GEMSTONES
in
WESTERN AUSTRALIA

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
DEPARTMENT OF MINERALS AND ENERGY

GEMSTONES in Western Australia

Geological Survey of Western Australia
Perth 1994

18421—1

MINISTER FOR MINES
The Hon. George Cash, J.P., M.L.C.

ACTING DIRECTOR GENERAL
L.C. Ranford

DIRECTOR, GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
Pietro Guj

1st edition 1975
2nd edition 1981
3rd edition 1987
4th edition 1994

National Library of Australia Card Number and
ISBN 0 7309 0882 8
ISSN 0815–8568

Foreword

In recent years, commercial diamond mining has continued to develop and is now an established industry in Western Australia. At the same time, there has been heightened interest in locating deposits of gems and semi-precious and ornamental stone both for export and local processing. The popularity of gem collecting as a hobby continues to increase as more people than ever have access to the modern technologies of transport and navigating equipment. These considerations have prompted further revision of this Information Pamphlet, which is part of a series designed to assist the interested public in the search for minerals and rocks, and to widen their geological knowledge.

This pamphlet describes precious-stone deposits and lists known deposits and occurrences of semiprecious stones.

Additional information and assistance regarding the search for minerals can be obtained from any of the offices of the Geological Survey, where library facilities and databases containing lease and tenement details are available.

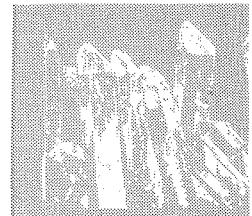
Pietro Guj
DIRECTOR
Geological Survey of Western Australia

Acknowledgement

The Geological Survey of Western Australia is indebted to Mr Frank Parker of the WA Branch of the Gemmological Association of Australia for his helpful suggestions during the preparation of this fourth edition.

CONTENTS

Maps



INTRODUCTION

Historically, Western Australia has been associated far more with gold fever than with rich endowments of precious stones; traditionally diamond, ruby, sapphire and emerald (and sometimes opal). Emerald occurs in small quantities and has been mined periodically since it was first discovered at Poona in 1912, and the small deposits of precious opal have been worked out.

However, discoveries in the late 1970s of diamond in the Kimberley district and the commercial development of two of these deposits has given a boost to the search for precious stones in Western Australia; no ruby or gem-quality sapphire has been found.

In Western Australia there is an abundance of semiprecious stones (which are any gemstones other than precious stones), particularly those composed of silica in both amorphous (opaline) and crypto-crystalline forms. Both professional and amateur collectors and lapidaries have ample scope to pursue their interests, although in such a vast State (2.5 million square kilometres) travelling costs in the process of collecting specimens can be quite high.

The Western Australian Branch of the Gemmological Association of Australia conducts courses on both theoretical and practical aspects of gem identification. There is a number of shops dealing in rough and cut stones in the Perth metropolitan area, and many of the larger country towns have a 'rock shop' that sells specimen material collected from surrounding districts. Contact details for the major lapidary associations in Western Australia are given later in this pamphlet.

In the 1950s tumble polishing of coloured siliceous rocks to produce baroque 'jewels' was the popular local practice and although this persists, more

sophisticated shaping and polishing is now yielding some attractive and valuable jewellery.

Much of the production of semiprecious stones is not recorded as it results from small findings on ground not held as mining tenements. Such finds are often kept secret by the discoverer and consequently the description of localities given below is not exhaustive.

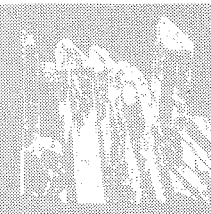
Numbered localities are shown on Maps 1 and 2: thus, in the example Northam **(62: 2334)**, 62 is the locality number. Numbers after localities refer to the area according to the system used in the Gazetteer of Western Australian Localities, which is published by the Department of Minerals and Energy (DOME), formerly the Department of Mines. These numbers each consist of four digits, which uniquely specify a 1:100 000 map sheet in Western Australia. The first pair of digits represents an easting (longitude) and the second pair a northing (latitude) associated with the Australian Map Grid. An Index Map with grid numbers is available with The Gazetteer.

Many of the 1:100 000 topographic maps are available from the Central Map Agency (CMA) of the Department of Land Administration, and a number of 1:100 000 geological maps have been published. The 1:250 000 series of both topographical and geological maps of the State are complete and available from the CMA and DOME respectively. Localities are often marked on Geological Survey of Western Australia (GSWA) 1:250 000 geological map sheets, and checking in the GSWA library may prove rewarding.

Throughout this pamphlet, reference is made to formal stratigraphic and tectonic names in Western Australia (e.g. Weeli Wolli Formation, Yilgarn Craton). Explanation of these terms, and broader aspects of Western Australian geology can be found in Memoir 3 (1990) and Bulletins, which are published by the GSWA and also available for perusal in the library.

Qualities of gemstones

Beauty, durability and rarity are the generally accepted attributes of a gemstone.



The beauty of a stone may not always be apparent in the rough form, the skill of the lapidary may be required to exhibit its true virtue.

The need for durability depends on the use to which the stone will be put: rings and bracelets require the greatest resistance to abrasion.

Rarity determines the monetary value of a gemstone, and many intrinsically beautiful stones may be purchased cheaply — simply because they are abundant.

So many varieties of rocks and minerals are regarded as gemstones that it is beyond the scope of this pamphlet to attempt to describe in any detail methods of identification. The intending collector should either undertake a formal study of gemmology or at least be familiar with an authoritative textbook on the subject, such as Borner (1962), Sinkankas (1964, 1970), Webster (1975), or Schumann (1979).

There are many pitfalls in the identification of gemstones. To take a simple example: it is common knowledge that diamond is the hardest of all minerals but to test a diamond by hitting it with a hammer would be disastrous as, like many other gemstones, it is brittle and readily shatters. The distinction between hardness (the ability to withstand scratching or abrasion) and toughness (the ability to sustain a blow without fracture) should be understood.

However, despite the difficulties of identification, any rock or mineral with attractive colour(s) or transparency and having a textural uniformity such that it can be shaped and polished may be worth collecting. Experience is obviously the best means of developing discrimination.

Prospecting for gemstones

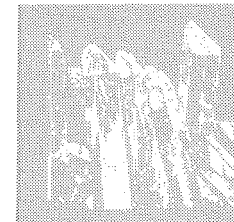
When searching for gemstones it is best to start in localities known to have yielded the material sought.

Some of these localities are described later. The more experienced prospector will obtain the best available geological information on the search area so that efforts can be concentrated in suitable host rocks. It is to be noted, however, that the more durable gemstones resist weathering processes and may be transported some distance from their source to be found in river beds or alluvial deposits. In fact, unless the search is to be confined to specific types of gemstones, it is true to say that almost all geological environments are capable of yielding some gem-quality material, particularly the extensive semi-arid regions of Western Australia, where conditions have been ideal for the process of secondary silicification.

This process — the permeation of rocks and soils by silca-rich groundwater over a long period — imparts the textural uniformity of a 'glass' to an otherwise non-uniform material and thus renders it capable of accepting a high polish. Silicification, aided by colour derived from various trace elements present in the original rock or soil, results in the wide variety of attractive common opals to be found in Western Australia.

For the novice 'fossicker' the first essentials are keen eyesight, patience, a locality map, geological hammer, a carborundum stone, a x10 hand lens, and a plentiful supply of small sample bags. Closely examine with the hand lens any rocks with which you are not already familiar. In some coarse-textured rocks the individual minerals may be large enough to pick out. Nodular concretions in soils or friable rocks should be broken open (if large) or abraded with the carborundum stone (if small) to determine what lies beneath the outer encrustations. Colour is best revealed by wetting the cleaned surface. If the wetted surface dries very quickly then the rock is probably too porous to accept a polish. Each specimen should be separately bagged, numbered, and its exact locality recorded in a notebook or plotted on the locality map. Identification of material collected may not be achieved until much later, by which time memory of the locality may be lost.

Carefully examine creek beds and any natural or man-made openings (with the exception of abandoned mine shafts or other dangerous situations). Particular attention should be paid to the zones immediately adjoining changes in rock type.



Where, and under what conditions can one collect rock and mineral specimens in Western Australia? These activities are governed by the Mining Act 1978, Regulations issued under the Act, and subsequent amendments to both. This legislation is complex and can only be briefly summarized here. Anyone intending to carry out a serious prospecting program that involves excavations or other disturbance to the environment should consult the legislation directly.

The Act provides for a document called the Miner's Right. This document, which can be purchased from the Department of Minerals and Energy, either at Mineral House in Perth or at any Mining Registrar's office, authorizes the holder — with a number of restrictions — to prospect or fossick on any Crown land in the State that is not already held as a Mining Tenement, and to remove up to 20 kg of material. In addition, an amendment to the Act allows the holder of a Miner's Right — subject to having previously obtained written permission from the holder of a Mining Tenement — to fossick on that tenement. 'Fossicking', in this context, means prospecting for minerals — other than gold and diamond — by means of hand tools only: metal detectors and any kind of power-driven equipment are specifically excluded. A Miner's Right currently (1994) costs $20 and remains valid for the lifetime of the holder.

The only way to be certain about the status of any particular tract of land is to check at the nearest (or the Perth) office of the Department of Minerals and Energy. Outside the southwest agricultural area, much of the land (including pastoral leases, reserves for the purpose of mining, and reserves for Public Utility [Land Act 1933]) is Crown land in this sense: other reserves are not. Even on Crown land, prospecting and fossicking are not permitted within 100 m of any cropped area, structure, or other improvement, or within 400 m of any water source. In the southwestern part of the State, much of the land is private property, and permission must be

obtained from the owner or occupier before entering the property. Databases are available for consultation by the public who wish to know more about tenement holdings.

On the other hand, a number of local shires (e.g. Carnarvon, Norseman) throughout the State have special 'fossicking areas' set aside, and a visit to the nearest municipal office or tourist centre is often advisable.

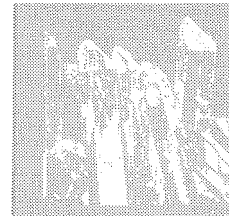
Aboriginal reserves and archaeological sites, and National Parks, are governed by other legislation. They are not generally available for prospecting or fossicking. Common sense, and consideration for the rights of property owners and others are essential. Remember that the holder of a Miner's Right is legally responsible for any damage that may be caused by his or her prospecting activities.

Finally, a word on safety. In recent years, the technology of transport and navigation has advanced enormously. More people than ever own or have access to 4WD vehicles, and small battery-driven navigation systems that use satellites for their operation are available at increasingly reasonable prices.

Nevertheless, it is essential that the fossicker be aware that travel in the remoter regions of Western Australia remains potentially as dangerous as ever. When setting out, adequate fuel, food and water is a prerequisite, as is a well-prepared vehicle carrying basic spares (wheels, tyres, puncture repair kit, levers, hoses, plugs, wire, tape, assorted tools etc), jacks, shovel, towbar, and perhaps a winch and dual-battery system. Carrying a high frequency radio transceiver is advisable in very remote areas. Secondhand units are relatively inexpensive.

Knowledge of basic bushcraft is advantageous, and a number of books on survival in the bush are available (e.g. 'Stay alive — a handbook on survival' by Maurice Dunleavy (3rd edition, 1987); available from the Australian Government Publishing Service).

Remember, there is no substitute for letting someone (police, friends etc) know where you intend going, and for how long.



DIAMOND

Diamond is a pure, crystalline form of carbon, and is the hardest natural substance known. Its durability, high refractive index, and dispersion give it unexcelled brilliance and fire when cut and polished as a gemstone. A large, clear, flawless diamond may be extremely valuable, but it is worth remembering that most diamonds mined are small, flawed and strongly coloured, and are suitable only for industrial uses such as drilling bits and grinding paste. Diamonds crystallize in the cubic system but the cube shape is rare; dodecahedral and octahedral forms are more common, but most stones are irregular. The colour of diamond ranges from black, through brown and yellow, to white, with dramatically increasing value. Pink and blue 'fancies' are even more valuable. Diamonds are measured in carats; one carat weighs 200 mg (one-fifth of a gram).

Diamonds are formed in the mantle of the earth at depths of 100–150 km and are brought to the surface by small volcanic pipes which tap these depths. The principal host rock for diamond is kimberlite or lamproite: both are olivine-rich, ultrabasic rock types. More rarely, small microdiamonds may also be found in less olivine-rich leucite lamproites. Erosion of kimberlite or lamproite volcanic pipes may give rise to secondary alluvial diamond deposits in river or beach gravels.

Kimberlites and lamproites are confined to old cratonic areas in Western Australia such as the Yilgarn and Pilbara, and the Kimberley region. Many hundreds of pipes have been identified worldwide, particularly in Southern Africa and the U.S.S.R., but most are barren or contain few diamonds. Less than 1% of pipes contain commercial amounts of diamond at grades of 20 carats per 100 tonnes or more.

Exploration for diamond is an expensive and lengthy undertaking and is beyond the resources of individual

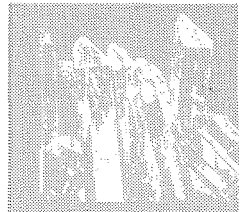
prospectors. Exploration usually involves stream-sediment sampling on a regional basis and the separation of heavy minerals in the search for indicator minerals (I.M.). The diagnostic heavy minerals include chrome pyrope, chrome diopside, picroilmenite, magnesian chromite and, of course, diamond itself. Other methods used to locate pipes include photogeology, aerial and ground magnetic surveys, and soil geochemistry. Once a pipe is found, it must be evaluated by means of extensive drilling, trenching, and the processing of bulk samples of several hundred tonnes.

Kimberley region

Alluvial diamonds were first found in Western Australia by gold prospectors at Nullagine **(17: 2954)** in 1895. Over the years a few hundred stones have been recovered from old river gravels, but their source is unknown and the largest stone is only 3.5 carats.

In 1939, Professor Rex Prider of the University of Western Australia suggested a genetic similarity between small lamproite plugs in the Noonkanbah area of the Kimberley region and the kimberlites of Southern Africa. Not until 1968 were these intrusions prospected for diamond, and kimberlite I.M. reported from Mount Abbott **(4: 3861).** In 1972, the Kalumburu Joint Venture (later re-formed as the Ashton Joint Venture) began exploring the whole Kimberley region for diamonds. In the North Kimberley, I.M. and a few small diamonds were found in the King George River area **(1: 4369);** this was followed by the discovery of barren kimberlite dykes and two small pipes. In the East Kimberley, more barren kimberlite dykes were found in the Wilson River area. Success came in 1976 with the discovery of several large, diamondiferous lamproite pipes in the Ellendale area of the West Kimberley **(4: 3862)**, which was followed in 1979 by the discovery of the rich Argyle pipe in the East Kimberley, a few kilometres south of Lake Argyle **(3: 4665).**

Alluvial gravels in Upper Smoke Creek, immediately downstream from the Argyle pipe, and in nearby Limestone Creek, average about 4 carats per tonne and have been mined out by Argyle Diamond Mines. Between 1983 and 1985, 3.6 megatonnes (Mt)



of gravel were processed to produce 16.6 x 10^6 carats of diamond. Lower grade alluvial deposits in Lower Smoke Creek and surrounding areas average only 1 carat per tonne but may be mined in the future. The mine developed on the pipe itself has cost $450 million and production began in December 1985. Another small diamond mine based on alluvial deposits along Limestone Creek and Bow River came into production in 1988. From 1985 to the present, annual production has varied from 25–40 million carats with 3–8 Mt of gravel being processed. This has made Australia the largest producer of natural diamonds in the world. The quality of the diamonds, however, is low: only 5% are gem quality, while 55% are of industrial quality. The remaining 40% are 'cheap gem' quality, used either as diamond 'chips' or as high-quality industrial diamonds. Few stones are larger than 1 carat and the largest stone is only 32 carats; the average value of the diamonds is around U.S.$10 per carat.

Note: In terms of the Argyle Act (1979) the general public and prospectors are forbidden entry, and the right to fossick, in the designated areas of the Argyle mine and the Ellendale area.

Other occurrences

Three small diamonds have been recovered from a group of small alkali picrite pipes in the vicinity of Wandagee Hill, northeast of Carnarvon. Alkali picrite is the only other known host rock for diamond. Exploration in the southern half of the State has recovered a few kimberlite I.M. from widely scattered localities, and an occasional small diamond, but no diamondiferous pipes. Whilst diamond exploration in the State has declined since the peak of the early 1980s that followed the Argyle discovery, there has been a surge in interest (although to a lesser degree) since 1987, with annual expenditure exceeding $25 million for the last four years. A number of indications

of diamond occurrences have been announced over this period (particularly since 1991) in the Kimberley, East and West Pilbara, Nabberu–Gascoyne, and Eastern Goldfields, and test plants are currently operating to evaluate the commercial recovery possibilities at (at least) two locations. In addition, the search for offshore potential has commenced off the northeast Kimberley coast and has attracted significant interest from investors.

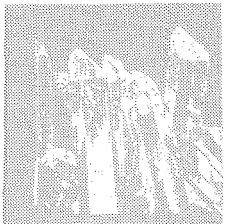
EMERALD

Emerald is a brilliant green transparent variety of beryl. In Western Australia, total emerald production to the end of 1980 is 48 165 carats (9633 g). The value of the stones is recorded as $109 570. Average current prices do not render the emeralds discovered in the State so far commercially attractive; the gems are generally of inferior quality. Although rumours to the contrary persist, no especially valuable gem is confirmed to have been recovered in Western Australia. The highest prices known to have been paid were $74 per carat and $125 per carat, respectively, for productions of 9 carats in 1974 and 7 carats in 1978 from Poona.

Poona (34: 2343)

Almost all the production has come from around Poona, where emerald was first recognized in 1912. Government Geologist H. P. Woodward first reported the occurrence of emeralds in 1914 after material was presented to him by Mr A.P. Ryan, a local prospector. The emerald occurs in both mica schist and quartz–beryl pegmatite matrix. The best emeralds are found in mica schist adjacent to beryl-bearing pegmatite. Here the crystals are greener, more translucent, and sometimes attain gem quality. Initially, due to the weathering of gangue minerals, translucent badly flawed stones were found in situ and free of matrix.

Only in 1977 was the first underground mine (the Aga Khan) set up; however production did not commence until 1979. Initial production of 1205 carats ($7230) came from a 20 tonne parcel,



with final production in 1980 at 8000 carats ($4800). The difficulty of mining the emeralds from the mica schist made the mine uneconomic and forced closure that year.

Australia-wide newspaper publicity was given to the alleged finding of a huge emerald crystal at a location about 16 km southwest of Poona on October 6, 1971. The stone, named the 'Mary B', weighed 138 carats and was insured for $30 000 but the origin of this valuation is obscure. Gemmologists H.R. Perry and R. Levinson. were engaged to separate the stone from its biotite schist matrix and Perry briefly described the two pieces of crystal (118 carats and 20 carats) that were recovered. In Perry's opinion, the transparent parts of the large piece were almost colourless and the apparent colour was caused by reflection from dark-green opaque material on the edges and a dark-green opaque area near the centre of the crystal. This opinion was vindicated in reports much later which ascribed only specimen value to the crystal.

Despite the lack of official production records from this field, there is little doubt that first-quality emerald has been and will continue to be won, although the individual stones are generally small.

Noongal (38: 2241)

Poor-quality emerald and beryl occur at Noongal (about 130 km southwest of Poona) in granitic pegmatites which cut mafic and ultramafic rock. Associated minerals are topaz, lepidolite, tourmaline, and muscovite. The colour of the beryl ranges from white to dark green (emerald). All emerald crystals that were extracted contain flaws, and were taken from biotite schist in a geological setting similar to that at Poona. No production figures are available for emeralds from Noongal, and the amount is assumed to have been small.

18421—3

Menzies (42: 3038)

This emerald deposit is located near Wonder Well on Riverina Station some 40 km west of Menzies. Again, the geological setting is similar to that at Poona.

Production over the years has been intermittent, but a small mining operation here (currently dormant) is reported (1989) to have yielded over 3000 g of emeralds to a value of around $10 000. However, several excellent but unreported stones are rumoured to have been won in the Menzies area.

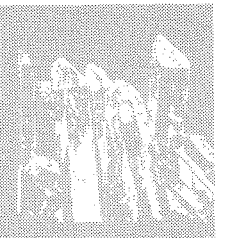
Other occurrences

Beautiful green flawed crystals of insufficient transparency to be of high value have been found at Warda Warra **(35: 2342)** in the Yalgoo Goldfield.

In 1954, at McPhees Hill **(12: 2655)**, 7 km north of Lynas Find, 8.68 carats (cut) of emerald were obtained from pegmatite that intruded biotite schist and migmatite. Emerald also occurs in lenses of pegmatite within biotite–chlorite schist, 6 km southwest of White Quartz Hill **(15: 2754)** — 19 km northwest of Hillside Homestead — but no production has been officially recorded.

In 1931, a prospector found a few crystals of emerald in the Wodgina district, about 3 km northwest of the Tantalite Lode **(11: 2655)**. Simpson (1948) described them as prisms embedded in feldspar, and of up to 10 mm in length and 5 mm in width. The stones were considered to be too turbid and flawed to be worth cutting. Emerald of variable quality has been noted in pegmatite that intrudes ultramafic schist at Pilgangoora **(13: 2655)**. The principal occurrence is located about 4 km north-northeast of Coffin Bore; no production is recorded.

Emeralds have also been reported at a locality 11 km east of Roebourne **(7: 2356)**.



SAPPHIRE

Green, yellow, and blackish-blue sapphires were reported (1992) to have been found in some abundance near Kununurra **(2:666)** in the northeast Kimberley. No further information has been forthcoming.

SILICEOUS GEMSTONES

The siliceous gemstone family can be classed into the following four divisions:

crystalline silica, which includes quartz crystal, amethyst, rose and smoky quartz, and citrine;

cryptocrystalline silica, known as chalcedony, which includes chrysoprase, agate, jasper, chert, carnelian, prase, onyx and some petrified wood;

opaline silica, which includes precious and common opal, cat's and tiger's eye opal, as well as some petrified wood; and

granular quartz, which includes quartzite.

For definitions of these terms reference can be made to any mineralogical or gemmological textbook.

There has been considerable confusion as to the terminology of siliceous gemstones. Because of this, and also because there is commonly an intimate admixture of more than one type in any one deposit, these are, with one exception, described together in alphabetical order according to deposit. The exception is precious opal, which is described separately because of its importance as a precious gemstone.

Precious opal

Production of precious opal in Western Australia has been limited to one year only, according to DOME records. This was 4.323 kg, produced in 1974 from a locality 13 km east of Cowarna Station Homestead **(68: 3335)**, and valued at $16 994.

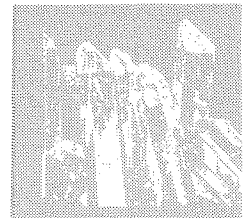
Exploration activities centred on the Cowarna Station locality have produced a quantity of siliceous material ranging in quality from crystal quartz through potch to rare precious opal. The precious opal was reported as being of varying grade and size but generally of high quality with green, blue, yellow and red (or blood-red) colour flashes and of higher quality than the average white Coober Pedy opal. Exploration was by way of bulldozed and backhoed costeans together with shafts and large-diameter drillholes to a maximum depth of 15 m. Silica veins occur as a subhorizontal and vertical network in a 5 m-wide belt of thin-bedded metamorphosed graphitic shales and tuff beds within amphibolite; the whole Archaean sequence has been intruded by quartz porphyry.

The host rocks strike at 348°, dip west at 70° or steeper, and are extensively kaolinized. They appear to extend for several kilometres north of the prospect area and possibly to the south. The maximum thickness of precious opal veinlets is 12 mm but potch veins reach a thickness of 75 mm. Quartz is very common, and transition from quartz to common opal to precious opal over 25 to 50 mm in the same veins has been noted.

Precious black opal is reputed to have been mined in 1904 from opal veinlets transecting graphite–chlorite schist and quartz veins 4.8 km north-northeast of Coolgardie **(55: 3136)**. By repute, small quantities were taken from the same locality in the 1960s, the thin slivers of black opal being cut and mounted on site as doublets or triplets. In 1991, a black opal weighing 16.5 kg was reported, but the location was stated merely as 'Eastern Goldfields'.

Other siliceous gemstones

Varieties of common opal are widespread in Western Australia. Simpson (1952, p. 313–24) lists 78 localities at which common opal has been found, and without doubt many times this number



exist. Most common opal is opaque and unattractive, but there are many varieties with colouration and patterning that are capable of being cut and polished to yield jewellery stones of considerable appeal. The popularity of a collecting locality depends on the colouration of the stone and accessibility of the deposit. Common opal almost invariably forms as one of the weathering products of ultramafic rocks (particularly serpentinites), and its occurrence, in association with particular soil types, is significant as an indication of nickel-prospective rocks beneath soil cover.

A similar association with ultramafic rocks applies to the occurrence of chrysoprase, which owes its apple-green colour to the presence of nickel. The chrysoprase is generally found as thin subhorizontal irregular layers and nodules in secondary magnesitic concretionary cappings. Chrysoprase has been used as a substitute for jade in oriental carvings, and in this application slab thickness and uniformity is of greater importance than colour intensity. Translucent deep-green chrysoprase is also cut cabochon style for jewellery purposes, and for this application good colour depth, uniformity and translucence are important.

The term 'tiger's eye opal' is used for that golden-brown chatoyant material which is formed from the silicification and staining by hydrous iron oxide of crocidolite (blue asbestos), whereas the unstained blue silicified material is known as 'falcon's eye opal'. The term 'cat's eye opal' is used here for the chrysotile variety of asbestos which has been silicified to produce a honey-yellow, brownish or green rock which exhibits chatoyancy. The latter has been variously termed siliciophite, quartz cat's eye, or opalized serpentine.

Jaspers are widespread in the siliceous parts of the jaspilites within the Archaean Yilgarn and Pilbara Cratons, and only the more commonly known localities are described here.

A number of parochial terms have been used in the literature (e.g. 'mookaite' and 'peanut wood'); where known, a brief explanation is given.

The following is a list of descriptions, in alphabetical order, of localities of siliceous gemstones in Western Australia. The first number inside the brackets refers to the position marked on Map 2.

***Balfour Downs* (17: 3052):** Brown and white agate is found on Balfour Downs Station.

***Bamboo Spring* (24: 2649):** Chalcedony and finely banded agate have been reported from a number of localities around the head tributaries of the Ashburton River. Among these localities are Bamboo Spring on the Ethel River, and Ilgarari on Bulloo Downs Station.

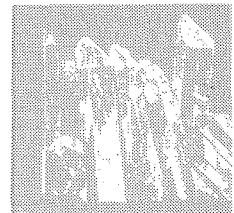
***Bamboo Springs* (14: 2853):** Quartzite and basalt rocks near Bamboo Springs contain veins of chalcedony and inferior opal; the chalcedony is often finely banded.

***Beacon* (50: 2437):** Gem-quality smoky quartz, citrine and quartz crystals have been reported from a locality 17 km northwest of Beacon. The crystals are found in soil that has formed over quartz-filled easterly trending fractures. Enquiries can be made locally.

***Belele* (28: 2545):** A green chromiferous opal has been collected on this station.

***Bullfinch* (51: 2736):** Massive milk-white opaque opal, known locally as 'enamel' has been collected from Manxman, 8 km northwest of Bullfinch.

***Bulong* (58: 3236):** 'Moss' or 'lace' opal has been found associated with magnesite on hills of serpentinite in the country between Bulong and Lake Yindarlgooda. Veins of both chrysoprase and green common opal occur here, particularly in the Taurus group of mines, 6 km northeast of Bulong townsite, where mixed siliceous material has been worked. In 1958, 11.3 kg



of opaline silica and 2.268 kg of chrysoprase were produced from this area.

***Byro* (27: 2145):** Both tiger's eye and cat's eye opal are found near Yarra Yarra Creek on Byro Station in the Gascoyne Complex. In 1960, 54.4 kg of 'tiger eye opal' was raised and sold for $97. This deposit is situated 6 km south-southeast of Coontrabillily Well on the southern side of Tathire Creek. The material is derived from an opalized silica capping on deeply weathered ultramafic rock. Small amounts of gem-quality opaline silica occur one kilometre northwest of Iniagi Well and north of Meegea Hill. The material is found in jasperoidal silica cappings on ultramafic rocks.

***Chichester Range* (6:2454–2753):** Agate occurs in vugs and amygdales within the Maddina Basalt throughout the Chichester Range (see also 'Hamersley Range').

***Comet Vale* (44: 3138):** Fine-quality chrysoprase occurs in veins.

***Coolgardie* (55: 3136):** See 'Precious opal'.

***Copper Hills* (12: 2854):** Veins of banded chalcedony, up to 0.3 m thick, occur in Archaean felsic volcanics between Copper Hills and Budjan Creek.

***Cowarna* (68: 3335):** See 'Precious opal'.

***Croydon Homestead* (8: 2455):** A pale-green chert, which occurs in faults through granite southeast of Croydon Homestead, makes a delicately coloured tumbling stone.

Cue (36: 2443): Striking red- and black-banded common opal occurs here.

***Davis River* (16: 3053):** Brown and white agate is abundant in the gravels of the Davis–Oakover–De Grey River system.

***De Grey River* (5: 2757):** Chalcedony, banded and plain jasper, and red and white agate occur in the pebble beds along the De Grey River.

***Divide Creek* (74: 2551):** Jasper.

***Eastern Creek* (16: 3054):** Green chert.

***Fields Find* (40: 2339):** Pink, grey and black 'picture' jasper is found in the Bullajungadeah Hills around Fields Find, as well as in the Gnows Nest Range to the northwest. Red- and black-banded jasper, known as ribbon jasper, is also found in these areas.

***Gabanintha* (31: 2644):** Bright-green common opal, coloured by copper, is recorded from Gabanintha, 30 km east of Nannine.

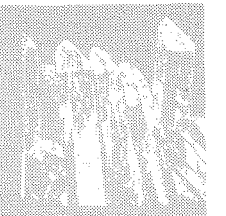
***Gallops Well* (12: 2955):** Green chert.

***Gascoyne Junction* (26: 1947):** Opalized black wood with marine bivalve borings infilled with white opaline silica is found in the Gascoyne Junction area and on Mooka Station. It is known locally as 'peanut wood'.

***Gnowangerup* (71: 2530):** Opalized wood is present in this area, 12 km north of Albany.

***Goomalling* (61: 2235):** Cat's eye opal is found in asbestos workings on the east and west sides of Slate Street, about 0.8 km southeast of the Goomalling railway station. It is also found near Bresnahan Soak at Ucarty, which is about 12 km southeast of Goomalling. A few crystals of quartz have been found in a ploughed paddock on 'Oak Park', about 14 km north-northeast of Goomalling.

***Grants Patch* (54: 3137):** Variously coloured 'breccia' opal and chrysoprase have been found at Grants Patch, which is 10 km southeast of Ora Banda. Between 1966 and 1970, nearly 2500 kg of chalcedony worth some $5000 was mined from a locality 3 km northwest of Grants Patch.



***Gregory Gorge* (7: 2254):** Magnificent clusters of quartz crystal have been found in the Gregory Gorge area on the Fortescue River.

***Halls Creek* (1: 4461):** Agate occurs extensively as infillings of vesicles in the Cambrian Antrim Volcanics northeast of Halls Creek. Chrysoprase also has been collected; the fragments, though small, are of such quality as to warrant further search.

***Hamersley Range* (6: 2353–2652):** The principal semiprecious stones found in and around these ranges are agate, prase, green and red jaspers, and tiger's eye opal. The agate and prase are usually found in association with basalt of the Fortescue Group and are common as chalcedonic infillings of vesicles and other cavities. In the zones which are underlain by the Weeli Wolli Formation, attractive red jasper is particularly abundant and makes excellent material for polishing. Waterworn fragments of red jasper can be found in any creek bed on this formation.

Tiger's eye opal has been found in many areas of the Hamersley Iron Province. It is found only within a few centimetres of the weathered surface of crocidolite (blue asbestos) veins, associated with riebeckite and hematite in the Brockman Iron Formation. In many areas, weathering reduces the asbestos to an incoherent yellow ochrous powder, but in some places there are persistent zones of opal up to 50 mm in width. The best known localities for this stone are near Marra Mamba on the northern side of the Hamersley Range, and in the area north of Deepdale in the western section of the province. Water-worn pebbles of tiger's eye opal are to be found in the beds of rivers draining these areas.

***Ilgarari* (25: 2849):** Onyx and carnelian have been reported from Ilgarari outstation on Bulloo Downs Station. See also 'Bamboo Spring'.

18421—4

***Jowett Well* (43: 3138):** Prase has been mined from a locality 8 km southeast of Menzies; that is, 1.5 km east-northeast of the Black Jack mine. In 1969, nearly 3000 kg was mined from this deposit.

***Jubilee* (59: 3337):** Good-quality chrysoprase is found 5.5 km north of the Jubilee mine, just north of Lake Yindarlgooda.

***Jutsons Rocks* (37: 3542):** Fire opal of a rich red-brown colour and high translucency has been obtained 37 km northeast of Laverton, towards Jutsons Rock. A 4 carat piece was brilliant and flawless when cut about 1926, but after three years' storage in a closed drawer it developed many cracks, probably as a result of dehydration.

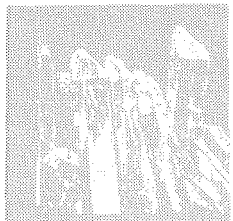
***Kalbarri* (34: 1742):** Opalized or petrified wood is found in various areas of the Carnarvon Basin. An example is north of the Murchison River, on Murchison House Station, near Kalbarri. Enquiries as to the exact location of deposits can be directed to the ranger of the Kalbarri National Park. The wood is of specimen rather than polishing quality. Some contains bivalve borings and is similar to the 'peanut wood' at Gascoyne Junction.

***Kalgoorlie* (56: 3136):** Red- and black-banded jasper can be collected about 7 km south-southwest of Kalgoorlie.

***Kangan* (9: 2655):** Quartz crystal deposits are situated about 1.5 km by track west-northwest of Kangan Homestead. In the 1940s, two deposits were opened up to shallow depths, exposing hundreds of crystals, varying in size from 1 to 40 cm long. However, only the smaller ones were clear and free from flaws.

***Karratha* (3: 2256):** Green chert occurs 2 km south of Karratha; this chert and other deposits in the Pilbara area are so coloured due to the presence of pale-green chrome muscovite (fuschite) or iron minerals. This material is considered to be suitable for ornament making.

Kennedy Range (21: 1848–1949): 'Mookaite', 'peanut wood' and petrified wood all occur at the southwestern end of Kennedy Range. 'Mookaite' is porcelaneous (or even opalized) Windalia



Radiolarite; it is variously coloured in red, white, yellow, purple and brown due to differeing amounts of iron and manganese contamination. The best-known locality for this material is on Mooka Station at the southwestern end of Kennedy Range, but smaller areas of similar material are found in most areas where the Windalia Radiolarite outcrops. 'Peanut wood' and petrified wood of similar quality to that at Kalbarri also occur in these areas. 'Peanut wood' is silicified (opaline) wood with abundant borings, which were made by the wood-boring bivalve, *Teredo*. The resultant holes were filled by radiolarian-rich mud and silt (Windalia Radiolarite); the wood and silt were later silicified.

Note: Reserve No. 33213, west of Kennedy Ranges, is vested in the Shire of Carnarvon for tourist purposes and collection of souvenir samples of gem stones. For more information contact the Carnarvon District Tourist Bureau.

Lake Rebecca (60: 3337): Some good banded jasper, suitable for tumbling, has been found in this area (southwest).

Linden (47: 3339): A finely banded jaspilite, 3 km east of Linden, has been considered for use as a decorative stone because of its unusually delicate bands.

Lionel (12: 2954): Tiger's eye and cat's eye opal of high quality are found associated with asbestos at Lionel, 25 km north of Nullagine.

Marble Bar (11: 2855): The Marble Bar Chert, from which the town of Marble Bar derives its name, is a strikingly beautiful read and white chert which outcrops in the Coongan River at Marble Bar Pool, 3 km west of the town. Although this particular outcrop is protected by a reserve, there are many similar parallel bars in the district, and waterworn pebbles can be found in most creeks in the district.

***Marillana* (15: 2752):** Between 1972 and 1974, 33 500 kg of quartz was won from the valley of the Fortescue River. This prospecting area was located 32 km east-northeast of Marillana Homestead, in the centre of a large outcrop of Oakover Formation. The outcrop is composed of limestone and calcareous gravels with opaline silica. None of that material was examined, and it is possible that it is the opaline rather than the crystalline form of silica.

***Marshall Creek* (75: 3041):** Chrysoprase occurs 70 km northwest of Leonora.

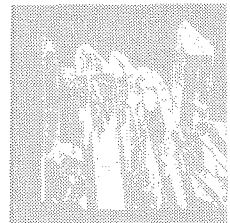
***Mooka* (22: 1848):** Between 1971 and 1979 the amount of chalcedony and opalite reported won from the Mooka mine area (16 km east-northeast of Mooka Homestead) is nearly 60 000 kg, for a value of $31 500. See also 'Kennedy Range' and 'Gascoyne Junction'.

***Moora* (48: 2136):** The Noondine Chert (formerly 'Coomberdale Chert') is a sequence of bedded chert and orthoquartzite with minor siltstone, claystone and sandstone beds, and orthoquartzite. In the Moora locality, orange, apricot and cream cherts and fine-banded pale-grey cherts could be stained for use as artificial onyx. These rocks outcrop in a 3 km-wide belt between Moora and Coorow; however, north of Watheroo outcrops are mainly obscured by sand-plain cover. The Noondine Chert at Three Springs is known as 'carnelian chert'.

***Morawa* (38: 2039):** Several quartz crystals up to 150 mm long are reported to have been found in a narrow gully at the foot of a quartzite hill, about 26 km west of Morawa.

***Mount Bakewell* (63: 2234):** Cat's eye opal from a locality 4 km northwest of York is of poor quality and crumbles on exposure to the atmosphere.

***Mount De Courcy* (13: 2152):** A major amethyst-producing area in Western Australia is 8 km south of Mount De Courcy. During the period 1967 to 1978, some 18 800 kg was produced from leases in this area. The amethyst occurs in a quartz vein that cuts the Duck Creek Dolomite (Lower Proterozoic) and is mainly inferior stone (poor-colour intensity or parti-coloured). However



some good gem-quality material is reported to have been won.

***Mount Herbert* (7: 2355):** Agate is reported weathered out from basalt.

***Mount Jackson* (52: 2737):** The hills around Mount Jackson are a favourite collecting area for jasper.

***Mount Phillips* (23: 2149):** This is a major amethyst-producing area in Western Australia, 18 km southeast of Mount Phillips Homestead and 2 km north of O'Connor Bore. Production from various leases in the 1970s to 1980s has totalled over 100 000 kg. (see 'Garnet')

***Mount Regal* (3: 2256):** Green chert.

***Mundiwindi* (20: 2950):** Fire opal, of rich red-brown colour and high translucency, is found in the vicinity of Mundiwindi as nodules ranging up to 2 cm or more in diameter.

***Nannine* (30: 2544):** Milk-white moss opal has been found in the Nannine district, 40 km south of Meekatharra.

***Norseman* (69: 3233):** Common opal and chalcedony have been mined from a series of small workings immediately south of the Native Mission about 11 km northwest of Norseman. Various colours of moss opal are found; some of these are almost opaque yellow ('gold lace'), translucent green, opaque pale-coffee coloured, and opaque white. The chalcedony occurs in the weathered zone overlying fresh rock. Over 150 000 kg of moss opal and chalcedony have been won since 1967. The tourist bureau at Norseman has information on fossicking localities in the area.

***Northam* (62: 2234):** Cat's eye opal has been found in the neighbourhood of Mount Dick, 6 km north of Northam, and at Meenaar, 20 km east of Northam.

***Nunyerry* (8: 2455):** A deposit of chrysoprase near Nunyerry has yielded attractive specimens.

***Ora Banda* (53: 3137):** Small angular pieces of common opal varying in colour from white, brown and yellow, to green are scattered about on the surface on the western side of the Black Flag road, about 2 km west-southwest of the town. A bright, almost emerald-green variety, which forms small irregular masses in brown opal, also occurs in the area.

***Ord Range* (4: 2757):** Attractive banded tiger's eye opal set in red, brown, and black jaspilite is mined from iron-formations in the Ord Range near Mount Goldsworthy, and has been sold under the trade name 'tiger iron'. The deposits are 4 km north-northwest of Mount Saint George, and access from the Port Hedland–Goldsworthy road is by way of a winding track branching off to the north near the crossing of the Strelley River.

***Paris* (67: 3234):** An occurrence of massive yellow to mauve variegated opal of an opaque but brittle type has been reported from the Paris group of mines.

***Paynes Find* (42: 2439):** Attractive quartz crystals are reported to have been obtained from a dump on the Orchid lease.

***Pear Creek* (5: 2856):** Green cherty material occurs at Pear Creek as the result of local opaline replacement of peridotite.

***Pinyalling Hill* (41: 2339):** A breccia composed of fragments of jasper set in a siliceous matrix is found on the eastern side of Pinyalling Hill. When slabbed and polished, this breccia is very attractive.

***Poole Range* (2: 4060):** Opalized or petrified wood has been reported from the Poole Range in the Kimberley Division.

***Poona* (35: 2142):** Bright green, chromiferous opal occurs in a glassy quartz vein 3 km east of Government Well. Other specimens of opal from the Poona area are milky white, greyish white, dull green, and brown.

***Roebourne* (3: 2356):** Roebourne is the centre of a small semiprecious stone industry. Stones are obtained from the

Cleaverville Formation (jaspilite), the Regal Formation and underlying sediments (prase, agate, carnelian), and from the Mount Roe Basalt (agate). In particular, bright-green chert occurring 2.2 km north-northeast of Edna Well has been excavated as a source of ornamental stone. It is believed that the colour results from the presence of small amounts of chromium.

***Rothsay* (39: 2239):** It has been reported that large masses of deep-green common opal, pigmented by chromium, were obtained from the dump of a shaft on the main lode at Rothsay, 1 km north of the main shaft.

***Rudall* (18: 3352):** Coloured siliceous rocks which are suitable for polishing occur along the Rudall River near the junction with Rooney Creek, and in caprock overlying the serpentinized peridotite along the Rudall River. Gem-quality stones are rare.

***Smithfield* (57: 3236):** A specimen of fire opal of good rich colour forming irregular masses and veinlets in an auriferous quartz is recorded from Smithfield, 10 km northwest of Kalgoorlie.

***Spargoville* (65: 3135):** Prase has been mined near Spargoville, with some 4000 kg having been produced before 1980. The prase is formed from fine-grained quartzite that is coloured green by the presence of sericite or fuschite. Almost opaque, golden to yellow moss opal and bloodstone also occur at Spargoville.

***Stirling Range* (70: 2592):** Opalized or petrified wood is found at the base of the Stirling Range near Cranbrook, Ongerup and Gnowangerup.

***Talga Peak* (11: 2856):** Green chert.

***Wandagee Station* (19: 5018):** Good-quality red- and white-banded agate has been found as nodules in sedimentary rocks on Wandagee Station.

***Wandarra Estate* (49: 2136):** Cat's eye opal of unknown quality occurs at Wandarra Estate, 15 km east of Moora.

***Warburton Range* (72: 4245):** Poor-quality brown and white agates, up to 45 cm in diameter, are common in conglomerates of the Lilian Formation 5 to 10 km northwest of Ainslie Hill in the Warburton Range. The density of colour and numerous cracks preclude their use in jewellery. Some may be capable of conversion by heat treatment to the more acceptable variety, carnelian.

***Warrawoona* (73: 2032):** Green chert.

***Weld Range* (29: 2444):** This is one of the best collecting localities for black- and red-ribbon jasper. Specimens showing folded (and even contorted) bedding are readily found.

***Westonia* (64: 2635):** Chromiferous green opal is found here, a little north of the railway line between Merredin and Southern Cross.

***Widgiemooltha* (66: 3235):** Bright-red to black, streaky common opal has been collected in this district. East of Widgiemooltha, large masses of silicified wood have been found.

***Wiluna* (32: 2944):** Striking red- and white-banded jasper is found in the Wiluna district.

***Wingelina* (33: 4645):** Chrysoprase at Wingelina occurs in a nickeliferous laterite, and is medium to dark apple green; some specimens rapidly fade on exposure to light and become milky and opaque. This deposit has been mined by various individuals and companies since 1967. Currently, the deposit lies within an Aboriginal Reserve. Associated with the chrysoprase are moss agate and magnesite, and in 1972 some 16 000 kg of the agate were mined along with 112 000 kg of chrysoprase.

***Wodgina* (10: 2655):** Jasper and jaspilite are found here.

***Yarra Yarra Creek*:** See reference under 'Bamboo Spring' and 'Ilgarari'.

PYRITE

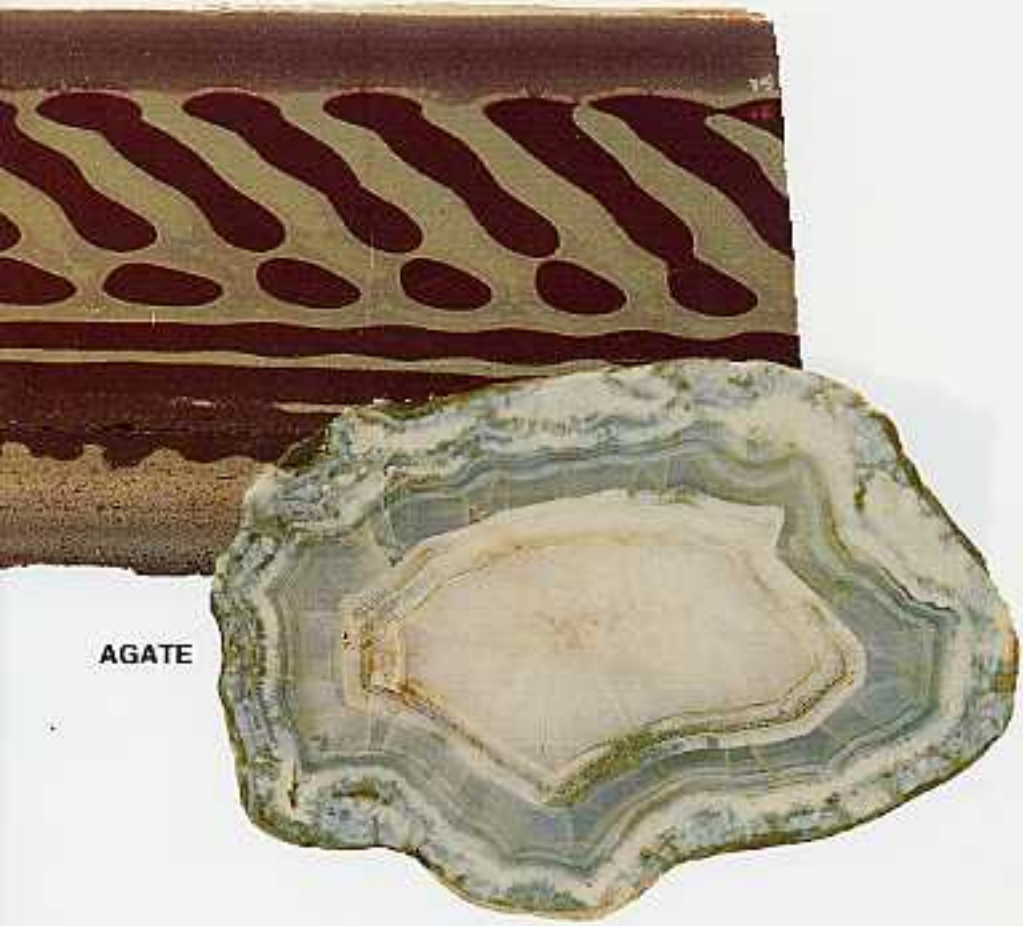
CHERT

TIGER EYE

ZEBRA ROCK

AMETHYST

TOURMALINE



AGATE

QUARTZ

SERPENTINITE

***Yerilla* (45: 3239):** Chrysoprase has been investigated in an opencut operation at a prospect 5 km east-southeast of Mount Catherine on Yerilla Station. A deposit has also been investigated at nearby Boyce Creek **(3238)**, 85 km east of Menzies.

***Yinnetharra* (23: 2148):** A total of 8290 kg of amethyst was produced between 1971 and 1976 from a small prospect 5 km south of Leake Spring on Mount Phillip Station, that is about 22 km northeast of Camel Hill. To the west-southwest, 1.5 km north of O'Connor Well, 1631 kg were produced between 1977 and 1979. Poor-quality amethyst has been recorded 3.5 km southwest of Gillie Well, which is 9 km southeast of Camel Hill; rose and smoky quartz are found 5.5 km south-southwest of Gillie Well. Rose quartz has also been found 8 km southwest of Gillie Well at the Cairn Mining Centre (20 km northwest of Yinnetharra Homestead). However, it has been reported that some of these localites have been ruined by blasting. The amethyst, rose quartz, and smoky quartz are found in quartz segregations in zoned pegmatite bodies.

***Yundamindera* (46: 3339):** Fire opal has been found in deeply weathered granite breakaways 10 km west-northwest of Yundamindera Homestead and 4 km northeast of Bulla Rocks Well. It is believed to be opal from this locality that has been described as follows: '...in the form of nodules, often an inch or more in diameter... colourless ... to more or less rich amber colour'. The best are identical with the Mexican fire opal, and are equally fitted to be cut for gems. 'Lace' and 'honey' opal have been obtained from opencut operations about 3 km north of Pyke Well on Yundamindera Station; it was in this locality that 1020 kg was mined in 1974, and fetched $400. Chrysoprase has been investigated at Pyke Hill, 9.6 km east-northeast of Yundamindera Homestead, and in opencut operations at a prospect 5 km south-southeast of Eucalyptus on Yundamindera Station.

Amazonite

Good specimens of the blue-green microcline feldspar, amazonite, have been obtained from a locality about 3 km north of Paynes Find in the Yalgoo Mineral Field. The translucent to opaque amazonite occurs in seams a few centimetres wide in scattered pegmatite bodies on both sides of the Great Northern Highway for a few kilometres north of Paynes Find **(41:2439).**

The best quality material in this area is found at a locality which can be reached by travelling north along the highway from Paynes Find for just over 2 km and, where the highway sweeps to the east, taking a track to the west. Turn right through the ruins of an old house and, after travelling a total of about 0.7 km from the highway, the dumps and a shallow shaft can be seen on the right.

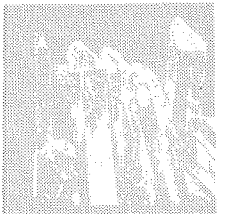
Amazonite has also been found about 5 km south of Warda Warra **(35: 2342)**, and 'good grade amazon stone' was intersected between 6 and 9 m in a drillhole about 120 m south of the abandoned Vermin Proof Fence.

Other localities where amazonite has been noted are Bineringie Station **(50: 3335)**, which is 50 km east of Widgiemooltha, and Cape Arid **(55: 3529)**.

Aquamarine

Aquamarine is a transparent, greenish-blue gem variety of beryl. During production of beryl from Yinnetharra **(23: 2148)** in 1943 and 1944, a small quantity of clear, pale to deeper blue-green aquamarine was obtained from the broken beryl ore. Water-clear and colourless stones were more plentiful than the pale bluish green.

Small valueless aquamarines have been obtained from the dumps of shafts at Poona **(34: 2343)**.



It has been reported that gem-quality aquamarine has been found in pegmatite at Spargoville **(48: 3135)** and that at least one faceted stone has been cut.

Beryl

White to pink beryl is found at Londonderry **(47: 3135)**, along with petalite, rosetted aggregates of delicately coloured lilac lepidolite (mica), and botryoidal dark zinnwaldite (mica).

Beryl, some of it aquamarine of gem quality, has also been collected from the Spargoville area **(48: 3135)** (See also 'Aquamarine').

Calcite

'Onyx marble' is the name which has been applied to translucent banded varieties of calcite of attractive colour. Fragments of this material varying in colour from deep cream through amber to dull brown, are found on and around Lake Austin **(36: 2542)**. It takes a good polish and has a fibrous structure with concentric banding.

Corundum

Corundum in coloured translucent forms (mainly blue) has been found at numerous localities, the most interesting being Jacobs Well and Dangin **(51: 2333)**, in the southwestern part of the State, and 5.5 km north-northeast of Byro Homestead **(32: 2145)** in the northwest. The gem varieties, sapphire (blue) and ruby (red), have not been found.

Diopside

Gem-quality specimens of chrome diopside are found in the Yinnetharra area **(23: 2148).** Deep-green euhedral crystals, 1 to 3 cm long, are found in mica schist.

Epidote-rich rock

Some epidote-rich granitic and gneissic rocks look attractive when cut in cabochons, particularly those which also contain pink feldspar. Such rocks are found in the granitic terrains along the south coast. One such locality lies in a large shear zone along the coastline west of Cape Riche **(54: 2628)**. The Namban Granite which outcrops east of Namban **(43: 2137)**, is a pink and green porphyritic granite that owes its striking appearance to the colours of feldspar. Microcline crystals are varying shades of pink because of hematite inclusions, and plagioclase may be pale green as a result of inclusions of epidote.

Fluorite

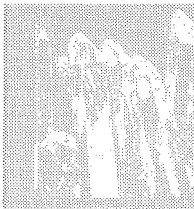
Fluorite deposits occur at Meentheena **(56: 2955)**, Cookes Creek **(56: 2954)**, and Ngarrin Creek **(56: 2956)** in the Pilbara Region. Only the Meentheena deposits have been mined, and although about 8 kilotonnes were extracted, no production has been officially recorded (GSWA Bulletin No. 127).

The fluorite is mostly transparent and is colourless, milky white, amber, green, lavender, and dark violet. The fluorite at Meentheena (220 km east-southeast of Port Hedland) occurs in quartz veins up to 5 m wide and, in one case, 1600 m long. The veins of fluorite penetrate agglomerate, basalt and andesite of the Mount Roe Basalt. The Cookes Creek granite contains veins of fluorite and quartz.

At Ngarrin Creek (about 27 km south-southwest of Callawa Homestead), a stock of fluorite porphyry intrudes the Warrawagine Batholith. Fluorite occurs only as microscopic veins and in vugs (0.2–50 mm).

Colourless to amber specimens come from Speewah Station **(57: 4565)**, about 100 km south of Wyndham; colourless, white and green varieties of fluorite occur at Turkey Creek **(4563)**, about 180 km south of Wyndham.

Dark-violet masses (up to 60 g) were found close to a cassiterite-bearing pegmatite, near Globe Hill Trigonometric Station **(19: 1952)**.



Fluorite is known to occur in association with scheelite and molybdenite mineralization within Mulgine Granite (greisen) at Mulgine Hill (or Mount Mulgine) **(58: 2339)**.

Small lenses of purple fluorite occur 3 km west-northwest of Mount Elvire **(59: 2254)**. The lenses are up to 30 m long and 1.8 m wide and occur in acid volcanic rocks of the Scamp volcanic association.

Garnet

Good specimens of garnet, together with staurolite and cordierite have been found in quartz–muscovite–biotite schists between White Well and Morrissey Creek on Mount Phillips Station **(23: 2149)** (30 km north-northeast of Yinnetharra).

Large, specimen-quality garnet has been collected from weathered schists north of Glen Mervyn **(52: 2130)**.

Grossular garnet has been reported at Roebourne **(7: 2356)**, but precise localities are not recorded.

Garnet deposits occurring in alluvial sands 100 km north of Geraldton **(1840)** have been commercially mined for a number of years.

Heliodor

Heliodor is the name given to the yellow transparent variety of beryl. A portion of crystal about 13 mm in diameter was found in a pegmatite at Katterup **(52: 2030)**, near Donnybrook on the road to Lowden.

Hematite

Selected hard massive crystalline hematite, the principal ore of iron, is collected at iron mines in the

Hamersley Iron Province **(22, 23: 2353–2851).** It is cut and polished to a lustrous blue-black ornamental stone which is particularly attractive in a silver setting. Hematite is also abundant in the Buddadoo Hills **(2140)** some 50 km southwest of Yalgoo.

Lepidolite

Lepidolite is a purple lithium-rich variety of mica. It occurs as crystals and plates, and mammilated masses are found at Tabba Tabba **(60: 2656)** and Londonderry **(47: 3135)**.

Limestones

Limestones, which are sedimentary rocks consisting chiefly of calcium carbonate, are abundant throughout the sedimentary basins of the State. A number of these take a good polish. An example is the Trealla Limestone which outcrops in Cape Range near Exmouth **(1754).** It is a relatively pure shelly to algal limestone; its quality is variable, but good-quality polishing and facing stone is common.

Other limestones in the Canning and Carnarvon Basins are also suitable for polishing.

Magnesite

Nickeliferous magnesite in various shades of green takes a good polish, and when veined with brown limonite makes attractive tumbling and cabochon material. It is usually found as a surface capping on weathered ultramafic rocks that contain nickel. It has been noted from several localities in the Eastern Goldfields, some of which are: Lake Rebecca **(46: 3338)**; the Bulong Complex **(45: 3236)**, which is a layered intrusion of mafic and ultramafic rocks between Bulong and Lake Yindarlgooda; and Kambalda **(49: 3235).**

In 1972, Wingelina Nickel Australia Ltd reported the production of 5073 kg of magnesite from Wingelina **(31: 4645)**. This was

valued at $2780, and it is presumed that it must have been nickeliferous.

Nickel-rich magnesite is also known as nickeloan magnesite, gaspeite, and 'citron chrysoprase'.

Malachite and chrysocolla

A potentially commercial deposit of these materials occurs 30 km southwest of Meekatharra **(2554)**.

Marble

Marble, which is a recrystallized calcite and/or dolomite, has been found at a few localities in Western Australia. These are all in the general area of Wyloo. One notable occurrence is 10 km southeast of Mount De Courcy **(20: 2152).** This marble deposit, which is located near the amethyst mine, lies within the Duck Creek Dolomite. The colours of grey, red, and pale and dark green make this an attractive and striking rock when slabbed and polished. Two other areas where marble has been found are 28 km north-northeast of Nanutarra **(18: 2053)**, and at Cheela Outcamp **(21: 2252).** Marble from Wyloo has been used as an internal facing stone in a few Perth buildings including the Police Headquarters in Adelaide Terrace, the CML Building, Allendale Square, and the Jewish Centre of W.A. in Yokine. Table tops, ornaments and trinkets also have been fashioned from this rock.

Moonstone

Fragments of moonstone, a semitransparent variety of orthoclase feldspar which exhibits a blue or white sheen, have been reported from pegmatite in the Morgan Range **(30: 4546)**, and from conglomerate at Bowes River **(37: 1841)**.

Morganite

Morganite is a pink variety of transparent beryl. A few samples of this rare type have been found at Poona **(34: 2343)**, and in conglomerate at Bowes River **(37: 1841)**.

Petalite

Petalite, in translucent and rarely transparent forms, is found in the pegmatite at Londonderry **(47: 3135)** and takes a good polish.

Prehnite

Prehnite occurs in vesicles and joints in basalt of the Antrim Plateau Volcanics in the East Kimberley Region **(5:)**. It has been found as waterworn pebbles in creek beds between Halls Creek and Kununurra.

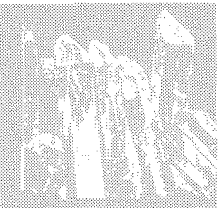
Rhodonite

Rhodonite has been reported at Five Mile Well, 7 km northeast of Roebourne **(7: 2356)**.

Serpentinite

Serpentinite is a rock consisting almost wholly of serpentine-group minerals; for example, antigorite and chrysotile (white, green, or brown serpentine). Accessory chlorite, talc and magnetite may be present. Although serpentinite is relatively common in the Archaean of Western Australia, most occurrences have never been investigated for their ornamental attributes.

Ornaments and jewellery made of a polished green stone referred to as 'Pilbara Jade' or 'Marble Bar Jade' have been marketed at the Comet mine, Marble Bar. This material has been obtained from near Lionel **(16: 2954)**, 25 km north of Nullagine in the Pilbara Craton. However, on examination the so-called jade has proved not to be true jade (jadeite or nephrite) but massive green



chlorite veined with serpentine. The colour ranges from black through shades of green with some white patches. The texture, however, is sufficiently uniform for the whole to accept a high polish and the material is a worthy addition to the range of Western Australian gemstones. Production of serpentinite from this deposit for 1977–81 was 1692 kg for $6458.

Beautiful trinkets have been carved out of specimens from Soanesville **(14: 2754),** of serpentinite traversed by innumerable small veins of chrysotile. The most striking pieces are those from slightly weathered material, which is somewhat harder and often tinted by ferric oxide. Such specimens, which show all tints from bronze through golden yellow to various shades of green, exhibit a chatoyancy due to of the fibrous structure of the asbestos veinlets.

In the hills 10 km south of Mount Satirist **(9: 2555)** masses of scaly, greenish black chlorite have been obtained. These are sufficiently dense and tough to be sawn and polished into pendants and other trinkets.

Serpentinite at Nunyerry **(8: 2455)** would possibly repay investigation for use as an ornamental stone.

Attractive talc–chlorite rock, which occurs as green and white highly contorted bands, and takes a reasonable polish, has been obtained from north of Mornong Well **(6: 2256),** about 20 km south of Dampier. It is possible that the talc–chlorite rock is associated with the basic volcanic rock unit indicated on geological maps of the area.

Serpentine rocks from the Regal Formation in the vicinity of Roebourne **(7: 2356)**, have been used as semiprecious stones. A chrysoprase mine is reported to be situated 500 m northwest of Carlow Castle mine (10 km southwest of Roebourne), and produces bright green-velvet cherty material figured with black and white silica veins.

Talc

Talc from Coodawa **(40: 2039)**, 10 km east-northeast of Three Springs, is readily carved and takes a good polish.

Topaz

It has been reported that cabochons have been cut from pale-blue semitransparent topaz that occurs at Londonderry **(47: 3135)**, in association with petalite in pegmatite veins, and at nearby Grosmount. A transparent blue gem-quality topaz has been found associated with beryl in pegmatite at Noongal (Melville) **(38: 2241)**. Localities where white translucent topaz occurs in pegmatite are Mount Francisco **(10: 2655)** (mainly opaque), Globe Hill **(19: 1952)**, and Poona **(34: 2343)**.

Turquoise

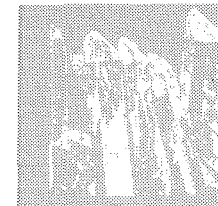
A little turquoise associated with quartz-filled joints in Archaean felsic tuff has been found 4 km west of Queen Lapage mine, on the northwest edge of Lake Yindarlgooda **(44: 3236)**. It is not a commercial deposit.

Tourmaline

Tourmaline has been reported from many localities throughout the State, and has been mined in several.

Dravite (brown translucent to transparent tourmaline), to the value of $15 593 from 9640 kg raised during 1969–1970, has been produced from an opencut 9 km north of Yinnetharra Homestead **(23: 2148)**. The dravite occurs in zones parallel to the schistosity in a phlogopite (mica) schist within augen gneiss in the area. Black tourmaline has been prospected 1.5 km to the north in mica schist.

Dravite has also been reported in migmatite from a number of localities between Thirty One River and Morrissey Creek.



Large crystals of black tourmaline (schorl) are a common accessory in muscovite-bearing pegmatite bodies in the Yinnetharra area. In the Cairn mining area **(24: 2148)**, which is 14 km northwest of Yinnetharra Homestead, 1035 kg of schorl realized $2123 during 1972 and 1973.

Both varieties have been sold as specimen material only. Transparent gem-quality tourmaline has not been found at these localities.

Zoned pink and green tourmaline crystals approaching gem grade have been collected from a large pegmatite vein in the valley of Cattlin Creek **(53: 2930)** about 2 km northwest of Ravensthorpe (especially on the west side of the Newdegate road), and at Cocaranup **(2830)**.

Tourmaline is widespread in the Archaean pegmatite veins of the Pilbara Craton; most of the material is black and opaque. Large masses of indigo–blue tourmaline have been found in the Wodgina district **(11: 2655)**, in particular on the former Mount Cassiterite, Commonwealth, Chamberlain, and Tinstone claims. This is apparently derived from the biotite–chlorite schist forming the wall of pegmatite veins. These are considered to be specimen rather than gem quality, as the masses are composed of aggregates of prisms no larger than 2 x 0.2 mm.

Bluish-green tourmaline of lesser gem quality is found in pegmatite at Spargoville **(48: 3135)**.

Variscite

The green hydrated aluminium phosphate, variscite, has been found at four localities in the Peak Hill Mineral Field.

It has been mined 1 km north and 5 km southwest of Mount Deverell **(27: 2548)**. These two localities

are respectively on the western side of ranges of hills on the north and the south banks of the Gascoyne River. The variscite occurs in narrow fault-controlled veins, less than 100 m wide, that cut silicified shale and mudstone.

Variscite has also been found in the Sawback Range, 1.5 km southwest of Sawback Bore **(28: 2447)**. It occurs in irregular patches in a brecciated chert. A minor occurrence of variscite is present nearby in thin, cross-cutting veins up to 10 mm wide in a dark-grey mudstone overlying a dolerite sill.

Another occurrence of variscite is located 9 km northwest of Mount Padbury **(29: 2546)**. It consists of green incrustations on deeply weathered basalt.

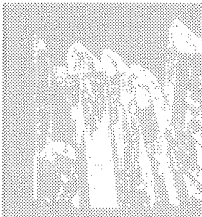
Variscite is found in veins on top of a hill of serpentinite at the east end of the Ninghanboun Hills, on the shore of Weelhamby Lake **(39: 2139)**. The variscite is multi-coloured, ranging from pure white to various shades of green, pink and light brown, and is intimately mixed with granular chalcedony and opal. Its quality is not known.

Brown and green variscite has also been reported from an unknown locality on Belele Station **(33: 2545)**.

'Zebra' rock

Zebra rock provides the basis for a small but valuable souvenir and jewellery industry which is mainly centred at Kununurra **(2: 4666)**. For some time it was believed that all of this rock would be covered by the waters of Lake Argyle; however, many occurrences remain exposed at times of normal water level. Zebra rock has been noted in the literature since 1924 and its origin remains the subject of unresolved debate. The rock consists of siltstone and fine-grained sandstone with unusual, indentically repeated red (iron-rich) patterns on an offwhite (iron-poor) background. It does not usually take a good polish; however, partially silicified siltstone sections have been found to take a sheen.

Slabs can be cut to show two quite different patterns. In one direction well-marked banding shows up. If cut across the



direction of banding, the red material shows up as large circular masses.

Zoisite

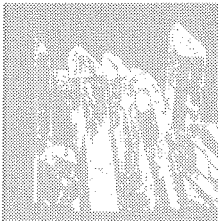
Zoisite has been reported in small quantitites from a number of localities in the northwest of the State; especially in the vicinity of Roebourne **(7: 2356)**.

LAPIDARY ASSOCIATIONS IN WESTERN AUSTRALIA

There are several lapidary associations in Western Australia. As a number of these are loosely constituted local associations around the State, there is little to be gained from listing here their current but often imminently obsolete details. However, up to date information on clubs, societies and fossicking areas etc. may be sought from

The Lapidary Association of Western Australia Inc.
P.O. Box 807
CLOVERDALE WA 6105
Ph: (09) 277 5883

The Gemmological Association of Australia
WA Branch
PO Box 355
NEDLANDS WA 6009
Ph: (09) 387 5959
(09) 384 1609



REFERENCES

A detailed list of references used in the compilation of this pamphlet can be referred to in the Geological Survey of Western Australia library.

Generally, the information was compiled from Geological Survey and Mines Department publications, Journals of the Gemmological Association of Australia, and the following monographs.

BORNER, R., 1938 (English translation by W. Mykerra, 1962), Minerals, rocks and gemstones: London, Oliver and Boyd.

CHALMERS, R.O., 1967, Australian rocks, minerals and gemstones: Sydney, Angus and Robertson.

SMITH, G.F.H., 1912 (*revised by* F.C. Phillips, 1958), Gemstones: London, Methuen and Co. Ltd.

WEBSTER, R., 1975, Gems — their sources, descriptions and identification (3rd edition): London, Newnes–Butterworths.

SIMPSON, E.S., 1948, 1951, 1952, Minerals of Western Australia (Volumes 1, 2 and 3): Perth, Government Printer.

General information on precious stones and minerals can be found in a number of books available through your public library, for example:

BAUER, J., 1974, A field guide in colour to minerals, rocks and precious stones: London, Octopus.

BUCHESTER, K.J., 1972, A treasury of Australian gemstones — gemhunting and cutting: Sydney, Ure Smith.

De SAUTELS, P.E., 1969, The mineral kingdom: New York, Grossete Dunlap.

MAYER, W., 1976, A field guide to Australian rocks, minerals and gemstones: Adelaide, Rigby.

MYATT, W., 1972, Australia and New Zealand gemstones: Sydney, Books for Pleasure.

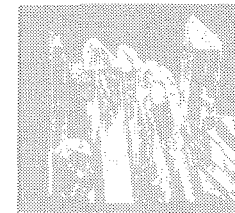
OLLIVER, J. G., and TOWNSEND, I. J., 1993, Gemstones in Australia: Australian Gemstone Industry Council, Canberra, Australian Government Publishing Service.

SCHUMANN, W., 1979, Gemstones of the world: New York, Sterling Publishing Company.

SINKANKAS, J., 1964, Mineralogy for amateurs: Cincinnati, Van Nostrand Reinhold.

SINKANKAS, J., 1970, Prospecting for gemstones and minerals: Cincinnati, Van Nostrand Reinhold.

STONE, S.N., 1983, A guide to collecting Australian gemstones: South Yarra, Lloyd O'Neil.



GLOSSARY

Amphibolite: A dark-coloured, coarse-grained rock consisting mainly of amphibole and plagioclase. It is a product of metamorphism of dolerite and basalts.

Archaean: The period of time in earth history prior to 2500 million years ago.

Basalt: A dark-coloured, fine-grained volcanic rock.

Breccia: A sedimentary rock in which the coarse-grained fraction consists of broken angular fragments.

Cabochon: An unfaceted cut gemstone of domed or convex form.

Carat: A unit of weight for gems, equal to 200 mg (i.e. 0.2 g). The term is said to have been derived from the weight of a seed of the carob or locust tree.

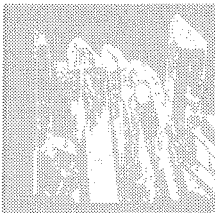
Chatoyancy: Commonly known as the cat's-eye effect, this is a silky sheen which is concentrated in a narrow band of light that changes its position as the mineral is turned.

Costean: Shallow pit or trench designed to expose rocks of interest.

Craton: A part of the Earth's crust that has attained stability, and has been little deformed for a prolonged period (*syn*: Block).

Crosscut: A tunnel that cuts across the trend of rocks.

Crypto-crystalline:	Textural term describing a specimen consisting of crystals that are too small to be recognized and separately distinguished, except by powerful magnification.
Crystal:	A homogeneous body which has plane and often lustrous faces which are indicative of a regularity in its molecular arrangement. A particular crystal shape is characteristic of that mineral.
Dolerite:	A dark-coloured, medium-grained igneous rock which commonly cuts across other rocks in tabular, intrusive masses.
Doublet:	A gem substitute composed of two pieces of gem, glass or synthetic material fused or cemented together.
Drive:	A tunnel driven along the trend of the reef.
Felsic:	Said of igneous rock composed chiefly of light-coloured minerals. A term derived from feldspar and silica.
Gemstone:	Any mineral, rock, or other natural material which, when cut and polished, has sufficient beauty and durability for use as a personal adornment or other ornament.
Gneiss :	A metamorphic rock in which light-coloured bands rich in feldspar and quartz alternate with dark-coloured bands rich in biotite and hornblende.
Granite:	A light-coloured, coarse-grained igneous rock composed chiefly of quartz, feldspar and mica; usually forms large masses.
Jaspilite:	A rock composed of alternating layers of fine hematite and light-coloured chalcedony.
Kimberlite:	A brecciated igneous rock that forms small vertical cylindrical bodies. It is greenish blue in colour,



but weathers at the surface to become a crumbly yellowish rock. It sometimes contains diamonds.

Lamproite: A brecciated near-surface igneous rock that forms cones, pipes and sheets. It is greyer than kimberlite, and often contains diamonds.

Mafic: Said of an igeous rock composed chiefly of dark-coloured minerals. A term derived from magnesium and ferric. See also ultramafic.

Migmatite: A mixed rock that is the result of molten granitic material invading country rock.

Pegmatite: An exceptionally coarse-grained igneous rock, composed mainly of quartz, feldspar and mica, which frequently forms veinlets intruding other rocks. Pegmatites are often a fruitful source of gems.

Peridotite: A coarse-grained, dark-coloured igneous rock composed chiefly of olivine. Most peridotite is chemically altered (hydrated) to form serpentinite.

Porphyry: An igneous rock of felsic composition that contains conspicuous large crystals set in finer grained material.

Potch: Opal of inferior quality that does not exhibit play of colour; it is found in association with precious opal.

Schist: A metamorphic rock containing a considerable amount of aligned flaky or elongated minerals such as mica or hornblende.

Shale: A laminated sedimentary rock consisting of various clay minerals assimilated into thin beds. Grains are too small to be recognized with the naked eye.

Sill: A tabular igneous body intruded parallel to the planar structure (e.g. bedding) of the surrounding rock.

Triplet: The opal triplet is a simple opal doublet (usually composed of a thin piece of precious opal backed by common opal) to which is cemented over the top a suitably fashioned cabochon of clear quartz.

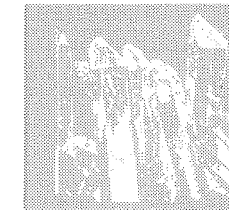
Tuff: A rock formed of compacted fine debris that was produced by explosive volcanic action.

Ultramafic: Said of an igneous rock in which there is a very high content of dark-coloured mafic minerals; an extreme variety of 'mafic'.

Vesicle: A small cavity of globular shape in a volcanic rock, formed by the entrapment of a gas bubble during solidification of the lava.

Ultramafic: Said of an igneous rock in which there is a very high content of dark-coloured mafic minerals; an extreme variety of 'mafic'.

Vesicle: A small cavity of globular shape in a volcanic rock, formed by the entrapment of a gas bubble during solidification of the lava.



Crystal systems

Minerals with a definite molecular structure form crystals according to one of seven systems. However, a crystal is characterized not only by its internal atomic arrangement, but also by its external form. Within each of the basic systems outlined below, the crystals of individual minerals often display numerous faces at various angles to form complex but predictable shapes. More detailed information and sketches may be obtained from most books on minerals and gemstones.

Cubic: Three mutually perpendicular axes of equal length (e.g. garnet; diamond).

Tetragonal: three mutually perpendicular axes, two of which are of equal length (e.g. zircon; cassiterite).

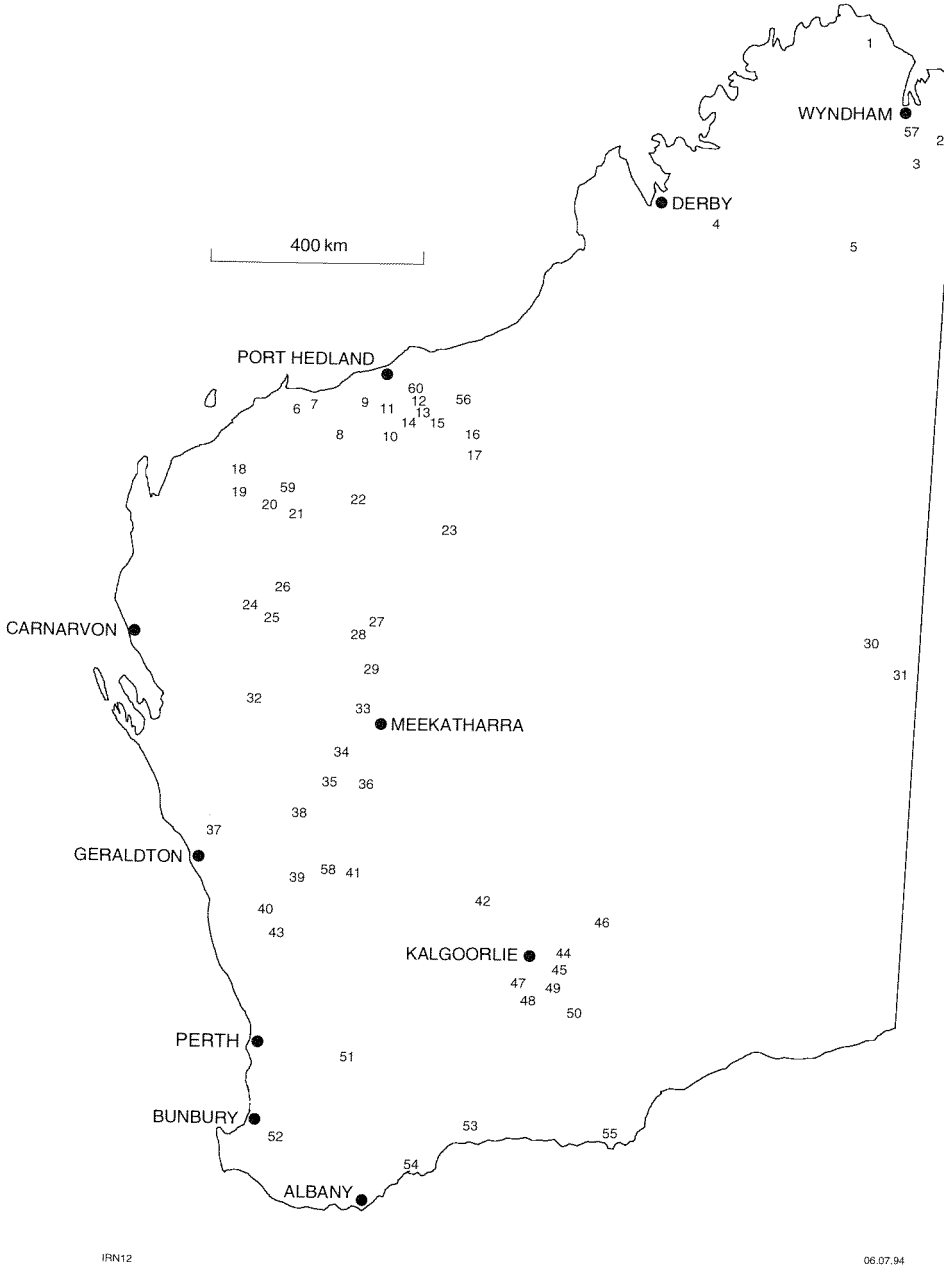
Orthorhombic: three mutually perpendicular axes of different lengths (e.g. topaz; prehnite).

Monoclinic: three axes of different lengths, only two of which are mutually perpendicular (e.g. gypsum; epidote).

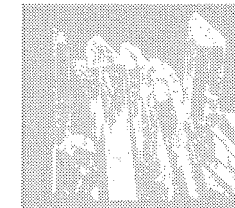
Triclinic: three axes of different lengths, none of which is perpendicular to the others (e.g. rhodonite; plagioclase).

Hexagonal: four axes, three of equal length lying in one plane at an angle of 120° to each other. The fourth axis is perpendicular to this plane and may be of any length (e.g. tourmaline; magnetite).

Rhombohedral/trigonal: three axes of equal length, as in the cubic system, but with an angle other than 90° between them. Sometimes considered a subdivision of the hexagonal system (e.g. calcite; quartz).



Map 1. Localities for gemstones (other than siliceous) in Western Australia

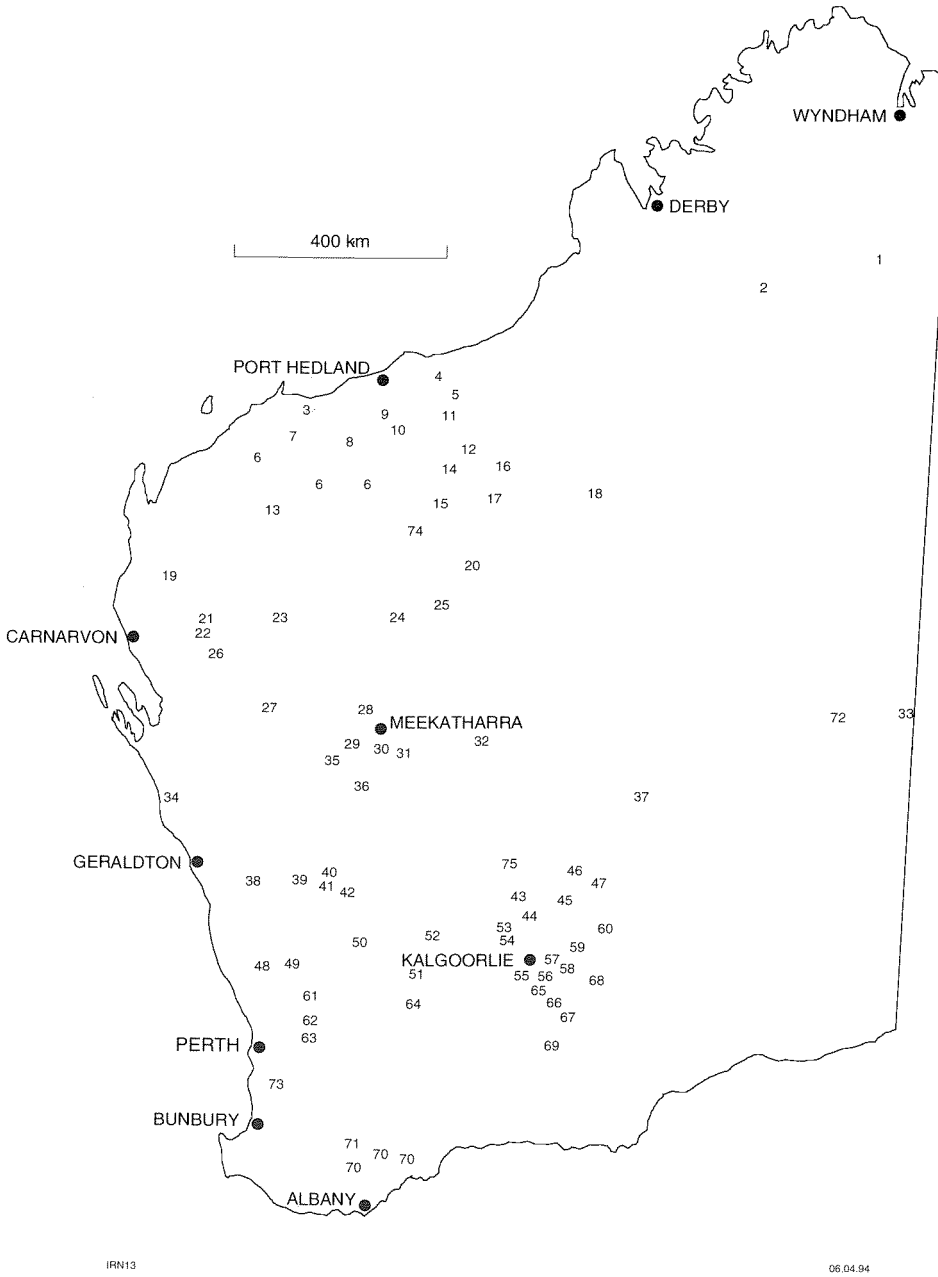


Map 1: Localities for gemstones (other than siliceous) in Western Australia

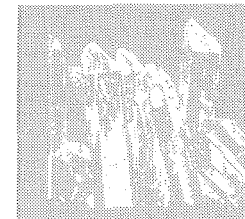
1. North Kimberley Province and King George River (diamond)
2. Kununurra ('zebra' rock)
3. East Kimberley Province anD Argyle prospect (diamond)
4. West Kimberley province(diamond)
5. East Kimberley region (prehnite)
6. Mornong Well (chlorite–serpentine asbestos rock)
7. Roebourne (serpentinite,rhodonite, zoisite, and emerald)
8. Nunyerry (serpentinite)
9. Mount Satirist (serpentinite)
10. Mount Francisco (topaz)
11. Wodgina (emerald and tourmaline)
12. McPhees Hill (emerald)
13. Pilgangoora (emerald)
14. Soanesville (serpentinite)
15. White Quartz Hill (emerald)
16. Lionel (serpentinite)
17. Nullagine (diamond)
18. Nanutarra (marble)
19. Globe Hill (topaz, fluorite)
20. Mount De Courcy (marble)
21. Cheela Outcamp (marble)

22 and 23. Hamersley Iron Province (hematite)

24. Cairn mining centre (tourmaline)
25. Yinnetharra (tourmaline, beryl and aquamarine)
26. Mount Phillips (amethystand garnet)
27. Mount Deverell (variscite)
28. Sawback Bore (variscite)
29. Mount Padbury (variscite)
30. Morgan Range (moonstone)
31. Wingelina (magnesite)
32. Byro (corundum)
33. Belele (variscite)
34. Poona (emerald,aquamarineand topaz)
35. Warda Warra (emerald and amazonite)
36. Lake Austin (calcite)
37. Bowes River (moonstone)
38. Noongal (emerald and topaz)
39. Ninghanboun Hills (variscite)
40. Coodawa (talc)
41. Paynes Find(amazonite)
42. Menzies (emerald)
43. Namban (epidote-rich rocks)
44. Lake Yindarlgooda (turquoise)
45. Bulong (magnesite)
46. Lake Rebecca (magnesite)
47. Londonderry (petalite, beryl, lepidolite, and topaz)
48. Spargoville (tourmaline, beryl, and aquamarine)
49. Kambalda (magnesite)
50. Bineringie Station (amazonite)
51. Jacobs Well and Dangin (corundum)
52. Glen Mervyn (garnet) and Katterup (heliodor)
53. Cattlin Creek (tourmaline)
54. Cape Riche (epidote-rich rocks)
55. Cape Arid (amazonite)
56. Meentheena, Ngarrin Creek, Cookes Creek (fluorite)
57. Speewah Station (fluorite)
58. Mulgine Hill (fluorite)
59. Mount Elvire (fluorite)
60. Tabba Tabba (lepidolite)



Map 2. Localities for gemstones (siliceous) in Western Australia



Map 2: Localities for gemstones (siliceous) in Western Australia

1. Halls Creek
2. Poole Range
3. Roebourne and Karratha
4. Ord Range
5. De Grey River
6. Hamersley and Chichester Ranges
7. Gregory Gorge and Mount Herbert
8. Nunyerry and Croydon Homestead
9. Kangan
10. Wodgina
11. Marble Bar
12. Lionel and Copper Hill
13. Mount De Courcy
14. Bamboo Springs
15. Marillana
16. Davis River
17. Balfour Downs
18. Rudall
19. Wandagee Station
20. Mundiwindi
21. Kennedy Range
22. Mooka
23. Yinnetharra and Mount Phillips
24. Bamboo Spring
25. Ilgarari
26. Gascoyne Junction
27. Byro
28. Belele
29. Weld Range
30. Nannine
31. Gabanintha
32. Wiluna
33. Wingelina
34. Kalbarri
35. Poona
36. Cue
37. Jutsons Rocks
38. Morawa
39. Rothsay
40. Fields Find
41. Pinyalling Hill
42. Paynes Find
43. Jowett Well
44. Comet Vale
45. Yerilla
46. Yundamindera
47. Linden
48. Moora
49. Wandarra Estate
50. Beacon
51. Bullfinch
52. Mount Jackson
53. Ora Banda
54. Grants Patch
55. Coolgardie
56. Kalgoorlie
57. Smithfield
58. Bulong
59. Jubilee
60. Lake Rebecca
61. Goomalling
62. Northam
63. Mount Bakewell
64. Westonia
65. Spargoville
66. Widgiemooltha
67. Paris
68. Cowarna
69. Norseman
70. Stirling Range
71. Gnowangerup
72. Warburton Range
73. Warrawoona
74. Divide Creek
75. Marshall Creek

Copies of this booklet can be obtained from:

Mining Information Centre
Department of Minerals and Energy
100 Plain Street
EAST PERTH WA 6004
Telephone: (09) 222 3459
Facsimile: (09) 222 3633

18421/11/94—2M Bks—L/6494