthurs Chambers, Brisbane; Denmead, 1945; Zahawi, 1979; Willmott, 1987.
University quarry								Refer to Helidon Sandstone Company's quarry, see above.
Wagner's quarry, formerly Wright's quarry or Freestone quarry	Helidon (168556)	Former ML 127 (Toowoomba)	3v (Helidon)	Helidon Sandstone: white, mauve, salt & pepper, brown, fine-grained sandstone	Worked	J.H. Wagner & Sons Pty Ltd; William Wright & Sons (1958-63)	Building stone, blocks, slabs, treads, tiles, random pavers, furniture, bench tops, monumental stone (Helidon Sandstone)	Largest quarry in Helidon district, trenching machines used to cut blocks from several levels/benches; Richards, 1918; Morton 1928, Wolff, 1957; Zahawi, 1979; O'Flynn, 1980; Spry, 1983; Willmott, 1987.
Waterfall, Plantation or Whitestone quarry	Helidon (158571)		4v,89,95 (Helidon)	Helidon Sandstone	Abandoned		Building stone	Worked, circa 1883; Anon, 1888; Willmott, 1987.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Helidon Ziegler's quarry (formerly Clearly's quarry	Esk (093632)		1308 (Murphy)	Helidon Sandstone: light brown, fine to medium-grained sandstone	Occasionally worked	R.C. Zieglers Monumental	Tiles, blocks, monumental stone (Helidon Sandstone)	Large area cleared of top soil surrounding old Quarry, new quarry face developed for block extraction; Zahawi, 1979; O'Flynn, 1980; Willmott, 1987.
Ziegler's quarry	Helidon (108577)		79 (Helidon)	Helidon Sandstone	Worked	R.C. Zieglers Quarries (Helidon)	Building blocks, monumental and landscaping stone (Helidon Sandstone)	Several faces developed on Montgomery's property, large resources remain; Zahawi, 1979; O'Flynn, 1980; Willmott, 1987.
Highfields quarries	Oaky		? (Geham)	Marburg Formation: white, coarse-grained sandstone, current bedding	Abandoned	?	Building and monumental stone (Highfields Sandstone)	Three quarries were worked (circa 1877 or 1878); No 3 or main quarry beside railway 2·5km west of Spring Bluff; stone performed poorly in service; Anon, 1888; Richards, 1918; Wolff, 1957; Spry, 1983, Willmott, 1987.
Ipswich Geary's quarry	Ipswich			Brassall Sub-Group: light pink to greenish-brown, medium to coarse-grained sandstone	Abandoned	?	Building stone (Goodna Sandstone)	Quarry was not located; stone was used in old St. Stephens R.C. Church, Elizabeth Street; stone is easily weathered; Anon, 1888; Richards, 1918; Wolff, 1957; Houston, 1967; Willmott & others, 1979; Spry, 1983.
Unnamed Goodna quarry	Ipswich				Abandoned	?	Building stone (Goodna Sandstone)	Reported large 'freestone' quarry on opposite side of river, from Por. 135 Moggill; Rands, 1890.
Jericho	Jericho (449386)			Colinlea Sandstone: labile to quartzose sandstone	Abandoned	?	Building stone	Quarry situated 12km west of Alpha, Senior, 1973.
Logan Village Caradini's quarry	Beenleigh			Woogaroo Sub-Group: bluish-white and brown	Abandoned	Caradini	?	Quarry was not located; reported to be in bank of Logan River, 1.6km from railway station; stone easily weathered; Anon, 1888; Richards, 1918.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Logan Village Watt's quarry or Logan Village quarry	Beenleigh			? Woogaroo Sub-Group coarse-grained sandstone	Abandoned	Alexander Watt		Quarry was not located; reported to be 5km from railway station, in cliff about 30m high; stone not recommended for public use; Anon, 1888; Rands, 1890; Richards, 1918.
Longreach	Longreach 1:250 000			Glendowner Sandstone: fine-grained sandstone (or silcrete), chalcedonic cement; hard	Abandoned	M. Bullock (stone mason)	Building and landscaping stone (Longreach Sandstone)	Sandstone quarried from 'Longway' and 'Goodbury Hills' Homesteads; stone used in Stockman's Hall of Fame, opened 1988; Draper, 1983.
Mount Molloy	Rumula		Brooklyn Holding (Mappe)	? white, coarse-grained sandstone	Occasionally worked	B. Hollis	Building and landscaping stone	Quarry was not inspected; stone reported to be too soft.
Murphy's Creek ? Cameron's quarry	Esk (087652)		65 (Murphy)	Helidon Sandstone: white, light grey to brown, medium-grained sandstone	Abandoned	? John Cameron	? Building stone (Murphy's Creek Sandstone)	Two small quarry benches, beside Fifteen Mile Creek; Anon, 1888; Richards, 1918; Wolff, 1957; Willmott, 1987.
Tweed's Quarry	Esk (094604)		185 (Taylor)	Helidon Sandstone: white to grey, medium-grained sandstone	Disused	Neville Tweed	Building stone (Murphy's Creek Sandstone)	Old large quarry beside railway line, 3m face; owner planning to redevelop quarry; appreciable resources to north; Willmott, 1987.
Unnamed quarry	Esk (090616)		71 (Murphy)	Helidon Sandstone: medium-grained sandstone	Abandoned	?	Building stone (Murphy's Creek Sandstone)	Small quarry face; 3 to 4m high, sandstone bed less than 2m thick; Willmott, 1987;
	Esk (091615)		R.71 (Murphy)	Helidon Sandstone: medium-grained sandstone	Abandoned	?	Building stone (Murphy's Creek Sandstone)	Small quarry in same sandstone bed as above; 3 to 4m high face; Willmott, 1987.
	Esk (086626)		115A (Murphy)	Helidon Sandstone: white, light brown sandstone	Abandoned	?	Building stone (Murphy's Creek Sandstone)	Small to medium-sized quarry 2 to 3m face, little or no overburden; Willmott, 1987.
Pentlands or Torrens Creek quarry	Hughenden 1:250 000			Warang Sandstone: massive, brown sandstone	Abandoned	?	Monumental stone	Quarry was not inspected, stone used in Charters Towers and Townsville; Richards, 1918; Wolff, 1957; Spry, 1983.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Stanwell via Rockhampton								
Stanwell quarry	Mount Morgan (287983)			Razorback beds; light brown, medium-grained sandstone	Worked	Stone Products Pty Ltd (previously Redhead Quarries Pty Ltd)	Building stone tiles, blocks, slabs (Capricorn Sandstone)	Company redeveloped one of six old quarries in this area in 1988; previously worked 1883; and 1916 (F.M. Allan & Co.); blocks transported to Parkhurst for processing; stone used in many Rockhampton buildings; Richards, 1918; Wolff, 1957; Willmott, 1976; Trezise, 1982, 1989; Trezise & others, 1983.
Tamborine Village								
Mundoolun quarry	Beenleigh (082134)			Marburg Formation: brown, fine to coarse-grained sandstone	Worked	Sandstone Emporium	Tiles, crazy pavers furniture (Mundoolun Sandstone)	Old quarry re-opened in 1988; blocks processed at Alberton plant; stone used in Mundoolun Church (1900); large reserves; Anon, 1888; Richards 1918; Wolff, 1957; Willmott & others, 1978.
Warwick								
Gunn's quarry	Warwick			Marburg Formation:	Abandoned	?	Building stone (Warwick Sandstone)	Quarry was not located; reported to be 3km from Warwick, adjacent to and east of railway; stone used in Presbyterian Church, Warwick; Richards, 1918; Wolff, 1957; Spry, 1983.
Mitchells' Gollan's or Hong Kong quarry	Warwick			Marburg Formation:	Abandoned	?	Building stone (Warwick Sandstone)	Quarry was not located, reported to be 800m from Gunn's quarry; stone used in Warwick Convent (1892); Richards, 1918; Wolff, 1957; Spry, 1983.
Mount Sturt	Warwick			Marburg Formation: brown, fine-grained sandstone	Abandoned	?	Building stone (Swan Creek Sandstone)	Quarry was not located, but reported to be about 14km from Warwick; 25m quarry face, 3-4m high, into west slopes of hill; stone used in Town Hall and old railway building (1888); argillaceous and clayey sandstone, finer grained then Warwick sandstone; stone doesn't take a good arris; Anon, 1888; Richards, 1918; Wolff, 1957.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Warwick								
Mount Tabor	Warwick			Marburg Formation:	Abandoned	?	Building stone	Quarry was not located, but reported to be on ridge, northwest from Mount Tabor; stone used in many Warwick buildings; Richards, 1918; Wolff, 1957; O'Flynn, 1983; Spry, 1983.
Sidling quarry (includes Bishop Tuffnell's quarry)	Warwick			Marburg Formation:	Abandoned	?	Building stone (Warwick Sandstone)	A number of small quarries commencing at Gunn's quarry, extending through Bishop Tuffnell's quarry and four other quarries towards Freestone Road; stone used in many Warwick buildings; Anon, 1888; Richards, 1918; Wolff, 1957; Spry; 1983.
Waterwork's Hill (also referred to as Scrubb quarry)	Warwick			Marburg Formation:	Abandoned	?	Building stone (Warwick Sandstone)	Quarry was not located; stone reported to be amongst the better Warwick sandstones; stone used in Warwick Hospital; Anon, 1888; Richards, 1918; Spry, 1983.
Yangan quarry or Midson quarry	Warwick (224799)		219 (Robinson)	Marburg Formation: brown, fine-grained sandstone	Abandoned	?	Building stone and monumental stone	Small quarry worked in recent years for restoration stone; stone used in many Government and commercial buildings in Brisbane and Warwick; Richards, 1918; Wolff, 1957; O'Flynn, 1983; Spry, 1983.

APPENDIX 2 : BUILDING STONE SOURCES - GRANITE

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Blackbutt District							
Blackbutt quarry	Nanango (093292)	99v, 100v (Taromeo)	Taromeo Tonalite: dark grey, medium-grained tonalite	Abandoned	K. Langton; P.J. Lowther and Son; Ulam Carrara Marble Quarries Pty Limited	Building and monumental stone (Blackbutt Granite)	Small operation, fresh rock worked from large boulders in the 1950's and 60's; previously ML's 73 and 104 (Nanango); 213t extracted between 1963-1966; small reserves remaining; Wolff, 1957; Martin & Neville, 1981;
Emu Creek quarry	Nanago (141181)	S.F. 283 (Colinton)	Taromeo Tonalite: light grey, medium-grained tonalite	Abandoned	L. Langton, P.J. Lowther and Son, and T. Wrafter	Building and monumental stone	Small operation, fresh rock worked from boulders, and outcrop, 1964-1977; previously ML's 127 and 130 (Nanango); disseminated pyrite and pyrite coating on joint surfaces.
Taromeo Creek Road quarry	Nanango (170336)	S.F. 283 (Taromeo)	Taromeo Tonalite: grey, coarse-grained tonalite, diorite xenoliths	Abanoned	L. Langton, Ulam Carrara Marble Quarries Pty Ltd (subs. of Pioneer Concrete Services Pty Ltd)	Building and monumental stone (Black Beauty)	Small quarry, in large, fresh boulders; previously ML 129 (Nanango); 93t of granite produced 1966.
Brisbane City							
Ashgrove	Caboolture (961635)	672 (Enoggera)	Enoggera Granite:	Abandoned	?	Granite kerbstones	Quarry not located; Jack, 1899.
Ashrove, Kerr's or Stirling's quarry	Caboolture (966634)	711, Sub.4 Por 166 (Enoggera)	Enoggera Granite; pink, medium-grained granite	Abandoned (1974)	W. Kerr, Stirling Granite Company, The Readymix Group (Qld)	Building and monumental stone	Very large quarry, several benches developed; previously a major crushed rock source; pyrite-free stone is tough, and takes a good polish; large reserves remain but further quarry development limited by proximity of urban development; Wolff, 1957; Houston, 1967; O'Flynn & others, 1983.
Cedar Creek quarry, via Closeburn	Caboolture (798782)	79v (Samsonvale)	Mount Samson Granodiorite: pink, medium-grained granite, and grey granite	Abandoned	A.G. Stronach	Building and monumental stone (Red Granite)	Medium-sized operation, fresh rock worked from large boulders; large reserves remain, in excess of 100 000 tonnes; rural-residential developments may restrict further development; A. and B. Journal of Queensland, 1932, 1934; Wolff, 1957; O'Flynn & others, 1983.
Kholo Creek quarry	Ipswich (835578)	43 (Kholo)	Karana Quartz Diorite: dark greenish-grey, medium-grained diorite	Abandoned	P.J. Lowther and Son Pty Ltd	Building and monumental stone (Mount Crosby or Kholo Granite)	Small quarry; large potential deposit, Willmott & others, 1979; some encroachment of deposit area by rural-residential developments; Wolff 1957; Willmott & others, 1979.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Brisbane City							
Saint John's Wood quarry	Caboolture (965642)	? 372 (Enoggera)	Enoggera Granite: granodiorite	Abandoned	?	Building and monumental stone	Quarry was not located; Houston, 1967; O'Flynn & others, 1983.
Samford quarry	Caboolture (873723)	Subdiv. 3, 97 (Samford)	Samford Granodiorite: light grey, medium to coarse-grained granodiorite	Abandoned	P.J. Lowther and Son Pty Ltd	Granodiorite slabs for base of Brisbane City Hall, and University of Queensland (St Lucia)	Small quarry, not located; rural-residential developments in Samford valley may prevent further quarrying; Wolff, 1957; O'Flynn & others, 1983.
Samford, Camp Mountain quarry	Caboolture (886689)	90, 100 (Samford)	Samford Granodiorite: light grey, medium to coarse-grained granodiorite	Abandoned	A.G. Stronach	Building and monumental stone; A.M.P. Building, Brisbane	Medium-sized, shallow quarry, stockpiles of large, partly cut slabs; Wolff, 1957; O'Flynn & others, 1983.
Samford, Highvale prospect	Caboolture (803712)	125, 126 (Samford)	Samford Granodiorite:	Potential deposit	Consolidated Mining Industries Limited	Building stone	Proposed quarry site, previous ML 1167 (Brisbane); site within Samford Valley Strategic Plan Study Area; rural-residential developments may prevent extraction of stone.
Charters Towers							
Golden Gate H.S., east area	Charters Towers (130713)	MHPL 9684 (Black Jack)	Ravenswood Granodiorite Complex; gabbro, orbicular gabbro	Potential deposit	G. Hamilton	Building stone	Application for extractive industries permit; no quarry development to date; small boulders, highly jointed.
Golden Gate H.S., west area	Charters Towers (121712)	MHPL 9684 (Black Jack)	Ravenswood Granodiorite Complex: dark grey to black, medium-grained gabbro	Potential deposit	G. Hamilton	Building stone	Application lodged for extractive industries permit; no quarry development to date; highly jointed stone, poor outcrop.
Clermont							
Theresa Creek	Clermont (614593)	12 (Theresa)	Retreat Granite: red-green, white and blue, medium-grained granite	Potential deposit	Dolma Transport (B. Martini)	Building stone (Theresa red, and leopard granite)	Sample material only produced to date; Korean interests investigating deposit.
Cooktown							
Grassy Hill	Cooktown	R.83 (Cook)	Finlayson Granite:	Abandoned	?	Building stone	Small benches cut into hill slope; Ball 1905; Lucas & de Keyser, 1965.
Crows Nest							
Anduramba quarry	Esk (110942)	17v (Anduramba)	Eskdale Granodiorite: grey, medium-grained granite	Abandoned	R.C. Ziegler and Son Pty Ltd	Building and monumental stone (Anduramba Granite)	Small quarry, partially waterfilled; additional resources, mainly boulders, on ridge south of quarry; previously ML 126 (Toowoomba); Dimmick, 1949; Wolff, 1957.
Austin	Esk (066933)	71v (Djuan)	Crows Nest Granite: coarse, pink to dark pink granite	Potential deposit	Lachlan Valley Granites; previously Jalsign Pty Ltd	Building stone (Austin red)	Extractive industry permit (Crows Nest Shire), quarry to commence early 1990; stone to be processed in N.S.W.
Bluff Mountain	Esk (145910)	65v (Anduramba)	Intrusive Tertiary dolerite	Potential deposit	Jalsign Pty Ltd	Building stone	Application for extractive industry permit (Crows Nest Shire), no quarrying to date.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Crows Nest Nukinenda	Esk (140082)	19 (Eskdale)	Eskdale Granodiorite: black, medium-grained porphyritic gabbro (dyke)	Trial quarry	Marlborough Gold Mines Limited (60%), Pavstar Pty Ltd (40%)	Block extraction for export markets; slab and tile production proposed	Small trial quarry, sample blocks (6t) initially extracted; application for extractive industry permit has been submitted.
Ravensbourne or Ulam Carrara quarry	Esk (194720)	35v (Buaraba)	Crow's Nest Granite:	Abandoned	Ulam Carrara Marble Quarries Pty Ltd	?	Quarry was not located; previously ML 147 (Toowoomba); O'Flynn, 1980.
Croydon	Croydon 1:250 000	?	Esmeralda Granite	Abandoned	?	Building stone	Quarry(s) were not inspected; local mine buildings constructed of stone; Doutch, 1977.
Gracemere Allan's quarry	Ridgelands (418028)	1A (Gracemere)	Bouldercombe Complex: blue-grey, medium-grained quartz gabbro	Abandoned	F.M. Allan and Co: Capricornia Quarries Pty Ltd	Building and monumental stone (Gracemere granite)	Small quarry, in fresh rock, commenced operations in early 1920's; previously ML 308 (Rockhampton); medium to large reserve remain east of quarry; Richards, 1926; Ball, 1927; Wolff, 1957; Willmott, 1976; Trezise & others, 1983; Trezise, 1989.
Lucas Street quarry	Ridgelands (416032)	1A (Gracemere)	Bouldercombe Complex: grey, medium-grained quartz gabbro	Occasionally worked	West Moreton Industries Pty Ltd, previously C.J. Allan (1958-1972)	Building and monumental stone, ornamental and landscaping stone	Medium-sized scraping, fresh rock worked from large boulders and tors; currently under ML 480 previous ML 308 (Rockhampton); small reserves, largely decomposed granite; Willmott, 1976; Trezise & others, 1983; Trezise, 1989.
Table Mountain	Mount Morgan (339984)	Lot 27 (Boulder-combe)	Bouldercombe Complex: green-grey, medium to dark grey gabbro	Potential deposit	Central Mining (Mr H.B. Clark) and R.G.C. Exploration Pty Ltd	Possible source of building and monumental stone; blocks, slabs, tiles	Quarry sale application, Queensland Forest Service; R.G.C. Exploration Pty Ltd, test drilling and sampling early 1990.
Georgetown Mount Direction	Galloway (060100)		?	Potential deposit	Talflag Holdings Pty Ltd	Building and monumental stone	Sample material cut and polished; quarry sale approved by Queensland Forest Service.
Emu Creek	Forest Home		Forsayth Granite: porphyritic, blue-grey, medium-grained granite	Trial quarry	Talflag Holdings Pty Ltd	Potential building stone deposit (Georgetown Common)	Sample block cut and polished; quarry sale.
Mount Garnet Sundown Road	Bullock Creek (826307) (828315)	OL 154 (Munderra)	Herbert River Granite: pink, medium-grained granite; grey medium to coarse-grained granodiorite	Worked	Australian Facia Stone Quarries	Building and monumental stone (Sundown pink) (Down grey)	Small quarries, recently opened; fresh rock worked from large boulders; quarry sales, Queensland Forest Service; orders and sales for blocks have been negotiated.
	?		?		V.D.G. Pty Ltd	Building stone	Application for quarry sale; block to be processed interstate.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Mount Isa							
Foschi quarry	Mount Isa 1:250 000	Mount Guide Holding (Heywood)	Sybella Granite: pink gneiss	Occasionally worked	Dacca Pty Ltd (Foschi Enterprises)	Building and monumental stone	Small quarry, blocks used locally; quarry sale, Queensland Forest Service.
Talflag's quarry	Mount Isa 1:250 000	Mount Guide Holding (Heywood)	Sybella Granite: pink gneiss	Disused	Talflag Holdings Pty Ltd	Potential building stone deposit, sample blocks excavated (Orbit black)	Small quarry, sample blocks cut and polished.
Mount Surprise							
Mount Surprise quarry	Galloway (171085)		Elizabeth Creek Granite: pink, medium-grained granite	Worked	Talflag Holdings Pty Ltd	Blocks for interstate and overseas markets, slabs, tiles building stone) (Surprise red)	Small, benched quarry in large exfoliated granite sheet; 7 to 20t blocks are extracted and transported (road) to Brisbane for shipping; large resource; quarry sale, Queensland Forest Service.
Nanango							
The Boulders prospect	Kingaroy (946477)	204 (Kunioon)	Taromeo Tonalite: grey, medium-grained, hornblende granodiorite	Proposed quarry site	Granite Resources Limited	Proposed building stone deposit	Drilling and sampling, blocks cut and polished; large resource; scenic area, 'The Boulders'; extractive industry permit, Nanango Shire.
Sanders' quarry	Kingaroy (812336)	23 (Tarong)	Dolerite dyke in Boondooma Igneous Complex	Trial quarry	Granite Resources Limited	Building and monumental stone, tiles, slabs, blocks (Maiden Black)	Small trial quarry, drilling delineated extent of deposit; highly to completely weathered near margins; highly jointed.
Barnes' quarry	Kingaroy (806328)	160 (Neumgna)	Boondooma Igneous Complex: pink, medium to coarse-grained granite (adamellite)	Trial quarry	Granite Resources Limited	Building and monumental stone, tiles, slabs, blocks (Nanango Peach)	Site cleared and small quarry developed in large exfoliated sheets of fresh rock; sample blocks cut and polished; deposit drilled; moderate to large resource.
Ootann (via Mareeba)	Chillagoe (504727)		Herbert River Granite: pink, medium-grained granite (adamellite)	Potential deposit	M. Graham	Possible building and monumental stone source	Large boulders and tors of fresh rock; sample block extracted.
Stanthorpe							
Dalveen (Split Yard)	Allora (901489)	659 (Rosenthal)	Ruby Creek Granite: granite, granodiorite, adamellite	Potential deposit	Consolidated Mining Industries Limited (1973-74)	Building stone	Mining Lease Application No. 57 (Warwick) not proceeded with, no mining occurred.
(Middle Creek)	Allora (932486)	136, 605 (Rosenthal)	Stanthorpe Adamellite: granite, granodiorite, adamellite	Potential deposit	Consolidated Mining Industries Limited (1973-74)	Building stone	Mining Lease Application No. 58 (Warwick) not proceeded with, no mining occurred.
Pozieres quarry	Stanthorpe (906383)	138 (Marsh)	Stanthorpe Adamellite: pink, medium to coarse-grained granite	Occasionally worked	South Queensland Granite (Mr B. Kassulke)	Building and monumental stone	Small quarry developed in large exfoliated sheets of fresh rock; large resource; drilling and testing completed.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Stanthorpe							
Stanthorpe	Stanthorpe (961294)	? (Folkstone)	Stanthorpe Adamellite: red granite	Abandoned	Messrs Edwards and Roberts	Building and monumental stone	Small quarry near railway station, good polish; A.R.D.M. 1915 and 1916.
The Summit (Jolly Lease)	Stanthorpe (949377)	37v (Stanthorpe)	Ruby Creek Granite: granite, granodiorite, adamellite	Potential deposit	Consolidated Mining Industries Limited (1973-74)	Building stone	Mining Lease Application No. 451 (Stanthorpe) not proceeded with, no mining occurred.
Townsville							
Castle Hill, Echlin Street quarry	Townsville (787698)		Castle Hill Granite: dark pink to red, medium-grained granite	Disused	Townsville City Council	Blocks for breakwater	Large quarry, previous source of crushed rock products; now site for explosives store and asphalt plant; unlikely to be reworked; Ball, 1905; Richards, 1918.
Hervey Range quarry	Townsville (?)	?	Unnamed granite: pink, medium-grained granite	Abandoned	Melrose and Fenwick, Townsville	Building and monumental stone	Blocks won from large boulders or tors of fresh rock, no actual quarry face developed; site was not located; stone was used in A.M.P. Building (circa 1938); large stone deposits remain in this area, east of Hervey Range.
Magnetic Island, Arcadia quarry and Cockle Bay quarry	Townsville (?)	?	Magnetic Island Granite: grey, medium-grained granite	Abandoned	Melrose and Fenwick, Townsville	Building and monumental stone	Quarries were not located; stone used in Custom's House and other Townsville buildings; scenic values, residential and tourist development may prevent further quarrying; Wolff, 1957.
Mount Spec quarry	Rollingstone (?)		Unnamed granite: grey granite	Abandoned	Melrose and Fenwick, Townsville	Building and monumental stone	Blocks worked from large boulders of fresh rock; site was not located.
Warwick							
Greymare quarry	Allora (699831)	750 (Greymare)	Greymare Granodiorite: light grey, medium to coarse-grained granite	Abandoned	P.J. Lowther and Son Pty Ltd	Building and monumental stone	Blocks of fresh stone won from boulders; stone used in many buildings in Warwick and Brisbane, including University of Queensland; Richards, 1918; Wolff, 1957; O'Flynn, 1983.

APPENDIX 3 : BUILDING STONE SOURCES - MARBLE AND LIMESTONE

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Betoota	Betoota 1:250 000	-	? (Calamia)	Tertiary limestone: hard, white, highly silicified	Abandoned	?	Building stone	Cacoory Homestead built of this stone, circa 1915; extensive deposits; Jauncey, 1965.
Bowen Blue rock	Bowen (551618)	1012 (237) (Bowen)	50 (Ben Lomond)	Edgecumbe beds: oolitic limestone	Possible resource	W.J. Hickmott and A.J. Blair		No production recorded from ML's 1012, 1013 and 1014 in 1989.
Limestone gully	Bowen (540650)	1013 (238) (Bowen)	50 & 51 (Ben Lomond)	Edgecumbe beds: oolitic limestone	Possible resource	W.J. Hickmott and A.J. Blair		
Ben Lomond	Bowen (507704)	1014 (239) (Bowen)	R.177 (Gloucester)	Edgecumbe beds: blue-grey uniform, fine-grained, oolitic limestone	Possible resource	W.J. Hickmott and A.J. Blair		Small roof pendant in granite, limestone crops out over 1ha, vertical relief of 25m, GSQ, 1978.
Bracewell Elliott's property	Bajool (854546)	Former ML 401 (Gladstone)	MHPL 800 (Nolan)	Mount Holy beds: fine to coarse-grained limestone, fossiliferous, white to dark grey, black and red	Proposed quarry	Australian Quality Marble Pty Ltd; R.I. & K.A. Savage, L. Cummins (1964)	Building stone	Application to quarry deposit lodged with Calliope Shire Council, 27.7.1987, but site was not developed; high-grade limestone, good potential for most uses; Krosch, 1981.
Bracewell Minerals	Bajool (875568)	3601 (411, Gladstone)	MHPL 741,769 (Nolan)	Mount Holy beds: medium to coarse-grained limestone, white-light grey-red, recrystallised, some breccia	Proposed quarry	British and Continental Motors Pty Ltd and Auto City Mackay Pty Ltd; previously Bracewell Marble Pty Ltd (in liquidation 1985)	Building stone, marble chips (terrazzo) and dust, possibly road base and aggregate	High grade limestone suitable most uses; low to high relief, large resource, Department drilling proved an extension of deposit to a vertical depth of 100m; Krosch, 1981.
	Bajool (?)	-	MHPL 892, 1364 (Nolan)	Mount Holy beds: fine to medium-grained limestone, white to grey, pink, red	Proposed quarry	Fencross Pty Ltd (a subsidiary of Steamships Trading Co. Ltd)	Building stone	Authority to Prospect Application No. 7/89 rejected, Gladstone, series of lenses, cavernous in part, good potential MHPL 892 and 1364.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Cairns								
Christmas Creek (Tiny Tim)	Bartle Frere (687807)	1266 (87, Cairns) (previous ML's 35, 38, 79 and 96)	State Forest	Hodgkinson Formation: uniform fine-grained, white to grey marble, black marble at depth (below 20m)	Disused (labour exemption in force)	Messrs B. Marcum and A. Buttfield (1973 -); previously C.J. Petersen and party (1956), G. Pezzelato of Cairns Terrazzo Monumental Works (1960-62), North Queensland Marble Pty Ltd (1962-65), H. McArthur and T. & M. Jacques (1965-72)	Reported to be suitable for building or monumental work (Malanda marble, Boonjie marble or Bartle Frere marble)	Exploratory drilling of marble deposit carried out in 1961; reports by Denmead 1956; Levingston, 1956, 1961; lease recently worked under agreement by Mr W.F. Morrow, sample blocks removed for testing.
Mount Peter	Bartle Frere (663099)	Previous ML's 15, 31, 32, 42, 43, 47-51, (Cairns)		Hodgkinson Formation: white, recrystallised limestone	Abandoned	G.L. & P. Kenny (1932-34), G. Pezzelato (1959-77), North Queensland Marble Pty Ltd, C.G. Penridge (1962, 1963), J.E. Averkoff (1965-68)	Agricultural lime, marble chips for terrazzo (Mount Peter marble)	Marble lens 60m long and 3.5m wide; steep terrain makes access difficult; previously quarried for a short time in 1960's; small deposit; Jensen, 1919; Connah, 1958; Willmott & others, 1988.
Cecilwood (via Gladstone)								
Marble Mountain	Bajool	3657, 3360 (805, MLA 813, Gladstone) (previously ML's 758, 759, 760, 761, 802 & 803)	7v, 17, 21, 40 and 41 (Raglan)	Capella Creek beds: marble, fine to medium-grained, minor coarse-grained (saccharoidal) marble to east; variable colours, grey, white, cream, pink, red, brown	Potential deposit	Peko-Wallsend Operations Ltd (1982-83); Rioace Pty Ltd (1988-89) Elderlodge Pty Ltd (1989 -)	Building stone, blocks; proposed manufacture of slabs and tiles; terrazzo chips and marble dust	No mining has occurred to date from any of these leases; drilling completed; small trial quarry established, sample blocks excavated for testing; exploration continuing on leases; deposit investigated by Krosch (1981).
Cedric Mountain	Bajool	3656 (MLA 804, Gladstone) (previously MLA 757)	17 (Raglan) 3 (Balaclava)	Capella Creek beds: marble, fine to medium-grained, grey, white, cream, pink, brown; minor crinoids	Potential deposit	Peko-Wallsend Operations Ltd (1982-83); Rioace Pty Ltd (1987-89); Elderlodge Pty Ltd (1989 -)		Exploration progressing, no mining to date; deposit investigated by Krosch (1981), limited potential, difficult access.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Childers								
(Stuart No.1)	Mount Perry	1213 (209, Bundaberg)	SF 169 (St Agnes)	Goodnight beds: light grey to white, fine-grained marble	Potential deposit	Widerhope Pty Ltd (sub. of Rhone-Poulenc Rural Pty Ltd)		No mining to date from three mining leases; samples sent to Italy; company proposes to carry out small scale mining using drilling and hydraulic block splitters; Reid, 1919; Wolff, 1957: Connah, 1958; Trezise & Graham, 1984.
(Stuart No.2)	Mount Perry	1214 (210, Bundaberg)						
(Stuart No.3)	Mount Perry	1215 (211, Bundaberg)						
Chillagoe								
Rankines Enterprise	Chillagoe (351019)	4797, (1376, Mareeba)	(Chillagoe)	Chillagoe Formation: medium to coarse-grained, white, pink marble	Disused, since late 1988	D.H. & C. Rankine; Global Marble Pty Ltd	Building stone, tiles, slabs, billets	Lease worked by Global Marble under an exclusive contract/tribute arrangement; medium-sized quarry,two 3m high benches; numerous solution cavities and boulders south-west corner of quarry; negligible overburden; large resource remaining.
Bianca No.1 (southern quarry)	Chillagoe (421898)	5184 (3970, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: fine to medium-grained, white to light-grey marble, limonite veins result in gold colouration, saccharoidal in part	Abandoned	Queensland Marble Limited; previously Anroma (1984-85)	Building stone, tiles, slabs, billets (Gold drop, ivory champagne, coral, Ciocho D'oro, Chillago Bianco Neve)	Medium-sized quarry, two 3m high benches; diamond-wire cutting; large resource remaining; proven reserves of 347 000t.
Bianca north (northern quarry)	(420903)			Medium-grained, white, light-grey, blue-grey marble	Occasionally worked			Largest of these three quarries, three benches, large resource remaining; reserves of 525 000t.
White quarry	(424898)			Fine-grained, white marble	Abandoned			Small quarry, unbenched, minor solution cavities, widely spaced joints.
Chillagoe rose	Chillagoe (415930)	5185 (3971, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: coarse to very coarse-grained marble, pink with darker reddish bands	Disused	Queensland Marble Limited; previously Anroma (1984-85)	Building stone, tiles, slabs, billets (Queensland crystal pink, Queensland pink Chillagoe Pink Crystallino)	Small to medium-sized quarry, two benches, waterfilled; flat plain, little or no relief; not worked by Queensland Marble Limited; proven reserves (in situ) of 780 000t.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Chillagoe								
Rosa	Chillagoe (418944)	5186 (3972, Mareeba) (1984-85)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: brecciated marble, fragments cemented by hematite and limonite; coarse-grained marble, grey to white, red iron-staining of matrix	Disused	Not yet worked by Queensland Marble Limited; previously Anroma	Building stone, tiles, slabs, billets (Breccia)	Two small faces developed in large breccia boulders; limited reserves of breccia; remainder of lease area underlain by coarser, grey to white marble.
Azzurro	Chillagoe (411937)	5187 (3973, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: coarse to very coarse-grained marble, light blue, white, pale pink and red	Disused	Not yet worked by Queensland Marble Limited; previously Anroma (1984-85)	Building stone, tiles, slabs, billets	Two small prospect quarries; 2 to 3m deep, in flat, featureless plain; pink/red marble was sporadic; proven reserves (of blue marble) of 477 000t.
Aquamarina	Chillagoe (416953)	5188 (3974, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: very coarse-grained marble, dark to light blue, white and grey-white banded marble (northern portion of lease); wollastonite	Worked	Thiess Contractors Ltd for Queensland Marble Limited; previously Anroma (1984-85)	Building stone, tiles, slabs, billets (Queensland blue, ocean blue, silver blue, light blue, Chillagoe blue, Aquamarina Crystallino)	Large quarry in flat terrain, four benches developed to total depth of about 10m, korfmann saws cut blocks from face; boulder deposits and solution cavities common near western end of quarry, upper level; proven reserves: white marble - 400 000t and blue marble - 98 000t.
Cobra	Chillagoe (391973)	5189 (3975, Mareeba)	Aroonbeta P.H. (Marcius)	Chillagoe Formation: medium to coarse-grained marble, grey to white; some banded marble; fossiliferous; some skarn and wollastonite	Occasionally worked	Queensland Marble Limited; previously Anroma (1984-85)	Building stone, tiles, slabs, billets	Quarry face (8m high) developed in high prominent outcrop and large boulders, 3-strand wire cutter.
White crystal	Chillagoe (396959)	5190 (3976, Mareeba)	Aroonbeta P.H. (Marcius)	Chillagoe Formation: medium-grained marble, white; banded grey to white marble to west	Trial pit and trenching of deposit	Queensland Marble Limited; previously Anroma (1984-85)	-	No quarry development; drilling intersected bands of white marble and mud, representing boulder fill.
Kalaira No. 1 or Greenfield's quarry	Chillagoe (348023)	5193 (3990, Mareeba)	Aroonbeta P.H. (Chillagoe)	Chillagoe Formation: marble	Disused (since 1985)	Kalaira Pty Ltd, V.J. Belino, Global Marble Pty Ltd (1986 -)	Building stone, tiles, slabs, billets	Extension of marble deposit from Rankine's lease (ML 1376); lease was not inspected.

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Chillagoe								
Global Marble	Chillagoe (379007) (381005)	5210 (MLA 4033, Mareeba; previously MLA's 4061 & 4062)	Aroonbeta P.H. (Chillagoe)	Chillagoe Formation; coarse-grained marble, white, pink, gold	Occasionally worked	V.J. Bellino; Austcorp Marble Pty Ltd, now Carrington Marble (1990-)	Building stone, tiles, slabs, billets (Champagne, Chillagoe rose)	Medium to large quarry, five benches each 3m high; over 20 000m^3 removed, as blocks up to 22t per block; estimated reserves of 1.48 million tonnes. Mining allowed under Section 23 of the Mining Act.
Acmav Gori No. 1	Mungana (261060) Chillagoe (416924)	5211 (4034, Mareeba) 5216 (4048, Mareeba)	OL 600 (Chillagoe) Aroonbeta P.H. (Calcifer)	Chillagoe Formation:	Potential deposits	A. Gori, C.L. Gori, M. Gori and A. Gori (Gori Terrazzo Tiles)		No mining on either lease; bulk of materials for terrazzo plant from overseas, some Global Marble marble used; mainly furniture and monumental work, terrazzo production ceased in early 1989.
N.Q.M.T. No.1	Mungana (333010) (325005)	5249 (MLA 4125, Mareeba)	Aroonbeta P.H. (Chillagoe)	Chillagoe Formation: coarse-grained marble, yellow, cream white (4125/01, Honey pearl); fine-grained, fossiliferous limestone, black to dark grey, fractured, minor pyrite (4125/02, black ice)	(4125/01) Disused (4125/02) Occasionally worked	Austcorp Marble Pty Ltd; previously North Queensland Marble Tiles owned by V. Bellino, Jnr; now Carrington Marble (1990 -)	Building stone, tiles, slabs, billets (Honey pearl and black ice)	Two quarries developed; medium-size quarry (4125/01) has two 3m high benches; the quarry has not been worked by Austcorp Marble. The 'black ice' quarry or trial pit has been recently excavated to 3m depth in boulder deposits. Maintenance depot and Monalama saw situated on this lease.
N.Q.M.T. No.2	Mungana (339003) (340001)	5250 (MLA 4126, Mareeba)	Aroonbeta P.H. (Marcius and Chillagoe)	Chillagoe Formation: medium-grained marble, white, grey, banded; foliated in part (4126/01); fine-grained marble; light grey to white, pink, fractured, (4126/01)	(4126/01) Disused (4126/02) trial pit, disused	Austcorp Marble Pty Ltd; previously North Queensland Marble Tiles Pty Ltd; now Carrington Marble	Building stone, tiles, slabs, billets	Small quarry (4126/01), one level only 2 to 3m deep; small volume of marble removed. Small pit or trial cut (4126/02), several blocks removed; deposit drilled west of this pit.
N.Q.M.T. or 'Crystal pit'	Chillagoe (397995)	5257 (MLA 4139, Mareeba)		Chillagoe Formation: coarse to very coarse-grained marble, white, minor pink and blue zones	Occasionally worked	Austcorp Marble Pty Ltd; previously North Queensland Marble Tiles Pty Ltd; now Carrington Marble	Building stone, tiles, slabs, billets	Small to medium-sized quarry, two 3m high benches; extensive solution cavities in upper 5m; blocks to be sawn from southern face; large resource but coarse grainsize may reduce strength and hardness.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Chillagoe								
N.Q.M.T. No.3	Chillagoe (411941)	6083 (MLA 4150, Mareeba)		Chillagoe Formation: marble	Potential deposit	North Queensland Marble Tiles Pty Ltd		Mining lease was not worked, abandoned 20.9.1988.
N.Q.M.T. No.4	Chillagoe (412952)	5266 (MLA 4151, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: marble	Potential deposit	Austcorp Marble Pty Ltd; previously North Queensland Marble Tiles Pty Ltd; now Carrington Marble (1990-)		No mining has occurred to date from this mining lease application. Request to withdraw application, Austcorp 16.10.89.
N.Q.M.T. No.5	Chillagoe (415954)	5267 (MLA 4152, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: marble	Potential deposit	Austcorp Marble Pty Ltd; previously North Queensland Marble Tiles Pty Ltd; now Carrington Marble (1990 -)		No mining has occurred to date from this mining lease application; request to withdraw MLA, Austcorp 16.10.89.
N.Q.M.T. No.6	Chillagoe (423955)	5268 (MLA 4153, Mareeba)	(Calcifer)	Chillagoe Formation: marble	Potential deposit	Austcorp Marble Pty Ltd; previously North Queensland Marble Tiles Pty Ltd; now Carrington Marble (1990-)		No mining has occurred to date from this mining lease application.
Bellconti	Mungana (339003)	5272 (ML 4158, Mareeba)	(Chillagoe)	Chillagoe Formation: fine-grained, black and white marble	Potential deposit	Australian Trans-Pacific Marble Pty Ltd (formerly Exville Pty Ltd)	Company's processing plant produces marble slabs, tiles and materials for furniture use (tables)	No mining has occurred to date, but, company operates cutting and polishing plant (for marble) at Chillagoe.
G.M. 2	Chillagoe (409957)	5274 (MLA 4160, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: marble	Potential deposit	Austcorp Marble Pty Ltd; previously Global Marble Pty Ltd; now Carrington Marble (1990-)		No mining has occurred to date from this mining lease application.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Chillagoe								
G.M. 3	Chillagoe (392962)	6081 (MLA 4161, Mareeba)	Aroonbeta P.H. (Marcius)	Chillagoe Formation: marble	Potential deposit	Global Marble Pty Ltd		No mining had ocurred, mining lease abandoned 29.9.1988 and area now partially covered by MLA's 4215 and 4242.
G.M. 4	Chillagoe (389989)	5275 (MLA 4162, Mareeba)	Aroonbeta P.H. (Marcius)	Chillagoe Formation: marble	Potential deposit	Austcorp Marble Pty Ltd; previously Global Marble Pty Ltd; now Carrington Marble (1990-)		No mining has occurred to date from mining lease. Request to withdraw MLA by Austcorp 16.10.89.
Marble	Chillagoe (420930)	5287 (ML 4213, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: medium-grained, white marble, similar to 'Chillagoe rose' (ML 3971, Mareeba)	Potential deposit	Queensland Marble Limited		No mining has occurred to date from mining lease.
Blue	Chillagoe (415940)	5288 (MLA 4214, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: coarse-grained, light blue marble; similar to 'Azzuro' (ML 3973, Mareeba)	Potential deposit	Queensland Marble Limited		No mining has occurred to date from mining lease.
White	Chillagoe (395967)	5289 (MLA 4215, Mareeba)	Aroonbeta P.H. (Marcius)	Chillagoe Formation: medium-grained. white marble	Potential deposit	Queensland Marble Limited		No mining has occurred to date from mining lease.
Black	Chillagoe (414915)	5290 (MLA 4216, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: fine-grained, dark grey marble; red, brown to orange brecciated marble with some coarse-grained white marble.	Trial pit	Queensland Marble Limited previously Anroma (1984-85)		Sample blocks have been removed from trial pit; proven reserves of black marble: 712 000t, probable reserves 668 000t; probable reserves of orange marble: 1.562×10^6t.
Coral	Chillagoe (389965)	5299 (ML 4242, Mareeba)	Aroonbeta P.H. (Marcius)	Chillagoe Formation: medium-grained, white with yellow, pink and brown streaks, marble	Potential deposit	Queensland Marble Limited (formerly Zapata Pty Ltd)		No mining has occurred to date from this mining lease; partially covers abandoned MLA 4161 (Mareeba).
Calcifer tone	Chillagoe (433974)	5300 (ML 4243, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: medium-grained, white with some pink marble	Potential deposit	Queensland Marble Limited (formerly Zapata Pty Ltd)		No mining has occurred to date from this mining lease; deposit was not inspected.
White fibre	Chillagoe (388953)	5301 (ML 4244, Mareeba)	Aroonbeta P.H. (Marcius)	Chillagoe Formation: medium-grained, white marble; wollastonite	Potential deposit	Queensland Marble Limited (formerly Zapata Pty Ltd)		No mining has occurred to date from this mining lease; deposit was not inspected.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Chillagoe								
Ebony	Chillagoe (460817)	5302 (MLA 4245, Mareeba)	Quaker Hill H. (Muldiva)	Chillagoe Formation: fine-grained, dark grey to black limestone; some recrystallised, black marble	Potential deposit	Queensland Marble Limited (formerly Zapata Pty Ltd)		No mining has occurred to date from this mining lease; good outcrop, shallow soil profile.
Martex	Chillagoe (400991)	5308 (MLA 4251, Mareeba)	Aroonbeta P.H. (Marcius)	Chillagoe Formation: medium-grained, pink, white marble	Potential deposit	Mr P.A. Spittles		No mining has occurred to date from this mining lease; applicant is seeking joint venture capital; deposit was not inspected.
Whynot	Mungana (338010)	5309 (MLA 4252, Mareeba)	Aroonbeta P.H. (Chillagoe)	Chillagoe Formation: fine-grained, black and white marble	Potential deposit	Mr P.A. Spittles		No mining has occurred to date from this mining lease; applicant is seeking joint venture capital; deposit was not inspected.
Thiess No. 1	Chillagoe (421967)	5318 (ML 4268, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: light to dark blue, silver-blue marble similar to aquamarina (ML 3974, Mareeba)	Potential deposit	Queensland Marble Limited 1989 -), previously Thiess Contractors Pty Ltd		No mining has occurred to date from mining lease; deposit was not inspected.
G.M.A. 1	Chillagoe (412952)	5357 (MLA 4315, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: marble, western extension of 'aquamarina' marble (ML 3974, Mareeba)	Potential deposit	Granite Merchants (Australia) Pty Ltd (1989 -)		No mining has occurred to date from mining lease; deposit was not inspected.
G.M.A. 2	Chillagoe (415954)	5358 (MLA 4316, Mareeba)	Aroonbeta P.H. (Calcifer)	Chillagoe Formation: marble	Potential deposit	Granite Merchants (Australia) Pty Ltd (1989 -)		No mining has occurred to date from mining lease; deposit was not inspected.
Debbo	Mungana (338015)	5363 (MLA 4321, Mareeba)	Aroonbeta P.H. (Chillagoe)	Chillagoe Formation: fine-grained, black, white marble/limestone	Potential deposit	Austcorp Marble Pty Ltd (1989-90); now Carrington Marble (1990 -)		No mining has occurred to date from mining lease; deposit was not inspected.
Vilma	Mungana (330014)	5364 (MLA 4322, Mareeba)	Aroonbeta P.H. (Chillagoe)	Chillagoe Formation: fine-grained, black, white marble/limestone	Potential deposit	Austcorp Marble Pty Ltd (1989-1990); now Carrington Marble 1990 -)		No mining has occurred to date from mining lease; deposit was not inspected.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Chillagoe								
G.M.A. 3	Chillagoe (394998)	5365 (MLA 4323, Mareeba)	Aroonbeta P.H. (Chillagoe and Marcius)	Chillagoe Formation: marble	Potential deposit	Granite Merchants (Australia) Pty Ltd (1989 -)		No mining has occurred to date from mining lease; deposit was not inspected.
G.M.A. 4	Chillagoe (395993)	5366 (MLA 4324, Mareeba)	Aroonbeta P.H. (Marcius)	Chillagoe Formation: marble	Potential deposit	Granite Merchants (Australia) Pty Ltd (1989 -)		No mining had occurred, mining lease application withdrawn.
G.M.A. 5	Chillagoe (379007)	5367 (MLA 4325, Mareeba)	Aroonbeta P.H. (Chillagoe)	Chillagoe Formation: marble	Potential deposit	Granite Merchants (Australia) Pty Ltd (1989 -)		No mining had occurred, mining lease application withdrawn.
C.P.L.	Chillagoe (393000)	6959 (MLA 4349, Mareeba)	Aroonbeta P.H. (Chillagoe)	Chillagoe Formation: marble	Potential deposit	Quemeg Pty Ltd, previously known by Capriol Pty Ltd, and Mousseclíff Pty Ltd (A. Savini)	Proposed slabs, billets for bench tops and vanity units, N.Q. markets	Formerly 5369 (MLA 4237. Mareeba); no mining has occurred to date from mining lease; deposit was not inspected; proposed plant at Chillagoe.
Duke Islands (Northumberland Group)								
Hunter Island (Favosites Point)	Percy Isles (051680)	Former ML 936 (Rockhampton)	Marble H. (Port Curtis)	Mount Holly beds: white, blue marble	Abandoned	Ulam Carrara Marble Quarries Pty Ltd (1964-1971); R.L. & J.E. Jones (1971-1979)	Marble, limestone and building stone	No mining recorded, ML 936 forfeited 16.10.1979; reserves of 254 000t above high water mark (Richards, 1918; Shepherd, 1955; Wolff, 1957; Krosch & Kay, 1977 ; additional reserves: Limekiln Beach (20 000t/m), Silica Hill (1.9 million tonnes above HWM) and Verde Antique Point (120 000t above HWM).
Marble Island	Percy Isles (063672)	Former ML 935 (Rockhampton)	Marble H. (Port Curtis)	Mount Holy beds: pink, white, blue, grey marble and limestone, conglomeratic in part	Abandoned	Ulam Carrara Marble Quarries Pty Ltd (1964-1971); R.L. & J.E. Jones. (1971-1979)	Marble, limestone and building stone	Small quarry was worked at the turn of the century; estimated reserves above HWM are 122 000t (Richards, 1918; Shepherd, 1955; Wolff, 1957; Krosch & Kay, 1977); several thousand tonnes quarried (Ball, 1904); mining lease forfeited 16.10.1979.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Duke Islands (Northumberland Group)								
Morkar Island	Percy Isles (059666)	Former ML 934 (Rockhampton)	V.C.L. (Port Curtis)	Mount Holy beds: pink, white, blue, yellow marble	Abandoned	Ulam Carrara Marble Quarries Pty Ltd (1964-1971); R.L. & J.E. Jones (1971-1979)	Marble, limestone and building stone	Small quarry was worked at the turn of the century; ML 934 was forfeited 16.10.1979; estimated reserves above HWM are 670 000t (Shepherd, 1955; Wolff, 1957; Krosch & Kay, 1977); only a few hundred tonnes quarried (Ball, 1904).
Gladstone Hinterland								
(See Bracewell, Cecilwood, Mount Larcom and Ulam)								
Greenvale area								
Broken River	Burges		Wandovale H. (Mytton and Craigee)	Jack Formation: limestone breccia, angular fragments of white, grey, orange, brown limestone, red calcareous matrix; fossiliferous	Potential deposit	North Queensland Gold Prospects (Mr I. Croker)	Building stone, tiles, slabs, billets	Proposed quarry sale, Department of Forestry; large resource company estimates reserves, to be 52×10^6t; forecast annual production of 50 000m^3.
Graveyard Creek	Burges			Chinaman Creek Limestone:	Potential deposit	North Queensland Gold Prospects (Mr I. Croker)		Proposed quarry sale, Department of Forestry.
Helidon								
Mount Cross	Esk (177639) p.a.		? (Murphy)	Cressbrook Creek Group: pink marble	Abandoned	?	Building stone	Small deposit reportedly worked many years ago (Willmott, 1987); no details available on operation or its exact location.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Limevale (via Texas)								
Limevale quarry (previously known as Inglewood quarry No. 1)	Texas (230162)	5918, 5920, 5935, 5936 (275, 426, 518 and 520, Stanthorpe) (previous ML's 245, 276, 341, 347, 348, 508, and 519)	25 (Silverspur)	Texas beds: fine-grained, light to dark grey limestone, fractured with calcite veins	Worked	Lime Products, a Division of T.N.T. Australia Pty Ltd (1989 -); Lime Products Pty Ltd (1963-1989), W.H. Bowser and Lever Limited (1923-25), R. Paton (1939-1949), A. Freeman (1949-1953), The Marberete Company Pty Ltd (1953-1960) and Granite Belt Marble Pty Ltd (1977-78).	Early quarry operations produced ornamental and building stone, more recently stone crushed for chips, burnt lime and dust; small part of crushings are still used for terrazo (Dover grey)	Two small to medium-sized quarries; southern quarry is worked with a 8m high face; northern quarry has not been worked for some years; crushing plant is located on ML 518; Dover grey marble used in Mount Thompson Crematorium and Commonwealth Government Offices, Anzac Square, Brisbane (Wolff, 1957); estimated reserves exceed 900 000t/vertical m. (Siemon, 1973); deposit drilled and tested by Department of Mines; total production 1939-75, 1982-88 was 33 620t; Denaro, 1989; Connah, 1958.
Lime Products Marble quarry (previously Inglewood quarry No. 2)	Texas (265188)	5918 (267, Stanthorpe) (previous ML 246)	28 (Silverspur)	Texas beds: dark grey to black marble (western deposit); blue-grey, light grey, white marble (eastern deposits); both deposits are fine grained	Disused	Lime Products Pty Ltd; previously W.H. Bowser and Lever Limited (1923-25), O. Jones (1931-34), Marmor Quarries Pty Ltd (1934-40) and The Marberete Company Pty Ltd (1940 -)	Building stone and marble chips for terrazzo	Several small shallow quarries and pits excavated in both deposits; deposits were drilled and tested by Department of Resource Industries, inferred resource of 465 000t/vertical m (Siemon, 1973; Denaro, 1989), of excellent quality, stone is reported to take a fine polish (Connah, 1958); stone from this area used in Suncorp Building (Wolff, 1957).
		Former ML 279 (Stanthorpe)	28 (Silverspur)	Texas beds:		R. Paton, R.J. Paton and N. Hobbs		Mining lease was not proceeded with by applicants.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Limevale (via Texas)								
Marble Queen	Texas (233206)	Former ML 350 (Stanthorpe)	4 (Silverspur)	Texas beds: fine-grained, light grey to white marble (main opencut), with banded dark grey to black marble in eastern part of deposit; crinoid fragments and pyrite are present	Abandoned	Australian Marble and Minerals Pty Ltd (1964-83); subleased to Dawes Stone and Slate Brisbane Pty Ltd	Building stone and marble chips for terrazzo	Deposit discovered by A.G. White, 1919, but attempts to develop resource were unsuccessful (A.R.D.M. 1919, 1920, 1921 and 1923); Prof. Richards reported on defects such as uneven distribution of dark carbonaceous material and pot marking; production (1965-1971) was 1600t (Siemon, 1973; Denaro, 1989); Main opencut and several exploratory cuts on main deposit; surface boulders were also removed; deposit drilled and tested by Department of Resource Industries inferred resource: 200 000t/vertical m.
Marble Princess	Texas (242232)	Former ML 351 (Stanthorpe)	4 (Silverspur)	Texas beds: fine-grained, light grey limestone	Abandoned	Australian Marble and Minerals Pty Ltd (1964-83); subleased to Dawes Stone and Slate Brisbane Pty Ltd	?	Small working, removal of joint blocks; no production figures recorded, (Denaro, 1989); small deposit, investigated and tested (Siemon, 1973).
Marble Duchess	Texas (239241)	Former ML 353 (Stanthorpe)	35 (Texas)	Texas beds: fine-grained banded grey to dark grey limestone, southern part brecciated	Mineral occurrence	Australian Marble and Minerals Pty Ltd (1964-83); subleased to Dawes Stone and and Slate Brisbane Pty Ltd	?	No production recorded, mining lease appears to have never been worked; deposit considered to be uneconomic (Siemon, 1973); low relief, difficult to quarry (Denaro, 1989).
Magee Creek marble deposit or Mineral Countess	Texas (179223)	Former ML 359 (Stanthorpe)	169, 173 (Texas)	Texas beds: fine-grained, light grey to grey marble with thin dark grey bands, surface colouration, gold, red, brown	Abandoned	Australian Marble and Minerals Pty Ltd (1965-83); subleased to Dawes Stone and Slate Brisbane Pty Ltd	Marble of good quality, suitable for ornamental use (Siemon, 1973)	Deposit has not been worked (Denaro, 1989); inferred resource of 83 000t/vertical m. (Siemon, 1973).

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Limevale (via Texas)								
Magee No. 1	Texas (173225)	Former ML 449 (Stanthorpe)	126v, 173 (Texas)	Texas beds: fine-grained, banded grey to dark grey marble	Mineral occurrence	Consolidated Mining Industries Limited (1973-74)	?	Deposit has not been worked (Denaro, 1989).
The Thompson	Texas (294079)	Former ML's 398, 398A (Stanthorpe)	MHPL 471, 9, 15v, 16v, 17v and 24 (Gunyan)	Texas beds: fine to medium-grained, grey to dark grey, fossiliferous limestone	Mineral occurrence	Longreach Metals NL (1970-72)	?	Small deposit, low grade, difficult access (Siemon, 1973; Denaro, 1989).
Oaky No. 1	Texas (230195)	Former ML 443 (Stanthorpe)	23 (Silverspur)	Texas beds:	Mineral occurrence	Consolidated Mining Industries Limited (1972-74)	?	Mining lease rejected (11.10.1974); area taken out over southern extension of Marble Queen deposit Denaro, 1989).
Creekbed	Texas (232216)	Former ML 452 (Stanthorpe)	4 (Silverspur)	Texas beds: fine-grained, banded, grey to dark grey marble	Mineral occurrence	Australian Marble and Minerals Pty Ltd (1973-75)	?	Mining lease rejected (2.4.1975); deposit has not been worked (Denaro, 1989).
Pipersliegh	Texas (215174)		44 (Texas)	Texas beds: fine-grained, banded, light grey to black limestone and marble	Trial quarries	Australian Dimensional Stone Industries Pty Ltd	Building stone	Two opencuts in main outcrop, displays some interbedding of other sediments and volcanics; inferred resource of 165 000t/vertical m (Siemon, 1973; Denaro, 1989).
Mount Larcom								
Shaw's property, Touch Stone marble project (Boab No. 1 and No.s 2)	Bajool (880609)	Former MLA's 765 and 766 (Gladstone)	71, 121 (Langmorn)	Mount Holy beds: fine to coarse-grained, white to light grey, grey, black, pink, red, orange limestone in part recrystallised to marble, some brecciation	Proposed quarry	Heritage Holdings Pty Ltd; previous application by Australian Quality Pty Ltd (1987), Hynmind Pty Ltd (1983-85)	Building stone, marble chips for terrazzo; initally blocks, feasibility studies of slab & tile manufacture for export overseas	Large, high grade resources (Krosch, 1981); diamond and percussion drilling of deposit by Dampier Mining Pty Ltd (subs. of BHP Co Ltd) under A to P 1416M (1974-79); extractive industry permit granted by Calliope Shire Council.
Mount Larcom quarry	Bajool (932557)	Former ML 790A (Gladstone)	Lot 1 (R.P. 4371) and 538 (Mount Larcom)	Mount Holy beds: medium to coarse-grained, multicoloured marble/ limestone (white, light grey, blue, pink)	Occasion-ally worked	W. Popenia; formerly Australian Quality Marble (1987) and Mount Larcom Quarries (1985-87)	Marble chips for terrazzo (Mount Larcom marble); potential for extraction of marble blocks for building stone Krosch, 1981.	Medium-sized quarry; stone, trucked to crushing plant north of Mount Larcom; marble chips were supplied to Marble Tile (Brisbane) and R. Rolfe and Co. (Townsville); Trezise, 1989;
Calliope Crossing	Gladstone (124490)	Former ML 388 (Gladstone)	66 (East Stowe)	Calliope beds: fine-grained, light grey-red recrystallised limestone	Abandoned	Marberete Company Pty Ltd (1959-80)	Marble Chips for terrazzo	Small outcrops, high grade limestone; production between 1963-67 was 127t; Krosch, 1981.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Mowbray River (via Mossman)	Rumula (362685)	5402 (43, (Mossman)	110 (Mowbray)	Hodgkinson Formation: coarse-grained, recrystallised white marble, with bands of dark grey limestone and intercalated phyllite and greywacke	Disused	A. McDowall (1968 -)	Agricultural lime, but has potential for ornamental and building stone (white gem)	Small quarry, high face developed steep hillside; reported to have been intermittently worked since 1940 (Amos & de Keyser, 1964); inferred resource of 53 000t (Denmead, 1949); rock crushed in Mossman; Cranfield & Hegarty, 1989; Wolff, 1957; Connah, 1958.
Raine Island	Coral Sea (100km east of Cape Grenville)		Fauna Refuge	Recent coralline limestone deposit	Abandoned	Raine Island Corporation	Building stone for restoration of beacon built in 1844	Restoration work using local Raine Island stone completed in 1987; small excavation for stone, which was shaped and cut on island.
Rockhampton Whyte's marble	Rookwood (916361)		6v (Aricia)	Undivided Silurian - Devonian sediments: fine-grained, light to dark grey recrystallised limestone; fossiliferous	Abandoned	W. Whyte	Possible building stone	Small outcrops, moderate to high grade, moderate relief (Krosch & Kay, 1977); prospecting trenches, revealed that deposit offered no potential for marble quarry (Reid, 1923).
Ulam Mount Camley	Bajool (606649)	5810, 5814, 5827 (921, 927 and 1012, Rockhampton) 5812 (923, Rockhampton)	119 (Ultimo) 22 (Raglan) 119 (Ultimo)	Mount Holy beds: coarse to very coarse-grained (saccharoidal), white light to dark grey marble	Worked	Omya-Southern Pty Ltd (1981 -); previously J. Craig (1964-66), Industrial Minerals Co Pty Ltd, (1966-78), Cudgen R.Z. Limited (197 -79), Minerals Pty Ltd (1979-81)	Mitchell's quarry, source of building and monumental stone now used for stone dusting, agricultural purposes and filler	Omya-Minerals Pty Ltd extracts marble from a large quarry (GR606659) on western slopes of Mount Camley, stone crushed; Krosch, 1981, 1985.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Ulam (Mitchell's quarry, Beau Monde north and south)		5811, 5825 (922 and 997, Rockhampton) (181, 182, 185,187 and 188, Rockhampton)	40v (Ultimo) 119 (Ultimo)		Abandoned			Mitchell's quarry situated within ML 185 (Rockhampton), which was worked in early 1920's by Australian White Marble Company, previously worked by J.A. Mitchell (1919); unable to compete with lower-priced imported Italian marble, by 1924 quarries were idle because of small demand (A.R.D.M., 1920-1923; Saint-Smith, 1917, 1920, 1921); large resource south of Mitchell's quarry, held under ML's 921, 922, 923, 927, 997, 1012 and MLA 1145 (Rockhampton) and MLA 816 (Gladstone).
South Ulam (Ulam Carrara marble, Carrara lime, and Ulam lime)	Bajool (611642)	3638, 3666 (750, MLA 815 and 819, Gladstone) (previously MLA 704, which was amalgamated ML's 263, 318, 319 and 435, Gladstone)	22 (Raglan)	Mount Holy beds: medium to coarse-grained, white marble, some grey banded marble; narrow dolerite dykes	Occasionally worked	Wells Lime Works; (1983-); previously A. & C. Packers (1981-83)	Marble crushed at Marmor for agricultural and chemical purposes; previously building and monumental stone (1920-1949)	Currently worked quarry is small, 3m high working face; large marble resource. Several old, abandoned marble quarries, most are water filled. (See text for details.)
(UlamCarrara marble mine)		Previous ML's 225, 227, 229, 258, and 259, (Gladstone)	22 (Raglan)	Mount Holy beds: medium-grained, white marble	Abandoned	W.H. Crew, G.H. Jenkins and A.H. Gibson (Ulam Carrara Syndicate) (1917-1920)	Building stone	Plant for processing marble was installed in 1920; Saint-Smith, 1917; new quarry and gang saw operational in the following year but during years 1921-46, company experienced difficulties selling marble due to lower-priced Italian imports. P.J. and L.J. Lowther (as agents for lessees) supplied stone to Imperial War Graves Commission.
	Bajool (613636, 614637 615637)	later formed amalgamated ML's 263, 318 and 319, (Gladstone)			Abandoned	W. & A. Hobler 1920-38), Ulam Carrara Marble Quarries Pty Ltd (1938-74) (subs. Pioneer Concrete Services Pty Ltd)	Building, monumental stone, headstones for war graves	

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Ulam								
Sunny South lease	Bajool (614637) (615637)	Former ML 288 (later 318), 232 (later 319) (Gladstone)	22 (Raglan)	Mount Holy beds: coarse-grained, white marble	Abandoned	R.G. Joyner (1917), F.M. Allan's syn. also known as Australian Marble Syndicate (1917-21), Ulam White Marble Company Ltd (1921-33)	Building and monumental stone	Quarry operations, mainly during early 1920's, plant erected 1921, with development work continuing into 1922; (Saint-Smith, 1917).
(Eureka)	Bajool	Former ML 238 (Gladstone)		Mount Holy beds:	Abandoned	W.H. Crew, L.E. & W.B. Hobler, F.M. Downes and A.H. Gibson	?	?
	Bajool (614638)	Former ML 266 (Gladstone)	22 (Raglan)	Mount Holy beds:	Abandoned	P.H. Ebbott (1920-22)	-	Adjacent to and north of ML's 227 and 228, no mining of marble recorded.
	Bajool (613640, 614641)	Former ML's 237, 274 (Gladstone)	22 (Raglan)	Mount Holy beds:	Abandoned	A.H. Gibson (1920-24)	-	Southern slopes of Mount Kelly, no mining of marble recorded.
Rubble mine	Bajool (614640)	Former ML 434 (Gladstone)	24 (Raglan)	Mount Holy beds:	Abandoned	L.J. Fairweather (1966-67)	-	Southern margins of Mount Camley marble deposit; no mining recorded; covers previous ML 249 (Gladstone) for manganese.
Mount Camley marble	Bajool	Former ML 435 (Gladstone)	22 (Raglan)	Mount Holy beds: marble	Abandoned	O. Howden (1966-1981)	-	No production recorded (Krosch, 1981).
Ulam marble quarry	Bajool (614645)	Former ML's 703, 704 (the latter was formerly 318, 319, 365 and 435) (Gladstone)	22 (Raglan)	Mount Holy beds:	Abandoned	M.F. Partridge (1974-81)	Statuary and ornamental stone	Production (1975-78) was 2580t (Krosch, 1981) from leases over area previously held by Ulam Carrara Marble Quarries Pty Ltd.
Mount Camley marble	Bajool	Former ML 738 (Gladstone)	22 (Raglan)	Mount Holy beds:	Abandoned	A. & C. Packers Pty Ltd (1980-81)		Lease rejected.
Joel	Bajool (616648)	(MLA 816, Gladstone)	22 (Raglan) 119 (Ultimo)	Mount Holy beds:	Potential deposit	Omya-Southern Pty Ltd	-	Northern and eastern extension of marble deposits on ML 750, Gladstone.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Mining Lease (District)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Ulam Ulam marble quarry	Bajool (610641)	5821 (985, Rockhampton)	40v (Ultimo)	Mount Holy beds: coarse-grained, white marble; garnetiferous	Potential deposit	R.E. McLintock (1988 -); M.F. Partridge (1975-84); K.A. MacDonald (1984-88)	Potential building stone source	No mining to date; partially former ML 263 (Gladstone).
Warwick - Elbow Valley (or Lucky Valley)								
	Warwick (131589)	5996, 5997 (8, 26, Warwick)	106 and 1200 (Wildash)	Rosenthal Creek Formation: fine to medium-grained marble; finer grained, light grey to white marble on ML 26	Disused	Lime Products, a Division of T.N.T. Australia Pty Ltd (1989 -); previously G.J. and D.J. Chisholm; trading as Warwick Lime and Marble (sub. of Allied Minerals Pty Ltd)	Mainly agricultural lime and marble chips for terrazzo; small slabs used by Warwick monumental mason (Saint-Smith, 1922)	ML's 8 and 26 formerly held by The Marberete Company Pty Limited (1953-78), Granite Belt Marble Pty Limited (1978), and Lime Products Pty Ltd (1978-81); crushing plant and main quarry on ML 8; inferred resource 20 000t/vertical m (Siemon, 1973); Saint-Smith, 1922; Wolff, 1957; Connah, 1958.
O'Dea No. 1 (ML's 55 and 56) Hydrolime (ML 18)	Warwick (128584)	6004, 6008 (59, 74, Warwick) previous ML's 11, 12, 14, 18, 19, 55, 56 and 62	1291 and R.49 (Wildash)	Rosenthal Creek Formation: coarse-grained saccharoidal, white to cream marble; darker grey, banded marble northern quarry face	Worked	Lime Products, a Division of T.N.T. Australia Pty Ltd (1989 -); previously G.J. and D.J. Chisholm, trading as Warwick Lime and Marble (subs. of Allied Minerals Pty Ltd	Agricultural lime, stock feed, marble chips for terrazzo; company investigating deposit for use as building stone	ML 59 formerly held by The Marberete Company Pty Ltd (1973-78), Granite Belt Marble Pty Limited (1978) and Lime Products Pty Ltd (1978-81) - ML 11 - F. Freeman (1938-48); ML 14 - F. Freeman (1949-53), The Marberete Company Pty Ltd; ML's 18 and 19 - Queensland Minerals Pty Ltd (1952-79); ML's 55 and 56 - The Marberete Company Pty Ltd (1972-73); ML 62 - The Marberete Company Pty Ltd (1973), J. and D.M. Chisholm (1973); Medium-sized quarry, 10m face; one level, material drilled and blasted, processed (crushing and screening) on ML 8. Inferred resource of 106 000t/vertical m (Siemon, 1973).
	Warwick	Former ML 25 (Warwick)	1219 (Wildash)	Rosenthal Creek Formation: coarse-grained, white marble	Abandoned	J.G. Craig (1964-66), Industrial Minerals Co. Pty Ltd (1966-67)	?	Small quarry and dumps; small deposit but solution joints prominent near surface (Siemon, 1973).

APPENDIX 4 : BUILDING STONE SOURCES - SLATE AND OTHER FLAGSTONES

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Cairns							
Mellow Mountain slate	Rumula (313663)		Hodgkinson Formation: laminated mudstone, dark grey claystone	?Abandoned	Mellow Mountain Slate Company	Tiles, pavers, random pavers	Quarry was not inspected; thought to have been worked in early 1980's; Pinnacle Road, Julatten; Cranfield & Hegarty, 1989.
Ellis Beach	Cairns	Timber Res. 315 (Dulanban)	Hodgkinson Formation: cleaved mudstone	Abandoned	M. Rogina and M.J.A. Bekker	Pavers, retaining walls (facing stone)	Small quarry, worked in early 1970's; ML's 58, 61 and 62 (Cairns); rejected, slate was not a mineral.
Crows Nest	Esk (180080) p.a.		Maronghi Creek beds: indurated mudstone	Potential deposit	Jalsign Pty Ltd		Deposit situated several kms north of Milford Rocks homestead (ruins); not yet developed.
Forsayth							
Gilbert River quarry (Cairns slate or Blackwell's slate)	North Head (370121)		Corbett Formation: 'slate' or mica schist	Occasionally worked	Cairns Slate (1986 -); previously I.K. Pike (1971-74) (1976-86) and slate) Enterprises Pty Ltd (1974, 1975)	Floor tiles, random pavers, slate for landscaping, furniture	Originally quarried by Mr I.K. Pike, ML's 845 and 846 (Georgetown), under joint venture with Pacific Earthmoving Company Pty Ltd; original ML's forfeited, area repegged as ML's 3309, 3310, 3526 (1062, 1063, 1625, Georgetown); pilot tile processing plant in Ravenshoe; O'Flynn, 1988.
Pike's or Pyke's quarry	North Head (495215) p.a.		Corbett Formation: 'slate', mica schist	Abandoned	I.K. Pike	Floor tiles, feature walls, landscaping (Pykes slate)	Robertson River quarry.
Gilberton							
Gilbert River quarry	Gilberton (595810)	Rungulla H.	Corbett Formation: multicoloured, banded siltstone and mudstone	Worked	Gilbert River Quarries	Slabs, tiles, pavers (Ribbon Slate)	Company proposes to open quarry and to build stone processing plant on Atherton Tableland, by 1990/91; estimated annual quarry production 81 000t; tiles - 400 000m^2/year & slabs - 120 000m^2/year.
Q.S.C.C.'s quarry	Gilberton (607777)	Rungulla H.	Corbett Formation: multicoloured 'slate'	Worked	Queensland Stone Constructions and Contractors Pty Ltd	Export to Italy, via Townsville	South of Gilbert River Quarries; proposed tile and slab plant to be built in Cairns.
Percy River quarry	Gilberton ?	Rungulla H.	Corbett Formation:	Abandoned	R. Story	Random pavers	Quarry worked in the late 1970's; stone supplied for local market.
?	Gilberton ?		fossiliferous slate	Potential deposit	E. Hollihan (Iona Station)	?	Ortana Pastoral Holding, south of Kidston.
Gold Coast Hinterland							
Gilston quarry	Murwillumbah (286960)	96, 108 (Gilston)	Neranleigh-Fernvale beds: slate	Abandoned	Dawes Stone Industries, Gold Coast City Council	Random pavers for patios, garden pools, decorative stone work, pillars, letter boxes	Small quarry, to be flooded by next stage of Hinze Dam; moderate reserves remain south of quarry, within dam catchment area; access may be restricted by GCCC; ML 1108 (Southport); Willmott & others, 1978.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Gold Coast Hinterland							
Gilston	Murwillumbah (298984)	73 (Gilston)	Neranleigh-Fernvale beds: slate	Abandoned (1977)	Sirrah Pty Ltd	?	MLA 1139 (Southport).
Guanaba	Beenleigh (250090) p.a.	33A, 35 (Cedar)	Neranleigh-Fernvale beds: greywacke	Abandoned	Lensworth Finance Limited	?	MLA 1140 (Southport), near the intersection of Guanaba and Tarata Roads; extensive rural-residential developments.
Mount Wongawallan	Beenleigh (259124)	159 (Pimpama)	Neranleigh-Fernvale beds: slate	Abandoned	A. Manduric and A. Simonow	?	ML's 1019 and 1020 (Southport); small reserves, extensive rural-residential development; Willmott & others, 1978.
Waterford	Beenleigh (148345)	?	Neranleigh-Fernvale beds: hard phyllite bands	Abandoned	Brisbane Slate Landscaping	Facing stones for paths, fences, patios, retaining walls, fireplaces	Stone of relatively poor quality extracted from two small quarries; Willmott & others, 1978.
Goomeri	Goomeri (282080) p.a.	428 (Kilkivan)	Undifferentiated Palaeozoic schist: quartzite, phyllite	Abandoned (1972)	F. Poole	'Bookleaf' stone, paving marketing in Brisbane	Small quarry operation, western bank of Fat Hen Creek; Brooks & others, 1974.
Gympie							
Anderleigh quarries	Gympie (604209)	92 (Curra)	Kin Kin beds: slate, phyllitic shale	Worked	Anderleigh Quarries (previously N. Sorrensen and Queensland Slate and Stone Pty Ltd)	Facing stone for retaining walls, pavers, swimming pools	Medium-sized, unbenched quarry, previously ML 560 (Gympie); blasted and ripped material is hand sorted; large resources. Krosch, 1972; O'Flynn, 1976; Murphy & others, 1976; O'Flynn & Graham, 1987.
Old Anderleigh slate quarry	Gympie (621207)	94 (Curra)	Kin Kin beds: slate	Abandoned (circa 1985)	Anderleigh Quarries (previously W.A. Steffens 1971-74)	Facing stone for retaining walls, pavers	Medium-sized, unbenched quarry adjacent to creek, water filled; large resources of hard blue-grey slate; previously ML 558 (Gympie); O'Flynn & Graham, 1987.
?	Gympie (618207)	94 (Curra)	Kin Kin beds: slate	Abandoned	Anderleigh Quarries		Small to medium-sized, unbenched quarry; slate not marketed due to poor quality; O'Flynn & Graham, 1987.
Bashford and Watson's quarry	Gympie (631213)	103 (Curra)	Kin Kin beds (Rk): Phyllitic shale, slate, dark grey, fawn	Abandoned	Messrs G. Bashford and P. Watson	Facing stone for retaining walls, pavers	Small quarry opened in 1987; flat lying slate in gully, parting on cleavage less than 5mm; large resource, extends south into State Forest; O'Flynn & Graham, 1987.
Hamilton and Johnston's prospect	Gympie (726145)	S.F.502 (Gympie)	Kin Kin beds (Rk): slightly hardened and cleaved phyllitic shale	Potential deposit	Messrs Hamilton and Johnston (1987)		Proposed quarry site adjacent to Sandy Creek Road, reportedly sold to Veteran Slate but quarry was not developed; material is highly weathered in part, and distorted by small igneous intrusion.
Noga's quarry	Gympie (730132)	121 (Goomboorian)	Kin Kin beds:	Abandoned (about 5 years ago)	W. Noga	Slate floor tiles, random pavers	Small quarry developed on Phillip's property, Sandy Creek area, quarry overgrown.
Veteran slate quarry	Gympie		Kin Kin beds:	Abandoned	T. Spratt trading as Veteran Slate, and Sunshine Slate; previously Hamilton	Facing stone, pavers	Quarry location unknown, Sandy Creek Road area.

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Imbil							
Yabba Creek Road or Barns' quarry	Gympie (592701)	7 (Imbil)	Amamoor beds: siltstone, andesite?, blue, black and multicoloured stone	Worked	Mary Valley Slate (Mr C. Barnes)	Stone for landscaping, walls, random pavers	Several small quarry faces, quarry development continuing; cleavage of stone is weak and variable; O'Flynn & Graham, 1987.
Maitland Downs, via Mount Molloy							
Ahler's quarry	South Palmer River (487047)		Hodgkinson Formation	Disused	J.J. Ahlers		Small quarry sale, 200m^3/year.
Bailey's pit	South Palmer River (491044)		Hodgkinson Formation	Occasionally worked	V.H. Bailey	Random slate	Small pit, no sales to date; difficult access; hand mining and rock splitting.
Joseph's pit	South Palmer River (554931)		Hodgkinson Formation: slate, brown, grey yellow, red, darker grey with depth	Occasionally worked	R.D. Joseph and recently Queensland Stone Constructions Pty Ltd (July, 1989)	Random pavers (Reedy St. George Slate)	Small quarry, slate drilled, blown and split on site, packed into pallets; quarry was on the market for sale.
Boserio's pit	South Palmer River (551931)		Hodgkinson Formation: multicoloured slate	?	River of Gold Slate Company (B. Boserio)	Floor tiles, random pavers (River of Gold Slate)	Small quarry, north of Reedy St. George Second Crossing; Queensland Forest Service quarry sale of 300m^3.
Rogina's pit	South Palmer River (545934)		Hodgkinson Formation: brown to grey slate	Occasionally worked	Rogina Stone and Slate (M. & M. Rogina)	Random pavers	Small unbenched quarry; Queensland Forest Service quarry sale of 500m^3.
Scott's pit	South Palmer River (550929)	(Whumbal)	Hodgkinson Formation:	?	R.W. Scott	?	Sale of 100m^3(1989).
Palmer River							
Winch's pit	South Palmer River (336224) p.a.	(Runga)	Hodgkinson Formation:	?	Palmer River Slate (T.J. Winch) (previously W. Scott)	Random pavers	Small, unbenched quarry, 3 to 4m face; poor access; conflict with gold mining operations.
Rannes	Mount Morgan (016458)	94 (Rannes)	Rannes beds: slate	Abandoned	G. and M. Hunt	(Mount McDonald Slate)	Quarry was not inspected; previously ML's 197 and 201 (Mount Morgan); slate barred from face and split with hammer and wedges; 89t produced 1971-73.
Warwick							
Voss' pit (Rivington & Alagyn leases)	Allora (603846)	12v (Canal Creek)	Texas beds: dark blue-grey, hard slate	Worked	W. and J. Voss previously A.L. Storey, and Stone Enterprises	Random pavers, tiles, landscaping and pitching stone (Leyburn Slate)	Series of small pits, 3 to 5m deep situated on ML's 5998 and 5999 (31 & 32, Warwick); 2610t of slate produced 1968-1989.

APPENDIX 5 : BUILDING STONE SOURCES - VOLCANIC MATERIALS

City or town (Quarry Name)	1:100 000 Sheet (Grid Ref.)	Portion (Parish)	Geological formation and rock type	Status	Operator	Uses (product name)	Comments and References
Brisbane City							
Fortitude Valley quarry	Brisbane (033636)		Brisbane Tuff	Abandoned	?	Building stone, kerbing, retaining walls (Porphyry)	Quarry situated in R.N.A. Showgrounds; negligible reserves; Houston, 1967; O'Flynn & others, 1983.
Herston quarry	Brisbane (025638)		Brisbane Tuff	Abandoned	?	Building stone (Porphyry)	Quarry situated in grounds of Royal Brisbane Hospital; Houston, 1967; O'Flynn & others, 1983.
Kangaroo Point quarry	Brisbane (034606)		Brisbane Tuff	Abandoned	Department of Harbours and Marine	Building stone, kerbing, training walls along Brisbane River, retaining walls	Large quarry, workable reserves are limited by development, cliffs; largely restricted to below water-level; Richards, 1918; Wolff, 1957; Houston, 1967; O'Flynn & others, 1983.
O'Connelltown or Windsor quarry	Brisbane (029650)		Brisbane Tuff	Abandoned	Previously Bowser and Lever Pty Ltd	Building stone (Porphyry)	Quarry situated near corner of Lutwyche and Newmarket Roads; site redeveloped for commercial purposes; Richards, 1918; Wolff, 1957; Houston, 1967; O'Flynn & others, 1983.
Spring Hill quarry	Brisbane (028627)		Brisbane Tuff	Abandoned	?	Building stone (Porphyry)	Quarry situated adjacent to Quarry Street; commercial and residential developments will prevent further operations; Richards, 1918; Wolff, 1957; Houston, 1967; O'Flynn & others, 1983.
Stafford quarry	Brisbane (024683)		Brisbane Tuff	Abandoned	Brisbane City Council	Building stone (Porphyry)	Large quarry, surrounded by residential development; ceased operations, exhaustion of workable reserves; Houston, 1967; O'Flynn & others, 1983.
Windsor Town quarry	Brisbane (029658)		Brisbane Tuff	Abandoned	Brisbane City Council	Building stone (Porphyry)	Medium-sized quarry, now B.C.C. storage depot; Houston, 1967; O'Flynn & others, 1983.
Herberton							
Chinaman Creek quarry	Atherton (060758)		Featherbed Volcanics: rhyolitic to rhyodacitic ignimbrite	Worked	M. Rogina	Flagstone, pavers, retaining walls	Small quarry, 10m long quarry face, about 4m high, no processing of stone apart from splitting.
'Tina Too' deposit	Atherton (068766)		Featherbed Volcanics: rhyolitic to rhyodacitic ignimbrite	Not worked to date	M. Rogina	Flagstone, pavers, retaining walls	ML 6881 (Herberton) held by G.J. and K.F. Bendon; proposed quarry site.
'Flagstaff' quarry	Atherton (059754)		Featherbed Volcanics: dark grey, rhyolitic to rhyodacitic ignimbrite	Worked	Queensland Stone Constructions Pty Ltd	Flag stone, pavers, retaining walls	Quarry situated on ML 6832 (Herberton) held by G.J. and K.F. Bendon; 5 to 6cm parting.
'BZ' quarry	Atherton (944728)	OL 540 (Irvinebank)	Featherbed Volcanics: grey to light green, rhyodacitic ignimbrite, highly cleaved (faulting)	Occasionally worked	A. and I. Karomujic, and M. Rogina	Floor tiles, pavers, retaining walls	Quarry situated in ML 6964 (Herberton); 25m long quarry face, over 6m high; stone processed into 20 to 50mm slabs at Cairns.
Toowoomba City							
Bridge Street quarry	Toowoomba (998517)	Quarry Res.	Main Range Volcanics: olivine basalt, columnar jointing	Worked	Toowoomba City Council	Kerbing and guttering, minor building stone	Large quarry, basalt worked from 3 benches with faces up to 25m high; large reserves remain in benches and quarry floor; O'Flynn, 1980.

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