A Treasury of Australian Gemstones

K.J. Buchester

The complete introduction to gemhunting and cutting Over 75 full colour and black-and-white photographs

To Dear Jan
Wishing you a
Very Happy Christmas
1973.
with love from
Mum & Dad.

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Introduction

Many Australians now realize that the country they live in is a veritable treasure house of gems and ornamental stones. Scattered throughout the length and breadth of the continent are deposits of opals, sapphires, agates and a host of the lesser-known, but equally attractive stones of intense interest to the amateur gemhunter and cutter. Some of these sources of supply are located on immense gemfields, portions of which have been partially worked whilst others have yet been scarcely prospected.

Publicity in recent years has resulted in renewed interest in these gem deposits, some of which have lain neglected for considerable periods. At the same time, new fields have been opened up and, for the first time in many years, some commercial production is beginning of gems and ornamental stones other than opals and sapphires. Formerly, knowledge of gem locations was confined to a handful of dedicated enthusiasts, or to miners engaged in the industry. Latterly, however, several books have revealed these facts to the layman and thus presented him with the opportunity of engaging in two of the most absorbing hobbies yet devised: gemhunting and gem-cutting.

Armed with this information, large numbers of newcomers have learned to identify the commoner gemstones, and have already ventured forth in search of them. Consequently, they have had the thrill of finding their first gemstone and, in their enthusiasm, have cared little whether it is of any great value. Others have progressed beyond this point and are already the proud possessors of collections containing a number of varieties.

These gemhunters who have had their initiation into the mysteries of the hobby no longer have to wonder what to look for in their search nor do they have to puzzle over the stones they have found. Is it an agate? Is it jasper? What does a rough sapphire look like? Where do we look for gemstones? Those, and many other questions have already been answered.

The seasoned gemhunter now asks new questions: What shall I do with this stone? How do I cut and polish it? What sort of machinery shall I need? It is to answer these queries that this book has been written.

The role of the lapidary is an interesting one. It has a long and noble background stretching back to the dawn of Man's awakening. In these modern days, it permits the individual to express himself in an age when this field is becoming more limited. Every new stone cut and polished is creative and brings pleasure to others as well as to its possessor. A fine collection of cut and polished stones, especially if fashioned by the owner, may become one of his most valued possessions, and will certainly be admired by others.

However, such skills are not easily acquired. The development of real craftsmanship and skill rests with the individual who will achieve these by concentration and practice—trial and error. If taken step by step, the intending lapidary will find it possible to teach himself the craft—and ultimately produce stones of the highest workmanship. If he is able to associate with other enthusiasts, so much the better, for then discussion and observation of their work must result in improvement of his own technique.

There is a little difficulty in attempting to teach a manual craft through the printed word; a great deal of initiative must be left to the reader. It might be said that five minutes at the grinding wheel will impart more than a thousand words.

However, the author can only hope that he has been moderately successful in this introduction to the art of the lapidary.

The amateur lapidary art, although gaining in popularity daily, is still young in Australia. There is a great deal yet to be attempted and conquered. For its beginning, we are indebted to the pioneers of the hobby, who introduced it really only such a short time ago but who devised for us this absorbing pastime for our leisure hours. Perhaps some of the readers of this book will, in turn, eventually find themselves able to instruct others.

It is hoped that this volume may provide a key to the further enjoyment of an activity which has already brought a great deal of pleasure and satisfaction to very many people, including the author.

Part 1 How to find Gemstones

Most of us, at one time or another, have idly picked up odd-looking or unusually coloured pebbles or stones, examined them and tossed them away. Or perhaps we have put them in our pockets, whence they have eventually found their way into a bottom drawer, there to stay. Looking back on those stones we no longer have, we wonder if perhaps they were gemstone varieties such as agate, chalcedony or quartz. But we knew little about stones when we found them and cannot remember exactly where they were picked up or what sort of rocks accompanied them, so their identity must remain for ever a mystery.

A gemhunter is like any other hunter. He will not roam all over the countryside looking for gemstones anywhere, or he will most certainly be disappointed. A fisherman would not dream of rigging up for big-game fish and then simply dropping his line in some wayside creek, hoping to land a marlin. He knows what he wants and has a fair idea where to get it. So with the gemhunter. Before looking for gemstones, he will try to pick his mark by travelling to a known gem-field or, at least, to an area which he considers, by its formations and accompanying rocks, to be likely to contain the gems he seeks.

Gemstones of all types are widely distributed over the earth's surface, some countries being particularly favoured with abundant deposits of certain types whilst others are practically devoid of these minerals. Diamonds and emeralds, for instance, are not to be found in England, nor are there any precious opals in the steppes of central Asia. On the other hand, Australia probably contains more precious opal than the rest of the world combined, and Africa is well able to take care of most of the world's demand for naturally occurring diamonds. Thus certain areas which are rich in particular elements and which have been subjected to the necessary geological action may contain a comparative abundance of minerals, whilst other localities, deficient in these elements, will be more or less mineralogically barren. This unequal distribution of mineral wealth has been the basis of many an international conflict in the past.

The geologist or experienced gemhunter knows, then, that it is improbable that he will find a certain mineral in an area which, because of its geological structure, normally does not carry such a mineral. He knows that he will not uncover a mineral (or gemstone) which obviously required heat for its formation in an area of sedimentary rock such as sandstone—unless the mineral was swept there from another source long ago and has become embedded. Depending upon the type of sandstone, he may expect to find opal there, but no quartz crystals or beryl or sapphire. For these, he would look in a locality where volcanic action has taken place, since heat and pressure were necessary for their formation; granite and similar igneous masses would be the most likely places to look. The quartz gemstones such as agate and chalcedony occur in cavities in basalt and similar fine-grained rocks, and so the agate-seeker would not work in granite country unless he noticed that it was intruded by basalt or other dense volcanics. A basic knowledge of rocks and their mineral-forming potential is therefore of great assistance to the gem-hunter, if not actually essential.

Classification of Rocks

Generally, rocks may be classed into three main divisions:

Igneous
Sedimentary
Metamorphic

Igneous rocks. These comprise all the types formed by cooling of molten magma brought up from the depths of the earth. They include the granites, basalts, diorites and trachytes, which differ from one another in their colour, degree of fineness, weight, and mineral composition. These are the mineral-forming rocks, and later intrusions and the mixing into them of other molten matter result in the combinations which ultimately cool to become the minerals and gemstones. Rapid cooling of the surface lavas results in hard, fine-grained masses devoid of large crystals but containing tough, micro-crystalline material such as agate, where free silicon combined with oxygen has permeated the cavities left by the release of gas. Slower cooling, which allows the addition of more molten matter before consolidation (and thus slows down even further the cooling action), produces coarser-grained rocks such as granites, in which the minerals and gemstones form in cavities, often as large crystals.

Sedimentary rocks. These were originally igneous rocks which eroded and decomposed into fine material, such as sand, and became reconsolidated by layering and the application of pressure. Sedimentary rock contains little mineral of its own, except perhaps calcium and other infiltrated minerals, but it may be the source, under certain conditions, of precious opal, as in the desert sandstones of Central Australia.

Metamorphic rocks. These are altered rocks which have been subjected to heat, pressure and other changes. Sandstone, under metamorphosis, alters to quartzite, a hard compact variety, whilst slate changes to schist, a much harder layered rock. During the process of alteration, gemstones such as garnet and andalusite may occasionally form.

Alluvial Deposits

All of these rocks, whether igneous, sedimentary or metamorphic, are subject to further physical changes brought about by weathering, or the action of rain, frosts, wind, and heat, as well as chemical action. This natural process slowly but persistently decomposes the rock masses by cracking them and gradually reducing them into smaller pieces. Landslides occur, exposing fresh rock, which in turn undergoes the breaking-down process until great masses of rubble lie around the original rock deposit. The gemstones, which are usually harder than the rock which surrounds them, become exposed or are liberated completely and join the lumps and boulders that once formed their home. Then the whole loose mass may be caught up by water and swept away into a huge running stream to be distributed, pebbles, boulders, gemstones and all, over a wide area. The continual action of sand swirling in the water, and the rubbing of one stone on another, soon grinds away the sharp points and edges of the stones, leaving them in a roughly rounded condition referred to as 'water-worn'. The gems have thus left their secure rocky abode and are now lying scattered amongst rock debris of all kinds in an alluvial deposit. The action of the water on these beds may continue or the entire mass may become covered with soil or more rocks and the course of the stream may change, leaving the deposit buried under many feet of covering. Much later, another stream may cut a fresh course through this deposit, exposing the smooth rocks which had been worn and laid down so long ago. Occasionally, these ancient beds may be covered with layers of fine material and re-formed into a new solid mass known as conglomerate, consisting of waterworn pebbles and boulders cemented together into a kind of natural concrete. The alluvial deposits are of great interest to the gem-hunter because they contain gemstones which have been freed and distributed and (except for those in conglomerate) made a great deal easier to recover.

Sources of Gemstones

The amateur gemhunter often may not have the time, finance or equipment—or even the inclination—to gouge out hard rock or to sink deep shafts in his search. If it were always necessary to chip and hack at the basalts to obtain agates, for instance, it would be hard work indeed. But fortunately there are the alluvial deposits described above, and the agate nodules—and a great variety of other gemstones—may often be found on the beds of streams or buried in the soft earth, whence, as stated already, they may be recovered without much difficulty.

Nature has been at work to assist the gemhunter in other ways. Sometimes landfalls have exposed a hidden layer or seam of fresh gem material. Perhaps flood water has turned over the rubble in a river-bed and exposed previously covered stones. Heavy winds may have toppled large trees, revealing gem material around the roots. Even insects have been of assistance at times; ants have been known to bring up small gemstones and deposit them on their heaps. One of the most productive diamond deposits* on the Copeton field owed its discovery to such activity by ants.

Man, too, has helped the present-day gemhunter, digging shafts and tunnels and piling up small mountains of debris in his search for minerals. Most of the early miners were singularly one-track-minded and if they were digging for gold that was what they wanted and most other minerals were simply thrown out onto the heaps. The quartz gemstones, particularly, such as quartz crystal, agates and jaspers were ignored; in any case, they had no real value in the early days. Such material as rutilated quartz ('grass stones'), citrine and cairngorm—desirable today—was shovelled onto the spoil heaps, together with the granite and quartzite fragments, by the Tingha tin-miners.

As a result of this sort of action, spoil heaps in highly mineralized areas often contain gem material for the amateur. Some of these locations have been picked over since, but careful searching will nevertheless often uncover previously overlooked material. On a very rich field, where high-grade stones

* Soldier Hill mine.

were once quite common, often only those of the best quality were taken and the remainder discarded. Some of these past rejects, which have become interesting today, are still in a number of the old dumps. Generally, most old mine dumps are worth looking into.

Old alluvial tin-fields are of special interest to the gemhunter. Here, the hard sandy material accompanying the tin deposits has been pulverized and removed to a huge heap known as a 'paddock'. During this process, the hard mass has been reconverted to loose sand, and distributed through it are the gemstones which accompany tin, such as topaz, quartz crystal, citrine, cairngorm and occasionally sapphires and even small diamonds. Very little, if any, of this stone was retained and most of it, as it originally occurred in the deposits, is located in the paddocks. On the old tin-fields there are also high, conical mounds of larger stones, consisting of the coarser rubble removed before treatment of the tin wash. These have been known to contain large lumps of quartz crystal and other quartz gemstones.

New road cuttings and quarries often yield gem material to the keen gemhunter. Quite a number of these quarries are worked for old river gravels, well waterworn and often containing gemstones such as agate, chalcedony, crystal, and petrified wood. Some fine agates have been obtained from the old railway quarries at Gurley and Bellata near Moree, N.S.W. Although it is not recommended that gemhunters should begin to dig up roads in search of stones, many a fine quartz gemstone has been found on the sides of gravel roads in material dredged from rivers and streams. In appropriate formations, quarry operations often reveal seams of gem material of interest to the gemhunter.

Beaches, too, quite often carry gem material in the form of worn pebbles. The stones have been brought down to the sea in rivers, or washed by waves from cliffs and deposited by the ocean along the shore.

For the gemhunter, then, the source of his material will be quarries and cuttings, old mine diggings and spoil dumps, pits, river-beds and beaches.

Methods of Gemhunting

When examining rocky river-beds, the gemhunter has the choice of two methods of search. He may either superficially inspect the surface and thus cover a wide area in a comparatively short time, or he may persevere in one likely spot by digging or removing the boulders. The first method has the advantage of being quick but has an obvious disadvantage if the area has previously been examined by a number of other gemhunters, unless floods or storm water have since swept over it and exposed fresh material. A well-picked-over area, known to contain gem material, must be prospected thoroughly if satisfactory results are to be obtained.

If the larger gemstones, such as the quartz varieties, are being sought hand-picking is sufficient. If, however, smaller gems, such as sapphires, zircons, beryl or garnets, are being sought, the gemhunter has to resort to sieving, for the size of these gems usually makes them indistinguishable from the bulk of the surrounding material. In this case, the site is dug, large stones obviously not of interest are removed, and the finer material thought to be gem-bearing is sieved. If the mesh of the sieve is too fine, it will clog up with sand particles and prevent efficient treatment. If it is too large, some of the smaller gemstones may slip through and be lost. The size of mesh recommended for general gem-sieving is $\frac{1}{8}$ inch, although a finer mesh may be used to recover very tiny and valuable stones, such as diamonds or perhaps sapphires. If desired, two sieves may be used, one of $\frac{1}{8}$-inch mesh or less and one of coarser mesh ($\frac{1}{4}$ inch or so) on top of this, to separate the larger stones from the small gravels. A vigorous shaking will result in separation. If a roughly circular motion is adopted, the heavier stones will tend to work into the centre of the mesh through centrifugal action.

For the gemhunter who wants to retain any gold dust or fine minerals present, the gem material may be washed in a miner's dish in the manner of gold-panning. The dish is particularly useful if water is freely available in pools or running streams. A small quantity of the gravels is shovelled into the dish, which is then almost filled with water. With both hands, the dish should then be shaken to and fro, with a swirling action, and tilted slightly so that the heavier material sinks to the bottom and the lighter sands and stones are swept away over the lip. Repeated treatment results in only the heavier stones remaining in the bottom of the dish, which is then inspected for gemstones and minerals. There is a certain amount of skill necessary to 'dish' correctly, and, as this can only be achieved through practice, the beginner should not be dismayed if he loses a few stones initially. Some prospectors use the gold dish to wash the sievings as well.

If there is no water available, any lumps of dirt are broken up by hand and the sieving is done in a dry state. If there is water handy, the material can be sieved in the water, so that even the smallest gemstones become visible.

To prevent fatigue in sieving, the sieve may be hooked with wire to a tripod or cut saplings. It is worth while taking the trouble to set up the tripod if a lot of sieving is intended at the same site.

When the gemhunter is looking for the larger specimens of quartz crystal, topaz, etc., in old spoil dumps, the rubble is first removed by hand or with a small hand scoop, such as a garden trowel. The wearing of gloves will prevent cuts from sharp and jagged rocks in these dumps. If there is finer material with the coarse debris, it should be separated out and sieved for the smaller gemstones. If there is any soil adhering to the rocks and no water present, anything that appears to contain small gemstones should be retained for later treatment in water by means of the sieve or dish.

When examining the old dumps, the gemhunter should work in from the sides rather than from the top down. If gem material is found at a particular level, excavation should be continued horizontally, for it is quite likely that the material will carry on as a definite layer deposited during original mining operations.

Liberated specimens of agate, chalcedony, bloodstone, and jasper, etc., may be embedded not only on the bottoms of existing creeks but also in the soft banks which may have formed parts of ancient watercourses. These old river-beds may also be found some distance away from existing creeks and may be recognized by the rounded boulders packed upon each other, as they were deposited long ago.

The presence of these waterworn boulders and stones anywhere—even high up on ridges—is an indication of old alluvial deposits, but the gemhunter should not confuse weatherworn granite with waterworn stones. Granite, as a result of weathering, becomes exfoliated and peels like an onion, leaving the rocks with a rounded shape reminiscent of waterworn stones.

The gemhunter learns to look for signs during his search. Some of them point to a gem deposit with an unerring accuracy, as if to say 'Gems? This way please!' The presence of small specimens of a gemstone often leads to the discovery of larger ones and often indicates the occurrence of gem types normally associated with it. If the searcher is in tin-bearing country, he knows it is quite likely that topaz, quartz crystal, beryl and possibly sapphires may be present. In a wolfram area, he may find fluorspar, beryl and topaz. A sign, even a small chip, of chalcedony in a basalt locality may lead him to agate, jasper, carnelian, bloodstone or any of the other members of the micro-crystalline quartz minerals. Small zircons show that there may also be sapphires in the vicinity, for the two stones are found together.

Practice and experience (and, it is hoped, the reading of this book) will teach the gemhunter to be observant, to follow up obvious indications and to recognize the significance of particular deposits. He will then be set to build up a fine collection of gemstones and to derive the utmost enjoyment from his hobby.

Identification of Gemstones

What is a gemstone? We may immediately think of a diamond, a ruby, an emerald, or perhaps a sapphire, for most of us have, at one time or another, admired these sparkling gems in a jeweller's window. But there are many others which we may not have seen or perhaps even heard of: the olive-green peridot, the purple amethyst, the shimmering blue zircon, the brilliant topaz and the honey-coloured citrine. These also are gemstones and, although they may not always command the attention given the more regal diamond, they are nevertheless well worthy of our admiration. Gemstones have been described as 'the flowers of the mineral kingdom' and in the wealth of their colourings with their unique patterns they do, indeed, rival Nature's floral works.

It was long the practice when the diamond, ruby, emerald and sapphire ruled supreme as the most coveted of stones to give these four the royal title of 'precious stones' and to dismiss all other gemstones, whatever their merit or rarity, as 'semi-precious'. Fortunately, this ridiculous custom has now almost died out, for who would prefer a badly flawed, low-grade diamond to a superb specimen of golden beryl or sherry-coloured topaz? We may perhaps be allowed to say that all gems are created precious, but some are more precious than others.

The name gemstone is now not confined to facet-cut sparkling gems but is applied generally to any stone possessing the three indispensable assets of beauty, durability and rarity. (The gemhunter may go even further than this and regard any stone that has appeal for him as a gemstone.) As thus defined, gemstones are not necessarily transparent, but may rely upon a delicate hue or a multitude of colourful markings in quite an opaque stone to qualify. The unparalleled agate, in its natural state a rough undistinguished lump of drab rock, becomes a gemstone when it is sawn, ground and polished to reveal its pattern of swirls of contrasting colour. Even some mineral ores become in the hands of a lapidary things of beauty. Rhodonite, for instance, once crushed for its manganese content, is a rich shade of rose pink interlaced with black veins, well worth the lapidary's attention. Petrified woods, which are actually merely fossils, may, when of suitable grain and colour, emerge as gemstones. To the gemhunter, then, any rock or mineral which is attractive in its natural state or may be made to yield a stone of pleasing appearance may be classed as a gemstone.

Although gemstones are minerals, all minerals are not gems. Of approximately 1,600 mineral species known, less than 100 can be used as gems and even fewer are normally made up into jewellery and sold. Also, gemstones are comparatively rare, since conditions have not always been suitable for their formation and preservation.

Every gemstone found has to be at least cursorily examined before it can be identified. Fortunately, each species has a combination of certain optical and physical properties which generally will enable a positive identification to be made. Some of these characteristics are quite unmistakable; for instance, agate, with its unique bands, can never be confused with any other variety. But not all gemstones can be identified by one single characteristic; many of them are of similar colour, shape and appearance. The gemhunter must then look for other features as well and, by a process of elimination, eventually arrive at a conclusion. Fortunately, although some gemstones may have a number of identical characteristics continued comparison and elimination will eventually disclose differences.

The characteristics which will enable identification are:

1. Hardness.
2. Specific gravity.
3. Fracture and cleavage.
4. Lustre.
5. Colour.
6. Degree of transparency.
7. Crystal system.
8. Refractive index.
9. Associated rocks or minerals.

Hardness

As may be expected, some gemstones are harder than others. Most people know that a diamond will easily scratch glass and, in fact, many regard this as a satisfactory test for an engagement ring. What they do not know is that practically every gemstone will also scratch glass. A gemstone generally is regarded as one with a hardness of 7 or more, while glass usually attains a hardness of 5 to 6. There are a few exceptions to this, notably opal and turquoise which, although of inferior hardness, are classed as gemstones because of their beauty and rarity.

But what is this hardness? The amateur gemhunter may justifiably be confused by the term. Some of the early miners certainly were. Having heard that diamond was the hardest stone, they simply placed any bright colourless stones on an anvil and pounded them with a sledge hammer. Needless to say, this test invariably resulted in a mass of shattered fragments, and probably many a fine diamond was pulverized in this way. The miners did not know that the term hardness referred to the stone's resistance to scratching and had nothing whatever to do with its ability to withstand a heavy blow. Diamond, although the hardest natural substance in existence, is in fact quite brittle, with many cleavage planes, and this peculiar property is utilized by the professional diamond-cutter.

Hardness can also be confused with toughness. Crystal quartz and agate are of the same hardness (7), but any lapidary can vouch for the fact that it is much more difficult to saw the agate. This is due to the compact micro-crystalline structure of agate as against the more open crystalline arrangement of quartz crystal. The crux of the whole matter is that the hardness of a stone is determined by the compactness of its internal structure. The molecules in a diamond are so closely packed together that they can withstand abrasion by any other substance, and, in turn, other gemstones can withstand abrasion by less compact gems.

We must then get down to resistance to scratching to determine the hardness of a stone. The durability of the diamond is due to the fact that none of the material with which it comes in contact is able to scratch or score it. Most of the dust of the atmosphere is composed of silica of a hardness of about 7, so that an imitation glass stone, or a gem of less than hardness 7 (such as opal), if worn constantly or carelessly handled will soon show signs of wear and deterioration.

Hardness is a very useful test in determining what any particular stone is likely to be. But it should be kept in mind that the stone's position in the hardness scale is relative only, and that there is no absolute figure. The difference in hardness between the diamond (10) and the sapphire (9) is infinitely greater than the difference in hardness between the sapphire (9) and topaz (8). A stone of hardness 8 (topaz) will scratch any stone of hardness less than this and will, in turn, be scratched by stones of greater hardness (8½ to 10).

Suppose we have an unidentified stone and would like to know what it is likely to be. We know that it is not a diamond or a sapphire and so do not worry about trying to scratch it with a piece of diamond (if we have one). We find that our piece of sapphire (9) scratches it easily, as does also our testing fragment of topaz (8), so we know that it has a hardness of less than 8. We now use our unidentified stone to scratch what we suppose will be less hard stones and try it on feldspar (6) and find that it does scratch this. We now know that our stone's hardness is somewhere between $6\frac{1}{2}$ and $7\frac{1}{2}$ and, by a process of elimination—examination for colour and perhaps other characteristics such as specific gravity and crystal structure—finally come to the conclusion that it is a specimen of colourless quartz crystal with a hardness of 7.

When carrying out the hardness test, the gemhunter will normally be testing rough gemstones, in which case the test should be made on a convenient and inconspicuous part of the gem. On no account should cut gems be tested on the front facets or face, since this may permanently impair them, necessitating expensive re-cutting and polishing. The best position for the test is on the girdle or rim of the gem, where a scratch will not be seen, and, even then, the very smallest of scratches should be made.

The stone being used for the scratching should bear a point, since a dull, rounded surface will not give a satisfactory test. Sometimes the scratching gem leaves on the other stone a line of powdered stone which is mistaken for a scratch mark when, in fact, the reverse is actually true. If there is any doubt, the stone should be rubbed lightly to see if, indeed, a scratch mark has been made.

The basic scale of hardness, known as the Mohs' scale, is as follows:

1	Talc	6	Feldspar
2	Gypsum	7	Quartz
3	Calcite	8	Topaz
4	Fluorite	9	Corundum (sapphire)
5	Apatite	10	Diamond

However, the Mohs' scale is a starting point only, and, although of considerable general use, is not sufficient to test all the gemstones likely to be encountered. A more comprehensive scale is as follows:

1	Talc	4	Fluorite
2	Gypsum	4	Rhodochrosite
3	Calcite	5	Serpentine

5 – 5½	Obsidian
5 – 5½	Sphene
5 – 6	Turquoise
5 – 6	Lapis lazuli
5½ – 6½	Opal
5½ – 6½	Rhodonite
5½ – 6½	Opalite
6 – 6½	Nephrite jade
6 – 6½	Feldspar (including moonstone, amazonite, labradorite and sunstone)
6 – 6½	Prehnite
6 – 7	Spodumene
6½ – 7	Andradite garnet
6½ – 7	Jadeite jade
6½ – 7	Peridot (olivine)
6½ – 7	Aventurine
6½ – 7	Prase
7	Quartz (including citrine, cairngorm, amethyst)
7	Tiger-eye
7	Grossularite garnet
7	Bloodstone
7	Rose quartz
7	Ribbonstone
7	Petrified wood
7	Jasper
7	Chalcedony (including carnelian and chrysoprase)
7	Agate (including onyx)
7	Staurolite
7 – 7½	Tourmaline
7 – 7½	Pyrope garnet
7 – 7½	Spessartite garnet
7 – 7½	Rhodolite garnet
7 – 7½	Andalusite (chiastolite)
7½	Almandite garnet
7½	Zircon
7½ – 8	Beryl (including aquamarine and emerald)
8	Topaz
8	Spinel
8½	Chrysoberyl
9	Corundum (sapphire, ruby)
10	Diamond

For testing hardness, there are available sets of hardness pencils, but these are rather expensive and the gemhunter may wish to prepare his own. This can be done by obtaining small specimens of each of some known gemstones such as quartz, topaz, corundum, and fluorite (the diamond may be out of the reach of most of us), and grinding each piece on the wheel to an elongated rectangular shape so that the stone bears four scratching points; if the stone is tapered to a single point, this may break off. The stones should then be firmly cemented with a strong adhesive into holders made of wooden dowel or similar material, and the hardness marked on the handle. They may then be easily manipulated in hardness tests and carried on field trips in the pocket.

Specific Gravity

Although the colours and general appearance of two different gemstones may be identical, they may often be distinguished by their specific gravity (S.G.). Specific gravity is the ratio of the weight of the gemstone to that of an equal volume of water; although this may seem involved, the relative weight is quite often apparent without calculations. The specific gravity may be determined precisely by (a) weighing or (b) testing in heavy liquids. These procedures, however, are not absolutely essential for the amateur gemhunter, who soon learns to estimate the relative weights roughly by placing the stones in the palm of the hand. An experienced gemhunter has little difficulty, for instance, in determining the difference between topaz and quartz pebbles, although they are almost identical in appearance. Some of the gemstones, however, do not show their differences in specific gravity so easily and here specific gravity is not so heavily relied upon for identification. Gemstones range in specific gravity from 2·15 for opal to between 4·30 and 4·70 for zircon (which is very high for a non-metallic substance).

Fracture and Cleavage

Although, under a sharp blow, most gemstones will break with a conchoidal (shell-like) fracture, some exhibit other characteristic types of splitting which assist in identification. Topaz, for instance, will split (or 'cleave') in a completely smooth plane at right angles to the length of the crystal. This is known as basal cleavage. Microline feldspar will cleave perfectly in other directions, if tapped sharply, leaving a smooth flat surface similar to the face of a natural crystal. Fluorite (fluorspar) will do likewise. This is known as perfect cleavage and occurs in varying degrees in a number of minerals. If not so perfect, it may be known as 'uneven' cleavage.

Fracture, on the other hand, is a breakage which may occur on any part of the gemstone and is never so definite and clean as cleavage. Fracture is usually classified as:

Even
Uneven
Hackly
Rough
Splintery
Conchoidal (shell-like)

Sometimes, the breakage effect is neither cleavage nor fracture but a separation between layers known as 'parting'. This is often well illustrated on the base of corundum crystals, a kind of 'steps and stairs' effect being obtained.

Lustre

Lustre is an optical property of gemstones and depends upon the way light is reflected from their surface. Metals such as lead and molybdenite are said to have a 'metallic' lustre. Most gemstones, however, are non-metallic and their lustre is generally described as one of the following:

Adamantine (a hard, shiny surface similar to a diamond)
Vitreous (glass-like)
Resinous (like the surface of resin)
Greasy
Pearly
Silky

Colour

Gemstones are of many colours. Most of us still tend to think of some gems as being of only one colour. The sapphire, for instance, is generally regarded as being only blue, jade as being green and garnet as being red. If each stone occurred in only one colour the task of identification would be simple, but

Nature, to confuse us, has juggled the gemstones and colours round a little so that we have green and yellow peridots, garnets, tourmalines, zircons, beryls, topaz, sapphires, chrysoberyl and even diamond. There are also blue tourmalines, zircons, beryls, spinels and diamonds, in addition to the well-known sapphires. The other colours also extend over as wide a range of gemstones, so that colour alone is not a positive identification of the stones we find.

However, the colour test is one that anyone can apply. It is useful in determining what a stone may be and certainly often indicates that a gem cannot be of a particular variety if its colour is one that does not occur in that variety.

The following colour tables will be helpful to the gem-hunter when assessing what a gemstone is likely to be from its colour. They will also indicate the wide range of colours found in some gemstones. Included are the hardnesses of the gemstones listed, which will help to narrow down the identification process, although, for accurate and positive identification, it may be necessary to solicit the aid of a gemmologist to carry out more exhaustive tests, such as a refractive index reading or a specific gravity weighing.

All the stones listed in the tables are transparent or translucent varieties.

WHITE OR COLOURLESS

	Hardness		*Hardness*
Opal (hyalite or milk opal)	5 – 6½	Zircon	7½
Orthoclase feldspar (moonstone)	6 – 6½	Beryl	7½ – 8
Chalcedony	6½ – 7	Spinel	8
Quartz crystal	7	Topaz	8
Tourmaline	7 – 7½	Corundum (white sapphire)	9
		Diamond	10

YELLOW

Amber	2 – 2½	Spodumene	6 – 7
Opal	5 – 6½	Chalcedony	6½ – 7

	Hardness		*Hardness*
Peridot (olivine)	6½ – 7	Zircon	7½
Citrine	7	Beryl	7½ – 8
Yellow quartz	7	Topaz	8
Grossularite (garnet		Chrysoberyl	8½
hessonite)	7	Chrysoberyl (cat's-eye)	8½
Tourmaline	7 – 7½	Yellow sapphire	9
Spessartite garnet	7 – 7½	Diamond	10

ORANGE OR BROWN

Amber	2 – 2½	Topaz	8
Fire opal	5 – 6½	Spinel	8
Chalcedony	6½ – 7	Chrysoberyl	8½
Cairngorm	7	Corundum (star	
Grossularite garnet	7	sapphire) orange	
Tourmaline	7 – 7½	sapphire	9
Zircon	7½	Diamond	10
Beryl	7½ – 8		

PINK OR RED

Fire opal	5 – 6½	Almandite garnet	7½
Kunzite	6 – 7	Beryl (morganite)	7½ – 8
Chalcedony (sard and		Topaz	8
carnelian)	6½ – 7	Spinel	8
Rose quartz	7	Chrysoberyl	
Rhodolite garnet	7 – 7½	(alexandrite)	8½
Tourmaline	7 – 7½	Corundum (ruby and	
Pyrope garnet	7 – 7½	pink sapphire)	9
Zircon	7½	Diamond (rare)	10

VIOLET OR PURPLE

Kunzite	6 – 7	Chrysoberyl	
Amethyst	7	(alexandrite)	8½
Rhodolite garnet	7 – 7½	Corundum (purple	
Tourmaline	7 – 7½	sapphire)	9
Pyrope garnet	7 – 7½	Corundum (star	
Almandite garnet	7½	sapphire)	9
Spinel	8		

BLUE

	Hardness		Hardness
Opal	5 – 6½	Spinel	8
Chalcedony	6½ – 7	Corundum (blue sapphire)	9
Cat's-eye quartz	7	Corundum (star sapphire)	9
Tourmaline	7 – 7½	Diamond (rare)	10
Zircon	7½		
Beryl (aquamarine)	7½ – 8		

GREEN

Peridot (olivine)	6½ – 7	Emerald	7½ – 8
Chrysoprase	6½ – 7	Topaz	8
Andradite (garnet demantoid)	6½ – 7	Spinel	8
Tourmaline	7 – 7½	Chrysoberyl	8½
Zircon (rare)	7½	Green sapphire	9
		Diamond (rare)	10

Degree of Transparency

Transparency, like lustre, is an optical property, easily judged by the eye alone, varying with the amount of light that passes through the gemstone. If the stone is quite clear with sufficient light passing through it to enable objects to be seen, it is described as being 'transparent'. If some light may be seen through the stone, but dimly, it is 'translucent'. If only thin sections or edges show light, it becomes 'semi-translucent'. The complete blocking out of light makes it 'opaque'. Some gemstones may be found in all states from transparent to opaque.

Crystal System

Most of the transparent gems which are faceted and polished are actually crystallized minerals. Practically all minerals will form into crystals if conditions are favourable during the cooling period. If there are no crystals at all, or possibly only small or distorted ones, cooling must have been too rapid or there must have been a lack of space in the rock in which the crystals formed. The larger and more perfectly shaped crystals are enabled to form under conditions which permit sufficient growing space and slow cooling.

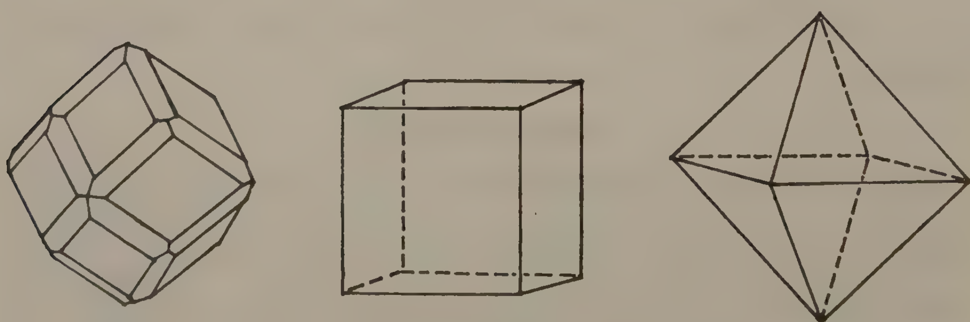
Crystallography itself is a highly specialized subject, a treatise on which would fill a book many times the size of this one, but there are some fundamental rules which are easily understood and which are of great value to the gemhunter in identification.

The crystallized gemstones fall into one of six main crystal systems. The term crystal means that the atoms constituting the material are arranged in an orderly internal pattern, often indicated by the smooth, flat surfaces of the typical crystal shape. Even if the crystal is distorted, flattened or bent, the normal crystal structure is nevertheless present internally. The crystallization pattern of the mineral, if it is in a recognizable form, has not been too deformed, or has not lost all of its outline by being waterworn, is often an important clue to the identity of the gemstone. For a particular mineral will form crystals of only one system.

The gemhunter will find it a definite asset to become familiar with these six crystal systems:

Isometric (or Cubic) System. The crystals have three axes, all at right angles to one another and all of equal length. Some gemstones which crystallize in the Isometric System are:

Diamond. Spinel. Garnet.



Garnet Fluorspar Spinel

Fig. 1. Isometric System

Tetragonal System. The crystals have three axes, all at right angles to each other, two being equal in length and the third longer or shorter. A gemstone which crystallizes in the Tetragonal System is: Zircon.

Fig. 2. Tetragonal System

Orthorhombic System. The crystals have three axes, all at right angles and all of different lengths. Gemstones which crystallize in the Orthorhombic System are:

Chrysoberyl. Peridot (olivine). Topaz.

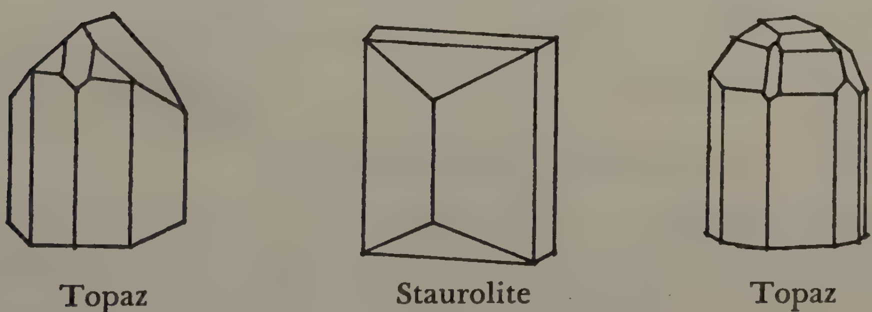
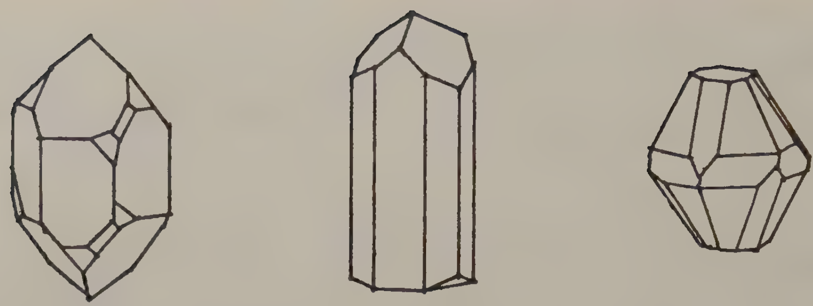


Fig. 3. Orthorhombic System

Hexagonal System. The crystals have four axes, a vertical longer or shorter than the other three, which are at right angles to it and intersect each other at 60°. Gemstones of the Hexagonal System are:

Corundum (sapphire). Beryl. Tourmaline. Quartz.

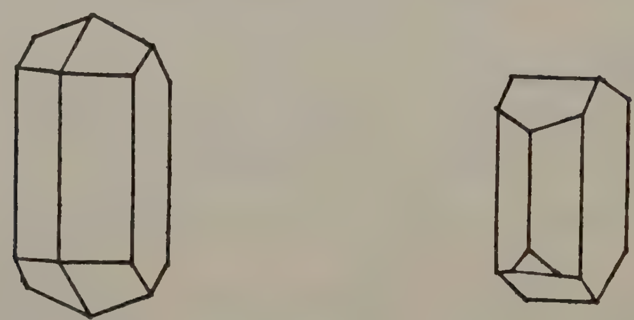


Quartz Tourmaline Corundum

Fig. 4. Hexagonal System

Monoclinic System. The crystals have three axes, all of different lengths, two of them at right angles and the third on an incline. Monoclinic gemstones are:

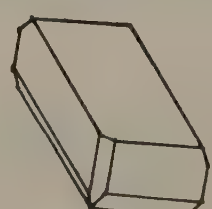
Sphene. Spodumene. Nephrite. Jadeite. Orthoclase feldspar.



Gypsum Orthoclase Feldspar

Fig. 5. Monoclinic System

Triclinic System. The crystals have three axes, all of different lengths and all inclined (i.e. not at right angles). Triclinic gemstones are: Turquoise. Rhodonite. Plagioclase feldspar.



Rhodonite

Fig. 6. Triclinic System

These descriptions of the crystal systems may at first appear difficult to follow. The diagrams of typical shapes will be of assistance, although it should be remembered that very rarely does the gemhunter find the ideal crystal as illustrated, with its symmetrical outline. Often the gem is shattered or worn so that little of the original crystal shape can still be seen, but even the remnants often enable identification of the gemstone. What is important to remember is that, if a hexagonal crystal is found, it cannot possibly be a diamond (cubic), and that a cubic crystal cannot be a sapphire (hexagonal), and so on. Quite often, as with quartz, beryl or topaz taken from rock deposits, perfect crystals are exhibited, leaving no doubt as to the identity of the stone.

Refractive Index

Determination of the refractive index of a gemstone involves the use of an instrument known as a refractometer, and is applicable only to cut stones. The instrument cannot be used to determine the refractive index of rough material in the field. But the index is such an important factor in the identification of cut gemstones that a reading of it under proper conditions will often result in complete and accurate recognition. The refractive index is a measure of the bending of light within the gemstone, the light being bent in much the same way as a stick partly submerged in water is apparently bent at water level. All gemstones have a particular refractive index which varies only slightly, and the use of index tables, together with the instrument, enables a qualified gemmologist to arrive at a quick and accurate conclusion.

Associated Rocks

The rocks found associated with gemstones may be an important factor in identification for the gemhunter who is actually obtaining his specimens in the field. Although they cannot provide a positive identification, the associated rocks and minerals are very often a guide as to what the gemstone is likely to be or, inversely, what it cannot be.

Experience, founded on observation and the examination and comparison, of all sorts of gemstones, will soon enable the gemhunter to carry out several of the above tests of characteristics and, by elimination, to arrive at an identification. If he is still in doubt, a qualified gemmologist may be able to help with more advanced techniques.

At the end of the book is an identification table in which the characteristics of each of the principal gemstones are listed.

The Quartz Gemstones

Perhaps the most puzzling of all gemstones are the quartz minerals, for it is not a simple matter to distinguish and classify the many varieties. There are many 'silicates' or gemstones composed of mineral elements combined with silicon, but the family of quartz minerals comprises quite a distinct group, and it is with it that we are concerned in this section. This series of stones is more often encountered than any other by the gemhunter in the field and it provides the bulk of the available collecting material. The distinction and classification of the quartz gemstones are confusing not only to the beginner: differences of opinion still prevail amongst experienced collectors on, for instance, where chalcedony ends and agate begins. The descriptions in this chapter will, it is hoped, be of assistance to the gemhunter, but it is only by handling and comparing specimens that complete knowledge can be obtained.

The minerals are all essentially of the same chemical composition and they are called quartz minerals because they are composed of silicon dioxide (silica), which is also the essential basis of quartz itself. However, there are differences in form, feel, colour and lustre which serve to distinguish the several varieties, which are then known by their individual names.

The quartz minerals may be divided into four main classes:

1. Crystalline.
2. Crypto-crystalline (or micro-crystalline).
3. Non-crystalline (amorphous).
4. Pseudomorphs.

Crystalline Varieties

As the name suggests, the crystalline varieties comprise those members of the quartz group which form definite single crystals, or groups of crystals, usually quite discernible unless the stones have been waterworn or have otherwise lost their natural appearance. These crystals, in a perfect form, are hexagonal (six-sided), but may assume external shapes quite unlike an ideal hexagon. They may be distorted or flattened, twisted or stunted, but internally they are quite regular in structure. When broken, they exhibit a typical conchoidal fracture. They are usually easily identified as:

Quartz crystal	Colourless, glass-like, milky or sometimes cloudy. (Composed of pure silicon dioxide.)
Amethyst	Pale mauve to deep purple, sometimes purple-black. (The colour was formerly thought to be due to manganese, but is now considered to be the result of a trace of ferric iron.)
Cairngorm or smoky quartz	Deep golden to brown, or smoky shades. (The colour is now believed to have been caused by the effect of radiation.)
Citrine	Yellow to golden yellow. (The colours are probably due to ferric iron and the application of heat.)
Morion	Black
Rutilated quartz	Clear or coloured quartz with inclusions of fine, needle-like crystals of rutile, usually called 'grass stones'.
Sagenite	Includes rutilated quartz and all quartz with mineral inclusions, such as cassiterite, tourmaline, molybdenite.

All of these crystalline varieties may be completely transparent, translucent or almost opaque.

Although milky quartz is found in crystal form, it usually occurs as a massive form or reef, which has to be broken to obtain individual specimens. The milkiness of this type is due, not to impurities, but to myriads of tiny cavities and channels within the stone, which destroy its transparency.

Rose quartz, a pink to rose-red quartz, has been found in a rare crystal form but normally only as massive quartz. The presence of fibrous structure within the stone may yield 'star-rose quartz' with proper cutting and polishing.

Yellow quartz, also a massive variety, occurs overseas, principally in Africa, but is yet unknown in Australia.

Aventurine, another massive type, has a spangled appearance as a result of the inclusions of mica or metallic substances. It may be reddish yellow, green or brown.

Star quartz and *cat's-eye quartz* are not always easily recognizable in their natural state, being of extremely fibrous composition and depending upon the skill of the lapidary and the manner in which they are cut for the characteristic effects they exhibit.

Crypto-crystalline (Micro-crystalline) Quartz

The crypto-crystalline varieties do not crystallize in the form of noticeable hexagonal crystals but are usually in lumps, broken masses and rounded or elongated nodules. No crystalline form can be seen with the naked eye, because the structure is so minutely formed as to be visible only under strong magnification. In appearance and feel these varieties are usually wax-like, quite unlike crystalline quartz, which has a hard feel and a glassy appearance. Crypto-crystalline quartz may generally be classed into three types:

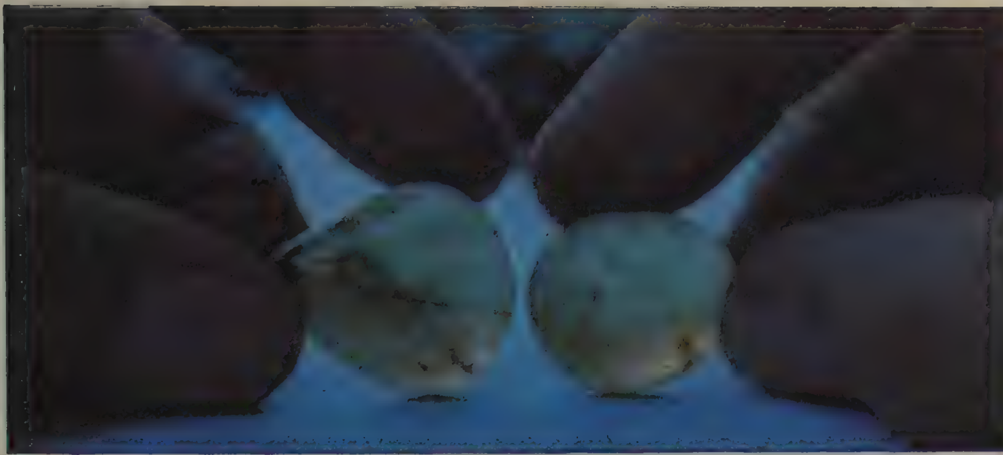
1. Chalcedony.
2. Agate.
3. Jasper.

There is really little distinction between chalcedony and agate, the structure and chemical composition being the same, but the term agate is broadly applied to those varieties of chalcedony which have bright colours, containing variegated patterns of bright or contrasting colours or definite markings, whilst those varieties which are of one rather pale colour throughout, with no pattern or with only dull variations, may be called chalcedony.

Chalcedony. Included under the heading chalcedony are the following:

Chalcedony	Colourless, grey, milky, white, without banding or with faint bands of these colours. *Pale blue*: Blue chalcedony. *Pale green*: Green chalcedony.
Iris chalcedony or iris agate	Lacks colour as does normal chalcedony, but when sawn into wafer-thin slices and polished exhibits a rainbow effect in the spaces between the layers. Any colourless chalcedony is potential iris agate before cutting, but it has been estimated that less than one in 10,000 specimens of chalcedony contains the rainbow or iris effect.
Carnelian	Red, orange or flesh-coloured chalcedony with or without faint bandings of these colours. May be classified as an agate.
Sard	Deep cherry-red or brownish-red chalcedony. May also be classified as an agate.
Chrysoprase	Bright, apple-green chalcedony. When uniformly coloured in this distinctive shade, the rarest type of chalcedony.

Agate. There are many sub-varieties of agate, the names of some of which are derived merely from the locality in which they are found or from their resemblance to some object. This system of naming lends itself to an interminable list of minor varieties and is quite confusing and misleading, especially to

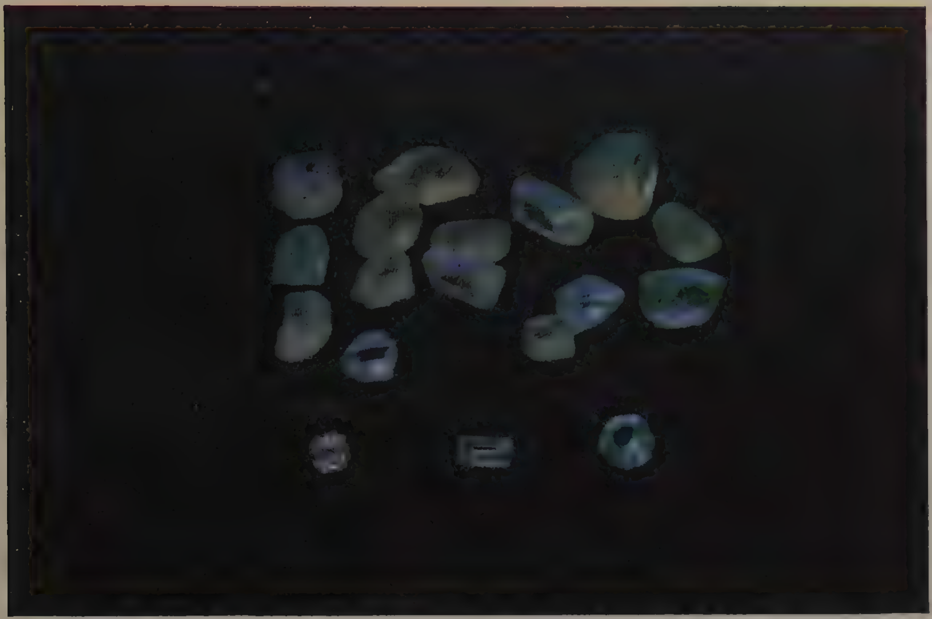


Above: Cut and polished grass-stones

Below: Quartz crystal group

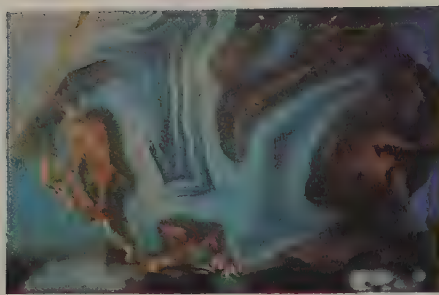
Quartz specimens courtesy Trustees, Australian Museum, Sydney

Some Australian Gemstones
Top left: Polished banded agate. *Centre left:* Opalized crystals. *Bottom left:* Polished opal. *Top right:* Black tourmaline (schorl) crystals. *Centre right:* Broken agate nodule with crystalline centre. *Bottom right:* Green fluorite (fluorspar)



Above: Rough and faceted topaz

Below: Rough specimen and two cabochons of chrysoprase
Specimen courtesy Trustees, Australian Museum, Sydney



Polished agate nodule
Specimen courtesy V. I. Gan-Timur

Queensland chrysoprase

Opals from Lightning Ridge, Coober Pedy and Andamooka
Specimens courtesy E. Gregory Sherman, Sydney

the new gemhunter. The list below is a general one and will allow classification of most of the agates found in Australia. If the gemhunter then wishes to adopt a special name for one of his pet agate specimens, he may do so.

Banded agate	Agate containing concentric, circular or elliptic bands of almost any colours.
Brecciated agate	Agate containing small, sharp pieces of broken agate ('breccia'), cemented together as a whole.
Fortification agate	Agate with zigzag parallel bands of colour resembling battlements on an ancient fort.
Eye agate	Agate with oval rings and contrasting colours, resembling an eye. On occasions, the resemblance can be quite startling.
Inclusion or moss agate	Agate with internal markings some of which, when cut, resemble trees, bush scenes, etc.
Sardonyx	Agate with red and white or brown and white straight bands or layers.
Plume agate	Agate with internal markings resembling, when cut, flowers or feathers.
Onyx	Not the dyed black stone of the jeweller, but agate with alternate straight black and white bands or layers.

Jasper. Jasper is an impure form of crypto-crystalline quartz which may be found in pieces or as great boulders or masses. In appearance and feel it is somewhat like chalcedony (greasy or waxy), but it usually assumes darker shades, such as brown, red, green, black, or blends of these colours. It may also be striped (ribbon jasper), banded or mottled. Sometimes, jasper grades imperceptibly into agate, when it becomes 'jasp-agate'. It may also assume a form somewhat like chert.

Bloodstone (or *heliotrope*) is a green jasper with red spots, resembling blood.

Lydianstone is a velvety, black jasper.

Non-crystalline (Amorphous) Varieties

Prase	A dull leek-green amorphous quartz.
Plasma	A dark-green amorphous quartz.
Flint	An opaque form of pure, amorphous quartz of dull colours of grey, etc. Its property of fracturing with a sharp edge enabled the manufacture of knives and spear heads in prehistoric times.
Chert	Classified as an impure form of flint.
Quartzite	The result of metamorphosis, whereby sandstone has been altered into this tough, compact rock. It may be of many colours such as red and yellow (the miners' 'butter-stone') and, when banded, makes an attractive gemstone.
Obsidian	Volcanic glass without any crystal structure whatever; usually black, although it may be colourless or greenish.

Pseudomorphs

Pseudomorphs ('false forms') are the result of silica infiltrating into casts left in rocks or of the replacement of gradually decaying material.

Petrified wood	Wood which has been replaced, atom by atom, by silica until the original timber has become virtually stone, often retaining its original structure.
Opalized wood	Similar to petrified wood, but with the original material replaced by common opal

Tiger-eye	Actually silicified asbestos, the crocidolite (asbestos) having been replaced by silica; the various resulting colours are caused by iron oxides.
Jasperized wood / Agatized wood	Wood which has been replaced, in the manner of petrification, by jasper or agate.
Pseudomorphs	Chalcedony and agate may replace easily dissolved minerals (calcite, fluorite, etc.) and assume their shape, resulting in true pseudomorphs.
	Fossils and fossil casts may undergo the same process, excellent examples of which are the opalized bones and shells of the Australian opal-fields.

Opal

For very many years, opal was thought to be simply an amorphous form of quartz and various theories were advanced to explain the 'flash' peculiar to it. However, the opinion now is that it actually contains small crystals of a high-temperature quartz known as 'cristobalite'. Opal, therefore, should not be scientifically included with the categories of normal crystalline, crypto-crystalline or amorphous quartz. It is discussed in the next chapter.

Oddities

Reference is often made to 'geodes' and 'thunder eggs'. These have a particularly pleasing appearance when neatly broken or sawn as display specimens.

Thunder egg is a term of American origin, referring to the volcanic birth and appearance of the specimen, and has been generally accepted in Australia. When cut or broken across, thunder eggs resemble eggs, the agate centre resembling the yolk and the outer layers the white. They are actually agate-filled nodules, the outside consisting of claystone, rhyolite or similar rock material. Thunder eggs are also called 'spherulites' and sometimes exhibit a remarkable star-shaped centre.

Geodes are nodules of agate or rock containing hollow centres lined with quartz or amethyst crystals. Some of these show attractive bands of agate in the outer layers, with sparkling crystals lining the hollow centre. Both thunder eggs and geodes are found over a wide area in Australia, especially in the eastern border country of New South Wales and Queensland, and are eagerly sought after by collectors as display pieces.

Sometimes pieces of agate or chalcedony will be seen to contain bubbles of water or gas in cavities. These are called enhydros' and are valuable additions to a collection.

Opal in Australia

Composition: A hydrated silica, $SiO_2.nH_2O$ (silicon dioxide with a number of molecules of water).
Hardness: $5\frac{1}{2}$ to $6\frac{1}{2}$.
Specific gravity: 1·9 to 2·2.
Lustre: Vitreous or resinous.
Fracture: Conchoidal.

The characteristics of the various types of opal are as follows:

Hyalite:	Clear, glass-like, in small globules.
Common opal:	
Wood opal	Wood which has undergone a petrification process in which the wood has been replaced by common opal, often retaining the original structure of the timber.
Resin opal	An opaque common opal of a resinous appearance, which may be in shades of brown, black, black-brown, etc.
Wax opal	Similar to resin opal, but with a waxy appearance or feel.
Pitch opal	Similar to resin opal, but of a black, pitchy appearance. There is some, but little, distinction from resin opal.
Opalite	A green or yellow-green common opal, which may be of one colour, be striped, or have black spots or fern-like inclusions.

Moss opal	A lighter-coloured common opal, which is translucent, and may be light green, light blue, yellow, etc., with inclusions resembling moss.
Potch	A common opal found with precious opal, but of a black or deep-blue colour. It is valueless as a gemstone but is used for backing opal 'doublets'.
Precious opal:	
Hydrophane (water opal)	Opal which becomes more transparent in water, sometimes almost invisible.
Flash opal	Opal with sudden flashes of brilliant colours.
Black opal	Precious opal with a grey or black background, which has the effect of accentuating the display of colour in the stone.
Milk opal	Opal with brilliant colouring on a white, milky background.
Fire opal	Transparent opal of red, orange or amber colouring showing no flashes but relying upon its body colour for its effect. The Mexican fire opal is the most brilliant, but fire opal is also found in Australia.
Pin-fire opal	Opal containing very small but brilliant pin-spots of colour.
Harlequin opal	Opal containing small patches of changing colour arranged in rectangular patterns as in the costume of a harlequin.
Opal matrix	Ironstone with thin veins or flecks of precious opal.

Opal has, at various times, been the recipient of many descriptions, some of which have been rapturous beyond belief, especially by some of the ancients who flew into ecstasies whenever opal was mentioned. But perhaps the most apt, and most sensible, was applied to it by T. C. Wollaston, who simply called it the 'gem of the Never Never'. For it is as truly Australian as the term Never Never, and Wollaston himself, having often endured the most incredible privations in his search for opal, was well able to see that Nature had deposited the best stuff well out of reach in the desert regions.

Although other countries have produced opal—some many centuries before Australia was even discovered—the staggering quantity of breathtaking opals mined in Australia has completely eclipsed the efforts of all other countries and made opal virtually Australia's national gem. Other lands may proudly claim famous diamonds or rubies or emeralds as their own. Australia's contribution to the world of gems is a long list of famous opals, headed by the huge 'Olympic Australis', measuring 10 inches by 5½ inches by 5 inches, and weighing 127 ounces, probably the largest mass of gem opal in existence. And yet this remarkable gem waited until 1956 for the gouger's pick to bring it to light. Who knows what other great opals still await discovery?

As mentioned in the previous chapter, opal had long been regarded as an amorphous (that is, without crystal form of any kind) hydrated silica, containing as much as 14 per cent of water in some types. However, research in the 1930s seems to point to the fact that it actually contains microscopic crystals of a silica known as cristobalite. There has been some controversy for many years on the cause of the play of colours in the opal, and it is now thought that the white light striking it is dispersed into colours by layers of alpha-tridymite and beta-cristobalite, of slightly variable refractive indices.

Opal is an example of a soft gemstone which, because of its unparalleled beauty, has all the value of a much harder and more durable stone. An opal should be handled with great care, since it may easily become abraded, even by contact with ordinary dusts, and its porosity causes it to absorb greases and oils readily. It will not stand heat, even during cutting and polishing.

But all the care that has to be lavished on it is compensated for by the fact that the owner of a fine opal is fortunate indeed. It cannot be made synthetically, having defied all efforts to produce it in the laboratory. And good opal is becoming scarce; most of us would be quite happy to have the opal rejects the early buyers used to throw into their candle-box as inferior.

The first discovery of opal in Australia is now generally conceded to have been at Angaston in South Australia before 1849. Why the finder, Mingaye, did not persevere with the deposit is a mystery, especially as he was a geologist and would have known something of its value. However, we hear no more of opal until two discoveries were made in Queensland in the same year, 1872, at Listowel Downs, near Adavale, and at Springsure.

The Queensland discoveries resulted in the opening up of vast opal-fields stretching from Kynuna, north-west of Winton, to Hungerford, on the border of New South Wales, an area 550 miles long by 250 miles wide. The Bull Creek field followed in 1885; then came Opalton (1888), the Paroo field (1893), Kynuna (1894) and Karoit (1897). The potential of the new opal industry impelled a Mr Bond to form a company in 1878, combining the Aladdin mine on the Kyabra field with eight other leases. The industry, however, was short-lived and the total production up to 1901 was worth only £131,000, a small amount when compared with the value of the yield of White Cliffs in New South Wales field and, later, of the fields in South Australia. (White Cliffs produced £140,000 worth in 1902.)

Some of the Queensland opal occurs in a manner quite distinct from that of the opal found in other areas. As well as the usual sedimentary type, there occurs 'boulder opal', nodules of sandstone-ironstone mixture containing precious opal. The Yowah district produces yet another type of occurrence: the opal is contained as a kind of kernel in small concretionary ironstone boulders, known as 'Yowah nuts'.

The Queensland fields' short life came slowly to a close with the disastrous drought of 1896 to 1902. The scarcity of feed for horses and the lack of water for the miners gradually made the country quite uninhabitable. Most of the miners left the field and never returned. Those who did not go droving or get other work probably found their way to the less arid opal-fields of New South Wales. The Queensland fields have now lain neglected for more than sixty years and, apart from sporadic fossickers, have attracted few prospectors during that period. But they are not worked out. Such a vast area is known to contain opal and such a small portion of it has been worked that there is no doubt that, with modern facilities and sufficient water, there is still a great deal of opal to be won.

Meanwhile, the New South Wales fields had been developing since the discovery of opal at White Cliffs in 1884. This field has been a constant producer since that year and thus may be regarded as the oldest operative opal-field in Australia. In the year 1901 there were over 900 men working on the White Cliffs field. However, rich as was White Cliffs, it was soon to be overshadowed by the newly found Lightning Ridge.

Although opal was noticed in the Lightning Ridge area during the 1880s, little importance was then attached to it, the stone not being recognized as being of commercial value. It was left to Charlie Nettleton to actually discover the field in 1902 at what is now known as the Six Mile. This was probably the most important incident in the history of gem-mining in Australia, for it was at Lightning Ridge that black opal was first found. This new type of opal did not achieve popularity without some opposition from the gem trade. The buyers were evidently a little cynical about it, having been accustomed to the lighter-coloured stone from other fields. This attitude was reflected by E. W. Streeter in *Precious Stones and Gems* (1892):

Under the name of Black Opal, a stone appeared a few years ago on the market and, like anything new, was eagerly sought after and attained a high commercial value. Certainly the colours are very lovely in these specimens yet how they acquire their blackness and deep tints is questionable. *Some other hand than unassisted nature may have been at work.*

As late as 1908 S. B. J. Skertchly wrote in his *Story of the Noble Opal*: '. . . the Black Opal, rare and matchless as of yore, is valued at much less than its recognised brother.'

However, its unique beauty and its eventual acceptance by the trade as a gem formed by 'unassisted nature' soon made the black opal a recognized feature of the world of gems. In 1904, £1,000 worth of Lightning Ridge opals were sold and men poured onto the field; by 1909 there were 800 miners at the Ridge in search of the gem. The output began to climb —to £40,000 in 1909, £46,200 in 1910, and £57,300 in 1911. The total value of opal mined on the field to date is well over £500,000, but today the Ridge is receiving attention from only a handful of miners. Little new work seems to have taken place for many years, most operations being confined to the picking-over of existing dumps for stones that may have been previously overlooked, or to the digging of drives from existing shafts. Production in 1962 was valued at £100,000. It is generally considered by authorities on opal that a great deal of stone is yet to be won from Lightning Ridge, since the mined portion of the opal-bearing country is extremely small.

Australia has been exceedingly fortunate that she possesses such vast areas of opal country so that, when one field peters out another is discovered to enable the good work to be carried on.

As the Lightning Ridge field gradually declined, a new strike was made at Coober Pedy in South Australia in 1915. This field has continued to be worked until the present time and now is extremely productive. The more recent discovery (1930) of the Andamooka field in South Australia has helped to provide a further stimulus to the opal-mining industry in Australia. Production from the South Australian fields, of which approximately 65 per cent comes from Coober Pedy, is increasing rapidly, and in 1963 accounted for 90 per cent of the production for the whole of Australia, worth £1,268,456. During the last quarter of 1963 production from the South Australian fields was at the rate of £3,250,000 per annum.

In Western Australia the discovery in 1904 of an isolated occurrence of precious opal near Coolgardie did not have any sequel, although it was reported at the time that the opal was of good quality. Attractive common opal has been recorded from many localities in Western Australia.

Opal has also been reported from several localities in Victoria, but from descriptions it appears to be a type of common opal. Only common opal has been reported from Tasmania.

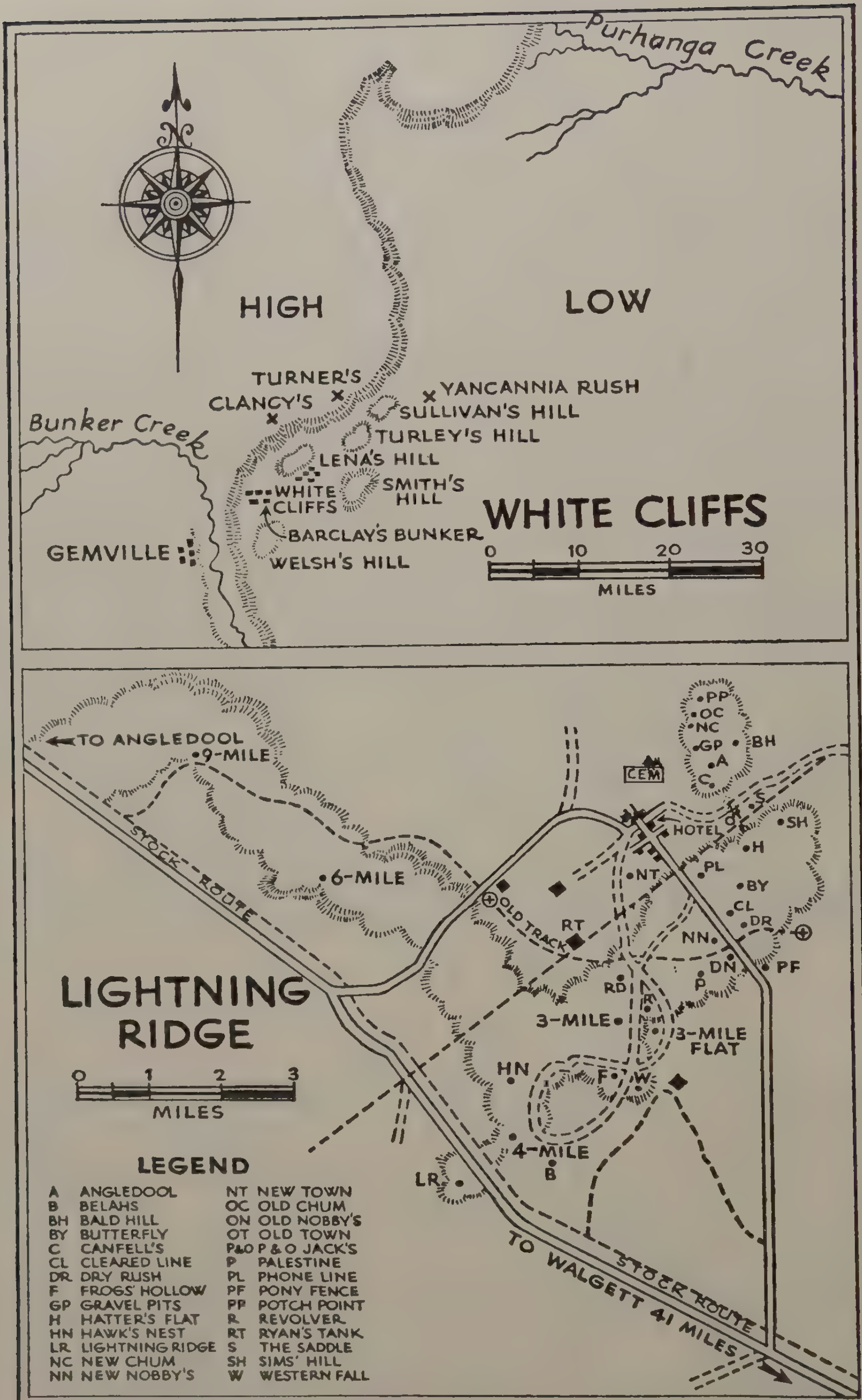
Opal was discovered in 1901 at Tintenbar, about 7 miles from Ballina on the Richmond River in New South Wales. This was in the form of loose pieces in the red soil of the hillsides, or in decomposed basalt. The opal was of two types, an orange transparent variety similar to the Mexican fire opal and a type of black opal, distinguishable from the Lightning Ridge stone. Opal was also found in cavities in a decomposed volcanic rock at Teven, about one mile from Tintenbar. Mining commenced in 1919, but ceased a few years later and no further record is available of ensuing production.

The opal-fields of New South Wales, South Australia and Queensland will now be considered separately, with particular attention to the location of the individual mines and diggings.

NEW SOUTH WALES FIELDS

White Cliffs

The White Cliffs field is situated in the north-west of New South Wales near the town of White Cliffs, 67 miles north-north-west of Wilcannia and 125 miles north-east of Broken Hill. Since commercial production began in 1890, the field has produced about £1,200,000 worth of opal and, in its day, could be regarded as the foremost opal-producer in Australia, if not the world. Its peak year was 1902, when, as mentioned earlier, opal to the value of £140,000 was mined from the area. However, since the early 1930s, the yield has dropped



The opal-fields of White Cliffs and Lightning Ridge

(With acknowledgments to A. MacGregor's maps in The Opal Book, *by Frank Leechman)*

considerably, probably because of the disappearance of the old, original miners and the obvious attractions of the newly discovered South Australian fields.

The opal on this field occurs in veins in the fine-grained sandstone at a depth of up to 40 feet, under a capping of grey, hard quartzite ('shin-cracker'), and alternating with layers of clay and sandy materials.

The main mining area is in the vicinity of the town of White Cliffs and the old mines are as follows:

The Blocks area	¼ m. NW. of White Cliffs post office. (Large area about 1½ m. by ¾ m.)
Sullivan's Hill	Adjoining The Blocks to the east.
Moffat's Hill	½ m. NE. of The Blocks.
Clancy's	6 m. N. of White Cliffs post office.
Turley's Hill	¼ m. E. of White Cliffs post office.
Smith's Hill	1¾ m. S. of White Cliffs post office.
Lena's Hill	¾ m. SW. of White Cliffs post office.
The Bunker field (Gemville)	12 m. SW. of White Cliffs via Whipstick or Tarella station.
Barclay's Bunker	8 m. SW. of White Cliffs.
Welsh's Knob	9 m. S. of White Cliffs, near Wilcannia road.
On plateau	5 m. W. of Purnanga homestead, 30 m. NNE. of White Cliffs.

As well as on the main White Cliffs field, precious opal has been found in several localities over a wide area, corresponding roughly with the edge of the artesian basin; these localities may be regarded as forming an extension of the White Cliffs area. They are:

Milparinka	150 m. NW. of White Cliffs.
Tibooburra	120 m. NW. of White Cliffs.
Brewarrina	86 m. W. of Walgett.
Yancannia	50 m. NW. of White Cliffs.

Lightning Ridge

The Lightning Ridge field, in the north-west of New South Wales, has probably the most romantic background of all the Australian opal-fields—it has been the subject of several books —and, although not as old as the White Cliffs discovery, seems to have a staying power all of its own. It can truly be regarded as the home of the fabulous black opal, for who can think of black opal without bringing to mind the 'Ridge'?

The township itself is 36 miles north-north-west of Walgett and may also be approached from Collarenebri.

On this field the opal 'dirt' is the real matrix of the opal. There is a series of bands called 'levels', 2 feet or more thick, at various depths. As many as four such levels have been encountered at shallow depths, each containing opal near the roof of the level. This hard roof is called the 'steel band', and occasionally the entire level has been tipped on its side so that it is almost vertical.

The most valuable opals occur as nodules ('nobbies'), which are snipped to show the colour within. A large proportion of nodules, however, contain sandstone or worthless opal.

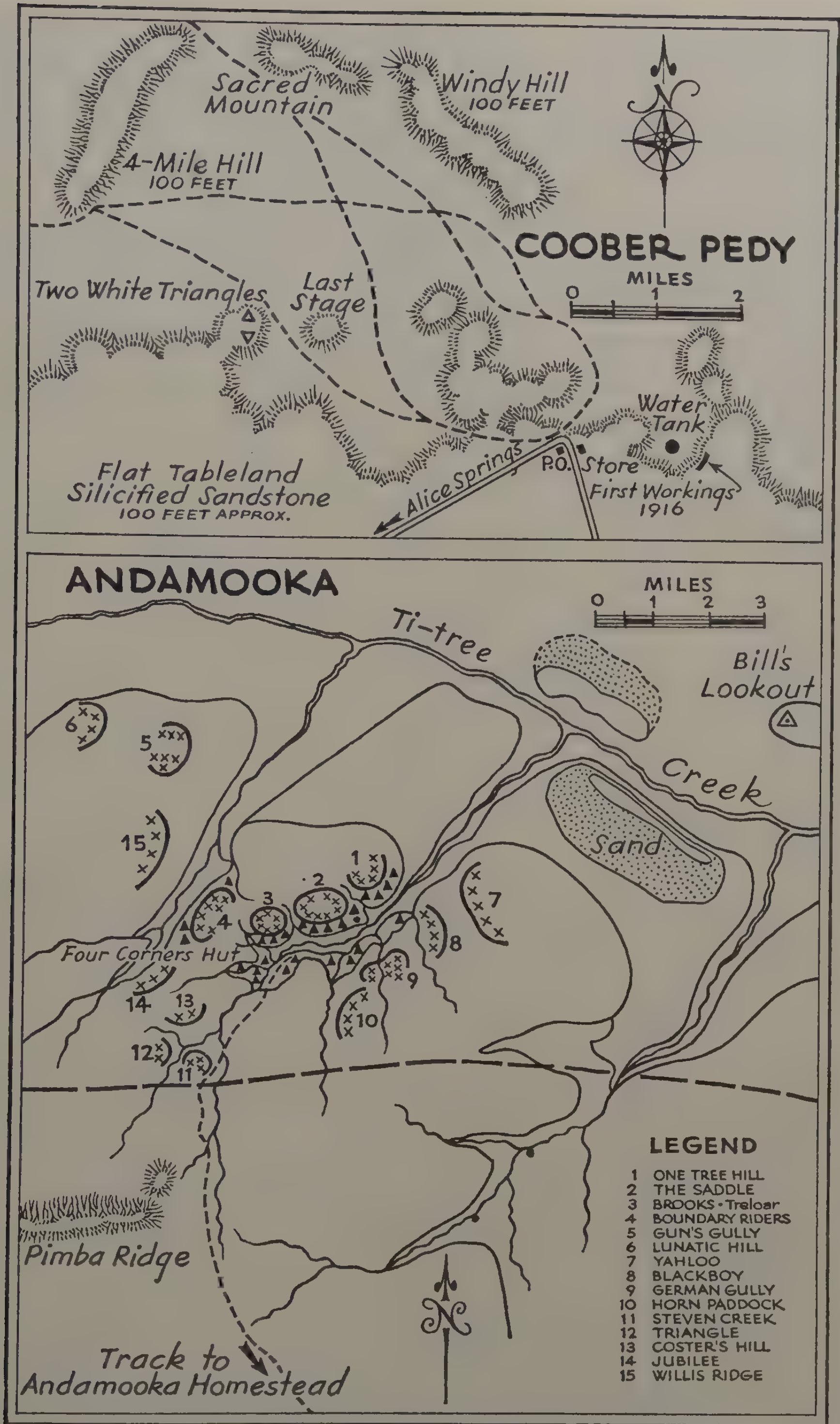
For a number of years the hundreds of old heaps alongside the shafts have been turned over in a search for opal previously overlooked ('noodling'), and many fine opals have been found in this way.

Many of the earlier miners simply drove straight shafts and made no attempt at driving outwards from them, so that if opal were not found in the shaft it was abandoned. Sometimes, newcomers who persevered by gouging out into the surrounding dirt were rewarded by fine opal.

SOUTH AUSTRALIAN FIELDS

Coober Pedy

The Coober Pedy field in South Australia is one of the last discovered opal deposits and, since its first production in



The opal-fields of Coober Pedy and Andamooka

(With acknowledgments to A. MacGregor's maps in The Opal Book, *by Frank Leechman)*

1916, has yielded opal to the value of many hundreds of thousands of pounds. Unlike some of the older Australian fields, it has shown an increasing production in recent years.

The area, however, is extremely arid and, in an attempt to overcome the shortage of water, a huge tank was built in 1924 to hold half a million gallons. Even this enormous reservoir is not always sufficient and occasionally runs dry or has to be cleaned. Water is then transported to the field from distances of up to 80 miles. Visitors are therefore warned not to rely upon obtaining unlimited water supplies when they arrive on the field and to take with them as much water as possible for their own requirements. The local progress association, however, is often able to supply water at a nominal cost per drum, to cover transportation charges. There are a number of stores at Coober Pedy, including a butcher's and a baker's, so that provisions are not a problem. As well, a plane service is available from Port Augusta and Adelaide.

The field itself is in the Stuart Range about 370 miles (by road) north-north-west of Port Augusta, 125 miles north of Tarcoola, and 95 miles west of William Creek (on the Central Australia Railway).

Because of the extreme heat, especially in summer, many of the miners live in dug-outs rather than in huts on the surface, and this habit has probably been the origin of the name of the area, which means 'white fellow's burrow' in the local aborigines' tongue. The great heat virtually brings operations to a halt during the summer months, and newcomers should consider very carefully before planning a journey to Coober Pedy at that time.

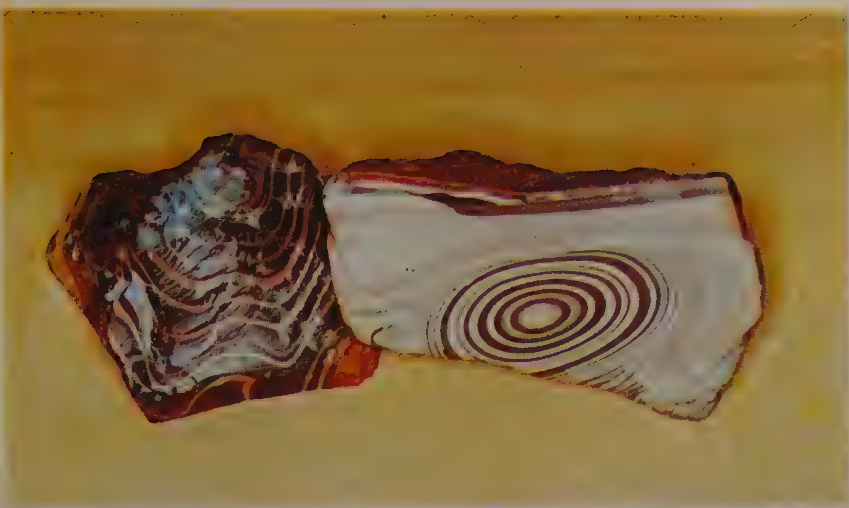
The opal is found in similar circumstances to that at White Cliffs, as seams in an iron sandstone overlain by layers of clay, quartzite and worn, rounded pebbles.

The actual mining area has a diameter of probably 15 miles, including what are known as the Three Mile Workings, the Five Mile, the Eight Mile, etc. Recently operations have been extended to The Granites, about 100 miles north of

Agates from Agate Creek, one of the best hunting grounds in the world
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Jasper. This variety is the rarer pink jasper and comes from the Jasper Farm in Queensland
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

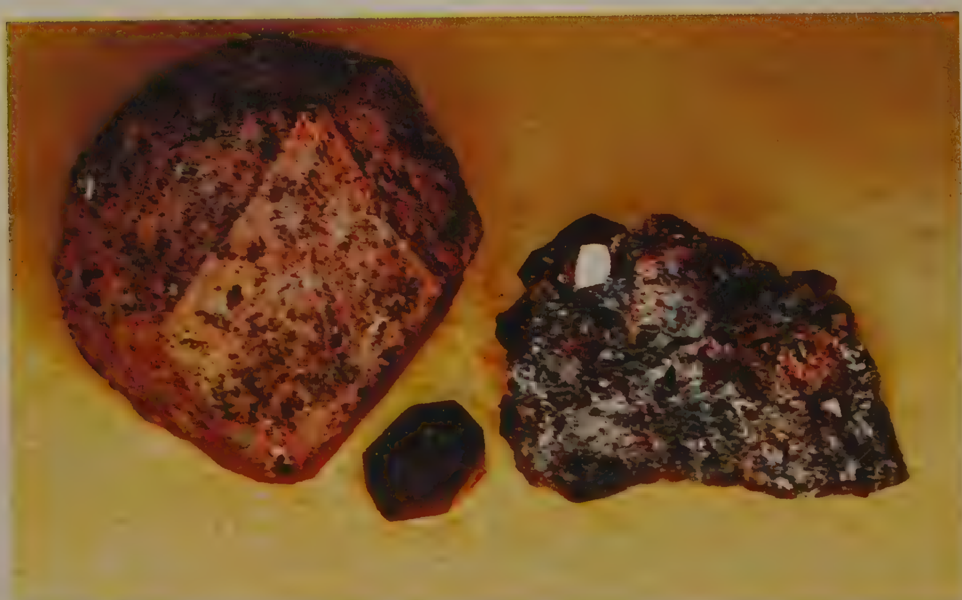
Turquoise, a unique gemstone. This specimen was discovered at Tennant Creek
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz



Jasper pebbles can be picked up on Australian beaches and in creeks, but these marked pieces called 'Ribbonstone' are not so easy to find. They come from Anthony's Lagoon in the Northern Territory
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Opalite (common opal), widely used in jewellery. Found in most Australian States
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

A perfect pyrope garnet crystal from Broken Hill
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz



Garnets. When not suitable for faceting they are used as abrasive agents
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Coober Pedy, and therefore it does appear that the opal-bearing deposits in this field are extensive and have yet to be defined.

In 1964, over 800 men were engaged in opal-mining on the field, and for a number of years most of the old heaps have been noodled for opal of all grades, even down to a low grade of 'potch with a bit of colour'; the prospects of finding opal by picking over old dumps are therefore now extremely limited.

However, for the serious miner who is willing to sink a shaft in new ground, the Coober Pedy field offers practically the best prospects of any opal locality in Australia. Fine opal is being constantly won and being as quickly snapped up by the gem-buyers, operating on behalf of Australian and overseas firms.

Andamooka

The Andamooka opal-field in South Australia is the most recently found of the Australian deposits, having lain undiscovered until as late as 1930. Like so many rich fields in this country, it was discovered by accident, by station hands from the nearby Andamooka homestead during a heavy rainstorm. Unlike some other discoveries, however, it was recognized immediately for what it was and steps were taken to develop the find. When the secret leaked out more prospectors flocked to the field and production began to climb. The value of opal won to 1957 was over £500,000, and in 1964 there were about 2,000 people in the area; not all of them, however, were engaged in actual prospecting or mining.

The field is situated north of Andamooka homestead and about 8 miles west of the northern end of Lake Torrens in the area south of Ti-tree Creek, which runs into Lake Torrens.

The precious opal is found amongst a conglomerate, as seams in a clay and as a coating on boulders, overlain by clay, shale, quartzite, sandstone and worn loose stones.

The field is the smallest in Australia, covering only about

16 square miles, but, since precious opal has been mined some distance away from the centre, it is reasonable to assume that future prospecting will reveal payable stone in other extended areas in the district.

QUEENSLAND FIELDS

Kyabra Opal-field

Centre of field: About lat. 26°20′S., long. 142°50′E. This field lies north-west of Eromanga, which is 64 miles west of Quilpie.

Yowah Opal-field

Centre of field: About lat. 27°59′S., long. 144°34′E. The Yowah field is part of the Cunnamulla mineral field and lies 28 miles west-north-west of Eulo.

Karoit Opal-field

Centre of field: About lat. 27°40′S., long. 145°25′E. Lying 34 miles north-north-west of Cunnamulla, this opal-field is also part of the Cunnamulla mineral field.

Fiery Cross Opal-field

Centre of field: About lat. 27°40′S., long. 144°25′E. This field lies outside the Paroo mineral field, 80 miles north-west of Cunnamulla and 12 miles west of Dundoo station.

Duck Creek Opal-field

Centre of field: About lat. 27°25′S., long. 144°40′E. The Duck Creek field is part of the Paroo mineral field and is situated on Yowah Creek, 40 miles north of Yowah and 58 miles north-west of Eulo.

Erounghoola Field

Centre of field: About lat. 26°40′S., long. 142°43′E. The mines on this field lie west of Eromanga.

Quart Pot Field

The Quart Pot field lies north of the Erounghoola field and north-west of Eromanga.

Bull Creek Opal-field

The mines on this field lie north-west of Quilpie.

Jundah Opal-field

The Jundah field is part of the Opalton mineral field and lies 130 miles south-west of Longreach or 170 miles west-south-west of Blackall, via Yaraka.

Opalton Opal-field

This field, which is in the Opalton mineral field, lies round the township of Opalton, 60 miles south-south-west of Winton.

Kynuna Opal-field

The township of Kynuna lies 90 miles north-west of Winton. The opal-field is part of the Windsor mineral field.

Paroo Mineral Field

Between lats. 27° and 28°S., longs. 144° and 145°E.
The field extends 75 to 95 miles west-north-west to north-west of Cunnamulla.

The Diamond

Composition: Carbon (crystallized).

Crystallization: Octahedral (eight-sided) and isometric.

Hardness: 10.

Specific gravity: 3·52.

Lustre: Adamantine.

Colours: Colourless, pale yellow, pink, orange, green, brown, blue, black.

Cleavage: Perfect.

Occurrence: In ancient drifts and river gravels or in decomposed volcanic 'pipes'.

Locations: India, Brazil, Union of South Africa, (Belgian) Congo, South-West Africa, Ghana, Sierra Leone, French Equatorial Africa, Southern Rhodesia, Tanganyika, Borneo, New South Wales, Queensland, Victoria, Tasmania, South Australia, Western Australia, British Guiana, California, Great Lakes region of U.S.A., Venezuela, Honan Province (China), Ural Mountains (U.S.S.R.), Siberia.

The diamond is the hardest natural substance in existence, but—and here we see Nature playing one of her many mineralogical tricks—it is basically nothing but crystallized carbon, one of the softest of materials! Exactly how this has come about is still something of a mystery, but it is known that extreme pressures and intense heat have been responsible. In fact, it has been estimated that pressures of 3,000,000 pounds per square inch and temperatures of over 7000°F. are necessary to crystallize carbon into diamond. Such pressures would occur at a depth of about 240 miles beneath the surface of the earth. In 1955 diamonds were first synthesized in a huge press that operated under comparable temperatures and pressures.

The diamond is generally regarded today as the most prized gem. But it was not always so, for, in ancient times, the emerald and ruby were held in far higher esteem. The diamond in its raw state bears little resemblance to the flashing stone with which we are so familiar, and this especially applies to those diamonds recovered from alluvial gravels. They are generally of a greasy appearance and are often coated with a dirty skin-like substance, revealing none of the scintillating beauty of a cut diamond. The 'Cullinan' diamond of 3,106 carats, the largest ever found, appeared so drab before cutting that King Edward VII, looking at it, observed that he would have kicked it aside as a lump of glass if he had seen it on the road!

Emeralds and rubies, with their rich green and red hues, were thus much more desirable in the days before the advent of skilful cutting and the discovery that diamond would cut diamond. Prior to this, only crude attempts could be made to shape and polish this extremely hard gemstone, and even then the result was usually a stone of much the same shape as the rough original. The invention of the brilliant cut, scientifically calculated from the optical and physical properties of the gem, enabled the diamond-cutter to impart to the stone its maximum brilliance and lustre.

Although expensive, diamond is not the rarest of gemstones. Several tons of stones are produced annually from mines throughout the world, mainly in Africa, a figure far greater than, for instance, the output of sapphires, although it should be remembered that, because of the great industrial value of diamonds, prospecting and mining are carried out on a very large scale. All the diamonds mined are not of gem quality, and it might therefore be thought that they would cost less. But the sale of diamonds is so rigidly controlled that only sufficient are released to cope with current demand, with no risk being taken of over-supply and a drop in market value. The extreme hardness of diamond, necessitating specialized slow and painstaking cutting techniques, also contributes to the ultimate high prices of cut gems. The brisk demand for diamonds of inferior size and grade for industrial use of all kinds has resulted in a high price also being maintained for stones which, in other days, would probably have been discarded as valueless. Despite the high annual yield, the world is thus still hungry for diamonds, both for adornment and for industrial use.

Before the discovery of the New World, all the diamonds in existence originated in India. The most famous stones of ancient times were Indian diamonds and, although some of these are no longer known, they must necessarily still be in existence, perhaps re-cut or transformed into smaller gems.

The Indian monopoly of diamond production, held for many centuries, came to an end with the discovery of stones of exceedingly high quality in 1727 in the Diamantina Province of the state of Minas Gerais, Brazil. But this was in the days before diamond control, and the abundance of the gems in the new discoveries soon resulted in a slump in values. The position became gradually worse as more diamonds were discovered in other parts of Brazil until action was taken by the Government to curb production and sales to stabilize prices. These new Brazilian deposits soon loomed as a threat to the controllers of the Indian market, and for quite a number of years it was suggested by these interests that the Brazilian diamonds were not Brazilian at all but merely low-grade Indian gems!

The Indian diamonds had been found in alluvial deposits in ancient river-beds and also embedded in a conglomerate rock. Although productive for centuries, these mines are now exhausted. In Brazil, the gems occurred in a similar type of river deposit containing gem gravels with pebbles and were also contained in a type of layered rock.

All these fields, however fabulous they had been, were to be overshadowed by the fantastic discoveries in South Africa, which began in 1867 with the curiosity of a Boer lad who wondered about the shiny pebbles lying near the Orange River. After some delay one of these 'pebbles' was identified —it was a fine diamond. Before long the area had attracted thousands of miners, and there was a rapid depletion of the alluvial deposits. However, some fine stones were recovered, including the 'Star of South Africa', of 83 carats, and the 'Stewart', weighing 288 carats. It was realized that the gems probably had a birthplace of volcanic origin, and an intensive search was then begun for likely areas; subsequently diamonds were found embedded in a decomposed material in pipes which are thought to be old volcanic vents. The material near the top of these pipes was of a yellow colour and became known as 'yellow ground'. Below this was a mass of harder material of a greenish-blue colour, called 'blue ground'. All of this volcanic material was found to be diamond-bearing. So extensive are these deposits that they are still being worked today, seventy years after their discovery. The area has yielded more than £500,000,000 worth of diamonds.

The occurrence of diamonds in Australia is discussed in the next chapter.

Diamonds in Australia

To those who are under the impression that diamonds are found only in Africa it may come as a surprise to learn that the king of gems occurs in every State of Australia. From Cape York to Tasmania and from eastern New South Wales across to Western Australia, diamonds have made their appearance, often in the most unexpected spots. Although Nature seems to have scattered them round wildly in most of the States in an effort to confuse us, she has been a little kinder in eastern Australia, by concentrating some of the supply, so as not to discourage the gemhunter completely. These concentrations are in the northern part of New South Wales.

Here, especially at Copeton and Bingara, there were flourishing diamond centres where many thousands of carats of gems were mined and sold at the turn of the century, when market prices were comparatively low. In the peak year (1899) the production from these northern New South Wales fields reached over 25,000 carats, whilst the total recorded production from Bingara and Copeton alone amounted to almost 250,000 carats. Some very fine gems were recovered from these fields and exported to markets overseas. As any gemstone may quickly become anonymous after being handled and cut, there are undoubtedly many Australian diamonds distributed throughout the world, unidentified as such and probably now quite honestly regarded as being African or Brazilian stones.

All of the diamonds found in Australia have been recovered from alluvial deposits as fragments, crystals or waterworn gems. If there are any main diamond-bearing rock deposits they have yet to be discovered. Attempts have been made in New South Wales to locate diamond pipes such as occur in South Africa in an endeavour to find the source of the gem, but so far they have been without success. In 1889 a shaft was sunk in the Ruby Hill area, about 12 miles south of Bingara on the Barraba road, the theory being that it was a volcanic pipe similar to the Kimberley ones. This mine was found to contain masses of rock consisting of garnets and other material which, when examined, proved to be an 'eclogite' rock, which is the actual rock present in the Kimberley diamond pipes. Diamonds were stated to have been taken out of this shaft, but this was never authenticated.

The mining of diamonds in New South Wales was confined to the treatment of old river gravels at Bingara and Copeton and on the Cudgegong River. It is quite probable that pipes may exist in parts of New South Wales, but they may be overlain by later flows of hundreds of feet of granites or basalts, sealing down the deposits and preventing the freeing of further diamonds.

The rough Australian diamonds, to the untrained eye, may easily be confused with topaz, zircon or even quartz, and, in fact, some of the early miners did confuse them. However, to the experienced prospector and gemhunter, a diamond, even when it is a rough waterworn fragment, exhibits certain peculiar properties that distinguish it from other gems. Sometimes it may even have an external 'skin' of more opaque appearance, but underneath this is the hard brilliant look of the diamond which is never forgotten when once seen. For those still in doubt, a diamond will easily scratch a sapphire. These Australian diamonds were once known as 'can-ni-faire' (cannot be cut), an allusion to the alleged superior hardness of the New South Wales stones. There appears to be some controversy on this point, but the late Jules Joris, Australia's foremost diamond authority and cutter, was adamant that the New South Wales stones were harder than others.

The stones may be transparent or translucent in colours of blue, brown, green, orange, red or yellow. Most of those found have averaged about 4 or 5 to the carat, although many of over 1 carat in weight have been found. The largest recorded diamond to come from the New England fields was a 6-carat stone.

Probably the first discovery of diamonds in Australia was in 1851 near Bathurst; at least, this is the first authentic record. Diamonds were then reported from the Macquarie River near Calula Creek, Pyramul Creek and Suttor's Bar. Later discoveries were made in the Cudgegong River, 19 miles north-west of Mudgee, in 1867. These reports might have started a rush to these localities but for the opening of the Bingara and Copeton fields a few years later.

NEW SOUTH WALES FIELDS

Bingara

The Bingara diamond-field had a strange beginning. The story opens with two prospectors, Westcott and McCaw (or McCall), panning for gold in Eaglehawk Creek. Noticing some small, bright stones in the dish, they concluded that they had struck diamonds and decided that, rather than broadcast news of their find, they would say nothing and continue quietly looking for more. But they had not reckoned with economics. Before long, their provisions were exhausted and, in a desperate attempt to keep the field for themselves, these two determined prospectors tried to live off the land by eating possums and all sorts of other native foods. Eventually they were forced, through hunger, to sell some of their diamonds to buy food and the secret was out. A discovery of more diamonds soon after by one Tom Low and his black gin dispelled all doubts about what was to be found in Eaglehawk Creek. The rush began in 1872.

The Bingara field is on the Narrabri–Bingara road, about 5 miles west-south-west of the town of Bingara in the Doctor's

Creek–Four Mile Creek–Eaglehawk Creek area. The old diggings, though now caved in, may still be seen on both sides of the road at this point, on the slopes and hills.

The diamonds are found in gravels, loosely cemented and with a variety of pebbles of quartz, zircon, spinel, garnet, sapphire, topaz and tourmaline. The diamond drift is, at its highest, 60 feet thick, and the gem gravels are from a few inches to 9 feet or more in depth. Most of the diamonds are rounded by wear but some are in crystal form, ranging from clear and transparent stones to straw-coloured and yellow ones.

The Bingara field proved to be a rich one. In the first year of mining 2,370 diamonds were reported whilst from that date (1873) to 1887 it was estimated that 12,000 diamonds were taken from the field.

The most famous and productive mine on the field, the Monte Cristo (sometimes rendered as Christo), was operated by Captain Rogers, who took out, in the year 1892 alone, 2,250 diamonds. The gem gravels in this mine were extremely rich, up to 40 feet in depth, all containing diamonds. One part of the mine became known as the 'Jewellery Shop' because of the extraordinary high yield of diamonds. Captain Rogers was still operating the Monte Cristo single-handed at the age of eighty-five, but then evidently thought it time for retirement, for he shortly afterwards sold his mine to an English syndicate for £5,000. At this time, diamonds were selling from the field at from 4s. to 6s. per carat.

Apparently, up to this time, there was some doubt whether the stones being produced were really diamonds, or perhaps there was some resistance in the trade to Australian diamonds, for the *Queensland Government Mining Journal* in 1900 stated:*

An opinion prevails in commercial circles that the stones from these fields are not diamonds, but a variety of topaz. During last year the

* 15th Oct. 1900, p. 186.

opinion of leading European experts was obtained on a parcel of stones taken from the Monte Christo Mine at Bingara, then owned by Captain Rogers, and were pronounced to be diamonds of good quality, both in hardness and brilliancy.

Another productive working was the Eaglehawk Claim, near Eaglehawk Creek and close to the spot where our two old prospectors found their first diamonds in 1872. Up to 1894 a total of 4,000 diamonds had been taken from this claim.

However, the infant diamond industry continued to be beset by difficulties and the Bingara chapter came slowly to a close. The *Queensland Government Mining Journal*, in the report quoted above, said:

> It is to be regretted that in many cases development work has been retarded by ignorance of the value of these stones and the proper way of obtaining them from the wash, and also from the lack of necessary capital and properly proven claims which gave ample evidence of their value. This latter fault has been largely responsible for the wholesale condemnation of several good claims which, if properly exploited, would be an important factor in the employment of labour and the general prosperity of a large district. Spasmodic attempts have been made to work the mines in the district alluded to but some unfortunate circumstances have always intervened to prevent a thorough test being applied. . . . *An immense area known to contain the wash in which diamonds are found still remains practically untouched* in spite of the fact that, given a fair water supply, the cost of working a diamond claim is not heavy.

The field ceased to produce in 1904, mainly because of lack of capital and of water with which to work the deposits. Attention was now concentrated solely on the Copeton, or Boggy Camp, deposits, 30 miles to the east.

Copeton

The Copeton field had been discovered at about the same time as Bingara, during tin-mining operations, when diamonds were noticed amongst the concentrates. The diamonds here were also found in a drift composed of gravels and sand loosely cemented together, the whole being overlain by a layer of white pipe clay, although sometimes they occurred in a hard, brown band of conglomerate.

The Copeton field is regarded as Australia's premier diamond location. From its first output in 1885 up to 1957, a total production of more than 170,000 carats was recorded. Most of the stones were taken out prior to the First World War; after 1912 the amount declined rapidly to a mere trickle.

In an attempt to publicize the Australian diamond-mining activities and to show the quality of stones being won, some diamonds from Copeton were sent to the Colonial Exhibition in London in 1886. These were from Brown's Crown Jewel mine, probably the first worked on the field, and they consisted of 285 stones weighing $104\frac{5}{8}$ carats. Of these, 280 ranged from $\frac{1}{8}$ to 1 carat and five from 1 to $1\frac{1}{2}$ carats. Evidently they were sufficiently impressive, for W. Davies and R. Etheridge jun. reported in 1887:

> The diamonds of N.S.W. in their physical characters are more nearly allied to those of Brazil than any other country. They have been largely sold in London as such. As regards colour, they differ practically but little from those of other fields. . . . The greater hardness of N.S.W. gems will probably raise the cost of cutting but this will be compensated for by their extra 'brilliancy'.

The quality and source of these stones being known, a rush began to the Copeton area. Soon a large part of the field had been pegged out as claims, and diamonds were being won in quantity. The stones generally were slightly larger than those from Bingara, averaging 3 and 4 to the carat. The largest stone, of $6\frac{1}{4}$ carats, was straw yellow in colour, a broken piece of diamond. From the shape of this fragment, it was estimated that the original gem from which it was broken would have weighed about 15 carats.

The Elliott Diamond Company seems to have had a particularly good run of luck in its operations. In July 1901 it was reported to have won £600 worth of diamonds during three weeks (valued then at about £1 per carat—today about £10!). In August 1901 the same company was reported to have 'recently disposed of 331 carats of diamonds at the rate of 25/- per carat'. In September of the same year, the company sent a parcel of 1,087 carats to the Melbourne head office, the result of three weeks' work. Although a huge quantity of gravels was treated to obtain these results, the yield was often extraordinarily high, ranging from 10 to 15 carats per load.

Other claims abundant in diamonds were the Koh-i-noor mine, Kirk's Hill, Staggy Creek, the Star of the South mine, Mt Ross, and Soldier Hill. At Kirk's Hill it was reported that four loads of washdirt yielded 1,100 carats of diamonds!

However, despite the high yield of diamonds (or perhaps because of it), the returns to the miners began to drop. Diamond prices slumped in the early 1900s and this, together with the scarcity of water necessary for treatment of the gravels, caused a gradual drift of diggers from the field. From then on only intermittent fossicking was carried on until production practically ceased altogether. The total production in the thirty-four years from 1923 to 1957 of just over 4,500 carats represented only a part of the yield of *one* of the former years. Some recent mining operations have been carried out in the area, including a shaft about 200 yards east of the Copeton post office and another driven into a hill a half-mile distant, but it is not known whether any diamonds have been recovered from these workings.

The field extends around the present settlement of Copeton on three sides and along Cope's Creek towards its junction with the Gwydir River. Many of the old diggings are still in existence and yield specimens of quartz crystal, topaz, tourmaline, beryl and an occasional diamond. Although these diamonds are still found by fossickers, it should not be imagined that they are to be picked up from the surface.

There is plenty of gem wash, but it must be treated with a sieve or dish, preferably with water (lack of which has always been a problem), to find the gems. But all the effort is well worth while if the gemhunter is able to display to his incredulous friends an *Australian* diamond he found on the Copeton field.

Cudgegong

This diamond-field, discovered before Bingara and Copeton, never did achieve the fame of its northern counterpart; nevertheless, it received consistent attention and continued producing diamonds long after the other fields had been abandoned. Operations in the area began in 1869, two years after the discovery of diamonds at Two Mile Flat, and continued, on and off, to as late as 1957, thus making the Cudgegong field the last survivor of all the Australian commercial diamond localities.

The diamonds in this area are found in ancient gravels varying in thickness from a few inches to 60 feet or so, and now lying high above the level of the Cudgegong River. The gems are scattered throughout the gravels, and with them are found tourmaline, garnet, topaz, zircon, sapphire, pleonaste and quartz. The main occurrences are at Horseshoe Bend, Jordan's Hill, Rocky Ridge, Hassell's Hill and Two Mile Flat, covering, in all, about 510 acres.

The Cudgegong diamonds averaged 4 to the carat, the largest recorded stone being $5\frac{5}{8}$ carats, whilst another weighed $3\frac{1}{4}$ carats. The actual number of stones recovered is not known, but it has been estimated at 3,000.

The localities where diamonds have been found near the Cudgegong and Macquarie rivers are:

2 m. N. of Gulgong.
Pyramul Creek.
Near Katella station, Burrandong.
Monkey Hill, near Sally's Flat.

Bald Hill, near Hill End.
Pine Ridge.
Muckerawa Creek.
Junction of Cudgegong River and Reedy Creek.

Crookwell

Diamonds were first discovered on this field in the 1880s in an area about 10 miles west-north-west of the town of Crookwell, during gold-mining operations. In the gem-bearing gravels are found also zircons, sapphires and topaz. A revival of interest in the locality took place in 1919, but after 1929 activity ceased. The diamonds recovered averaged 4 or 5 to the carat, with larger stones weighing up to 1 and 2 carats.

Localities for diamonds on this field are:

Potten Creek.
Lost River.
Red Hill, near Wheeo.
Spring Creek.
12 m. W. of Crookwell.

Mittagong

Operations were carried out from 1884 to 1896 at Digger's Creek, a small tributary of the Nepean River, 7 miles south-east of Mittagong. The diamonds recovered were of high grade and up to $2\frac{3}{4}$ carats in weight, and were found in gravels similar to those of the other New South Wales deposits. A few diamonds were also found in the Wingecarribee River in the Mittagong area.

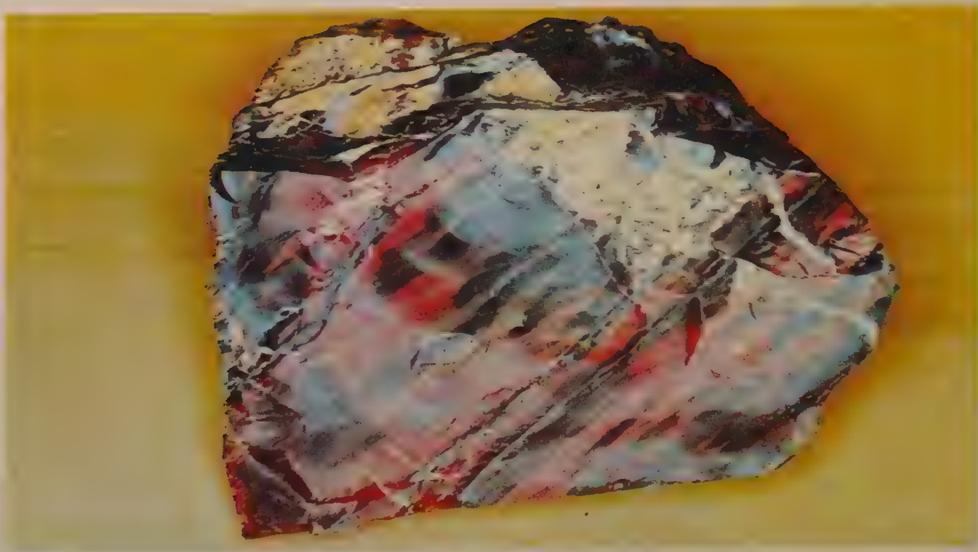
Other New South Wales Deposits

Diamonds have also been reported from the following localities in New South Wales:

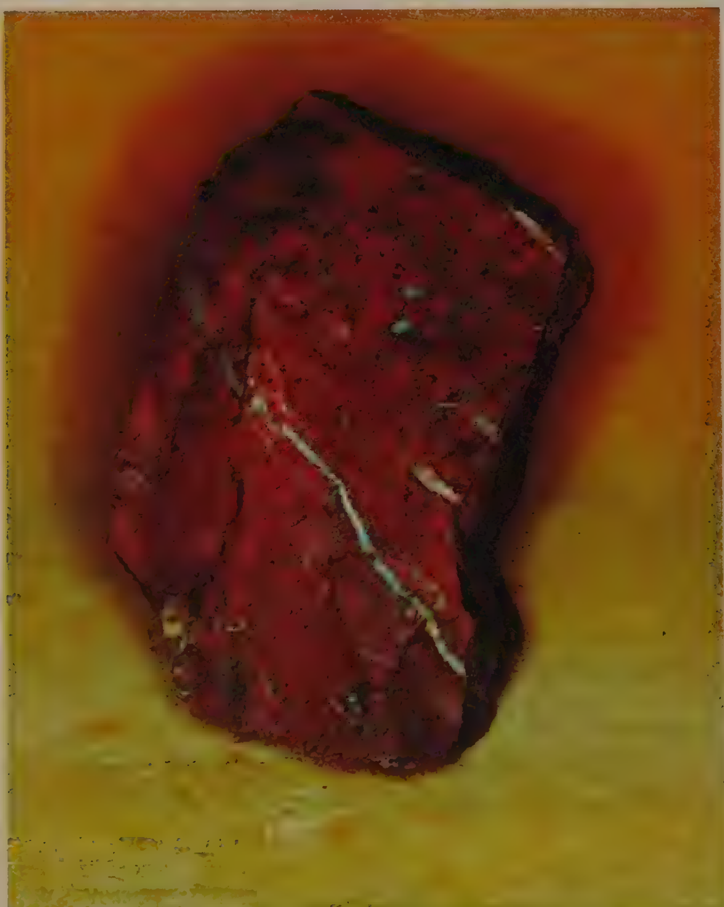
Narrabri (amongst a quartz pebble drift 2-4 ft thick, on hills)

Mt McDonald (near Abercrombie River)

A beautiful specimen of polished malachite
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

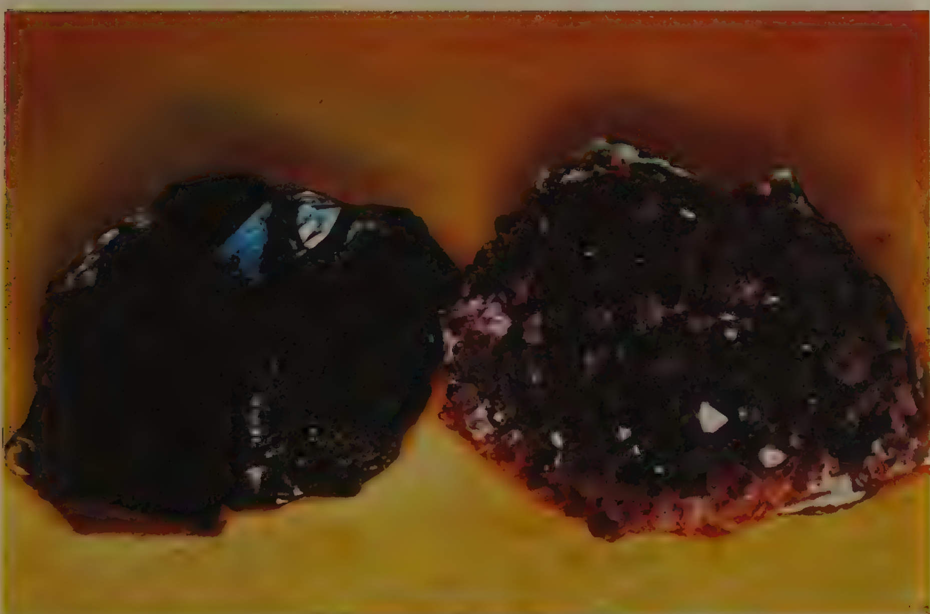


Mahogany jasper, also from Jasper Farm. It derives its name from its colour and markings which resemble the wood mahogany
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz



Red jasper. A good 'practise' stone for the amateur lapidary
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Olivine is found in basalt and other igneous rocks. Crystals of gem size are rare; these specimens were found at Mount Laura in Victoria
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz



Amethyst has good clarity and range of colours. The large specimen was found in Western Australia and the other in New South Wales
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

A brilliant display of agates from Agate Creek, showing all the typical sunset colours of the stone from this area

Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Mt Werong (where the largest diamond in New South Wales, $28\frac{5}{16}$ carats, was reported found in 1905)
Brown's Hill, Watson's Creek, 17 m. N. of Bendemeer
Ballina
Vegetable Creek, Emmaville
Calula Creek
Upper Tarlo
Bathurst district
Lachlan River
Euriowie
Bullawa
Slachen's Flat
Narangarie Range
Uralla
Shoalhaven River
Eulah Creek
Gragin Creek
Tingha
Oban
Backwater
Kookabookra

The total recorded production of about 250,000 carats of diamonds from the fields of New South Wales is probably very much understated, since diamond-miners, working in small parties, are well able to conceal the actual yield of their claims; in fact, in the past they were evidently noted for their natural reluctance to reveal this information.

OCCURRENCES IN QUEENSLAND

There have not yet been any commercial diamond-fields discovered in Queensland, nor, in fact, have any mineral deposits been mined exclusively for diamonds. The stones have been found over a wide area, stretching from Gilberton in North Queensland to Stanthorpe and the New South Wales border in the south, but only as a minor by-product during mining operations for gold and tin. A few diamonds were also found during sapphire recovery on the Anakie field near Rubyvale, especially at Policeman Creek. All Queensland diamonds are very small, between 4 and 8 to the carat, and may be regarded as isolated occurrences. However, if mineral or gem wash is being treated in any of the districts where diamonds have been found, a watch should be kept, for diamonds may be present in the sieve or dish with other stones, and may be mistaken at first for zircons, topaz or even quartz fragments.

Areas in Queensland where diamonds have been found are:

Gilbert River	
Broadwater Creek	Stanthorpe
Hunt's Creek	Stanthorpe
Quartpot Creek	Stanthorpe
Sugarloaf Creek	Stanthorpe
Lode Creek	Stanthorpe
Arbouin's Creek	Stanthorpe
Cannon's Creek	Stanthorpe
Kettle Swamp Creek	Stanthorpe
Severn River	Stanthorpe
Spring Creek	Stanthorpe
Herberton	
Retreat Creek	Anakie
Sheep Station Creek	Anakie
Policeman Creek	Anakie
Tomahawk Creek	Anakie
Central Creek	Anakie

OCCURRENCES IN VICTORIA

Diamonds have not been found in any quantity in Victoria and the State therefore does not possess any diamond-fields. However, in several districts small stones have been recovered from time to time when miners have been washing for gold, the largest diamond thus discovered being 1¾ carats. The districts in which diamonds have been found are:

Mansfield	Chiltern
Beechworth	Casterton

OCCURRENCES IN OTHER STATES

In South Australia diamonds have been found in only one locality, the Echunga goldfield, where they were recovered in small quantities during gold-mining operations.

In Western Australia a few diamonds, averaging 4 or 5 to the carat, have been taken from a gold-bearing conglomerate at Nullagine on the Pilbara goldfield. The largest stone weighed 3½ carats.

In Tasmania the stones have been reported only from a branch of the Pieman River, where they were found during alluvial mining operations.

The Sapphire

Composition: Aluminium oxide (Al_2O_3).
Crystallization: Hexagonal (six-sided).
Hardness: 9.
Specific gravity: 4·00 (heavy).
Lustre: Adamantine.
Colours: Colourless, grey, green, red (ruby), blue, pink, yellow, brown, black (corundum), bi-coloured.
May be transparent, translucent or opaque.
Fracture: parting planes.
Occurrence: As crystals or rolled pebbles in alluvial deposits.
Locations: Queensland, New South Wales, Ceylon, India, Burma, Thailand, Montana (U.S.A.), Southern Rhodesia, Tanganyika, Afghanistan, Yunnan Province (China), Manchuria, Angola, Norway, Colombia, Madagascar.

The sapphire is chemically described as aluminium oxide, and here Nature has set yet another of her many puzzles—how a soft material such as aluminium combined with oxygen, a gas, could result in one of the hardest of gemstones. For sapphire is of the hardness of 9 on the Mohs' scale and is thus the hardest of all gemstones with the exception of diamond.

The stone has been known and prized since ancient times, although the term 'sapphire' was probably applied to lapis lazuli and other opaque stones of a blue colour. The word originally meant 'blue', but the stone itself is now identified with a variety of the mineral species corundum and it does not occur, as so many think, only in blue shades, but is found in a wide range of colours embracing yellows, greens and even pink and violet. When it is red it is called 'ruby'.

The term corundum is applied, mineralogically, to all naturally occurring varieties of aluminium oxide, but is generally used commercially to describe the opaque black or dark stones used industrially as abrasives. It should not be confused with carborundum, which is a trade name for a synthetic abrasive material consisting of silicon carbide. Some corundum, however, has quite some value as a gemstone. This is the type exhibiting 'sheen' at right angles to the main axis of the crystal, usually seen on the ends of the rough stone as a bronze-coloured or silky effect. When skilfully ground and polished in the cabochon style with a high dome, the stone becomes the coveted 'star sapphire'. Fortunately, this variety is available from the Australian deposits, occasionally as enormous lumps of black star material.

When absolutely pure, corundum is colourless, the so-called 'white sapphire'. A trace of chromium oxide in its composition turns it a reddish colour graduating from a pale pink ('pink sapphire') to a true red ('ruby'). The deeper shade of slightly purplish red is widely known as 'pigeon's blood', the most valuable of rubies and often of all gemstones. The blue sapphire contains titanium, whilst ferric oxide is the colouring agent in the yellow stones. The green thus is the result of blue and yellow colouring combinations. Sometimes a stone will contain zones of distinct colours, such as yellow and blue or green and yellow, making very attractive gems known as 'parti-colours'.

As a non-metallic substance, corundum is extraordinarily heavy, having a specific gravity of 4 (that is, it weighs four times as much as the same volume of water). This property is of considerable assistance to the gemhunter when panning the gem gravels, for corundum varieties tend to remain in the bottom of the dish, allowing the lighter material to be washed away.

Gem-quality sapphires and rubies do not commonly occur as large stones, becoming progressively rarer over about 25 carats in weight. However, some monster gems have been found over the years. Amongst these are the 'De Long' star ruby of 100 carats and the 563-carat star sapphire 'Star of India', both of which were to be seen in the American Museum of Natural History before their theft in 1964. The Australian fields, too, have contributed to the world of gems with the famous 'Black Star of Queensland', of 733 carats. Probably the largest gem sapphire ever found was the giant 'Gem of the Jungle', weighing 958 carats, uncovered amongst the grass on the surface of the ground in 1929 in Ceylon.

The largest piece of corundum in existence is a colossal opaque pyramid-shaped mass over 2 feet wide and weighing 3 hundredweight; this is now on display at the Geological Survey Museum, Pretoria, South Africa.

The red variety, ruby, of a large size and of good colour and free from flaws is regarded as being one of the most valuable of gemstones and may rival or even exceed the diamond in value. Unfortunately, apart from a few minor occurrences, rubies have not yet been found in Australia and then only as small stones of an inferior colour. This does not mean that they do not occur in quantity in Australia but merely that they have not yet been reported. Corundum (or sapphire) exists in a number of localities; the chromium mineral is also found in Australia, so that the rare combination of these two, resulting in red corundum (or ruby), is possible.

The finest rubies are found in Burma near the town of Mogok and the mines there have been producing for many centuries. Most of the prized pigeon's blood stones are from this area, but large stones are now rare. Some of the world's largest and most valuable rubies are of Burmese origin and have weighed as much as 304 carats. The majority of the big ones have been cut into smaller stones and have found their way into the world's finest collections and royal regalia.

Because of the beauty, rarity and considerable commercial value of rubies, innumerable experiments have been undertaken in an attempt to produce them synthetically. It was known quite early in the nineteenth century that ruby (and sapphire) were coloured, crystallized alumina and several enterprising Frenchmen succeeded in synthesizing small rubies by subjecting to great heat various compounds of alumina and other chemicals. One of the earliest to achieve this was M. A. A. Gaudin in 1837, followed by E. Frémy, C. Feil and A. Verneuil. Frémy, in 1891, succeeded in producing quantities of small crystals of ruby, some of which were suitable for use as watch bearings. None of these attempts, however, resulted in rubies of commercial value, probably because of the lack, in those times, of apparatus capable of producing intense and sustained heat. In 1904 Professor Verneuil perfected his *chalumeau* or inverted blowpipe, in which powdered, pure alumina was sifted onto a jet, mixed with oxygen and fused with a powerful flame. The result was aluminium oxide. By adding small quantities of the colouring agents titanium, chromium or ferric oxide, he was able to produce rubies and sapphires.

It may well be thought that the introduction of synthetic sapphires, so closely resembling the real gems, would spell the end for the sapphire-miner. On the contrary, the demand for natural sapphires has increased, so that fine stones now command higher prices than ever before. Many hundreds of thousands of carats of synthetics are now produced annually, most of which are utilized for industrial purposes, such as machine and watch bearings.

Sapphire-mining is not difficult for the amateur. Unlike some other gems and minerals whose recovery involves hard rock-mining, sapphires are invariably found in the gravel beds of old creeks, rivers and drifts, into which they were swept long ago after having been weathered out of their original matrix. This does not mean that the gemhunter should dig amongst the sand in any creek looking for sapphires. The 'old' beds are really old and may have no relation at all in shape, size or direction to existing streams. It should be remembered that these old drifts caught up the sapphires, other gemstones, pebbles and boulders many millions of years ago and carried them along their course, to deposit them in layers and pockets everywhere. The gemstones, being somewhat heavier than the other material, will have sunk towards the bottom and come to rest on the solid rock bed or in clays. Quite often the banks of these old watercourses have been eroded over the years, leaving the original rock and pebble-strewn beds on top of ridges. These beds are recognized by the quantity of smooth, worn rocks they contain, indicating beyond doubt the action to which they have been subjected. In some localities on the Anakie field in Central Queensland sapphires may be found on such ridges at shallow depths under the boulders.

When water is available, commercial sapphire-miners often use a device known as a pulsator. This consists of a short metal race into which the gravels are shovelled and down which they are washed onto perforated steel plates; these hold back the larger boulders, which are discarded. Eventually the gem-bearing material reaches a series of small compartments with finer screens through which water is surged from below. This causes a pulsing action, and the gemstones are left on the bottom of the screens whilst the lighter, valueless material is washed away over the edge. The gem residue is then removed, hand-sieved, picked and sorted.

The amateur gemhunter is not able to set up such equipment, but much the same results may be obtained by the hand-sieving process, carried out where possible in a stream. Some prospectors use two sieves, one of coarse mesh to eliminate the large pebbles, and a lower one of finer mesh on which the smaller material is washed. A little practice will enable the gemhunter to perfect a circular, swirling motion with his sieve so that the lighter material finds its way to the perimeter, whilst the heavier gem material works towards the bottom of the centre of the sieve. With a quick turn of the wrist the sieve can then be inverted over a jute bag; the sapphires should be on top of the heap in the centre. It takes practice to ensure that this last movement does not result in the contents, sapphires and all, being scattered all around the frustrated prospector.

When water is not available for washing, as so often happens, the gemhunter has to resort to dry-sieving. This may at times be a little more difficult but it is, nevertheless, quite effective. The gravels are shovelled into the sieve and the large pieces, obviously not gemstones, are removed by hand, care being taken to scrape off and keep any soil adhering to them. The sieve may then contain clumps of dirt which should be broken by rubbing along the mesh. A circular motion will then cause the fine grains to pass through the mesh, leaving behind the gems and other stones to be hand-picked and sorted. Often it is good practice to keep all this material for later washing when water is available. Occasionally, soil of a clay-like nature will be encountered. Especially if it is wet, this material is almost impossible to treat without water, since clumps clog up the sieve and gems with a clay coating can easily be missed. Any clays that are suspected of being gem-bearing should be kept for treatment in the dish or sieve with water. Every gem contained in them will then be recovered.

It is quite probable that Australia possesses the last great sapphire deposits in the world. The Anakie field of Central Queensland is of vast extent, the actual limits not yet having been estimated, whilst the importance of the Inverell-Glen Innes fields in the New England district of New South Wales is only now being realized.

Gem sapphire in any quantity does not exist in Europe or Africa and is found in only a few isolated areas in the United States of America. In Asia, long the home of the sapphire, alluvial deposits in India, Ceylon, Burma and Thailand have been worked for many centuries and are probably now close to exhaustion point. The Indian deposits have received attention from literally millions of miners, whilst the Australian deposits, because of their comparatively inaccessible locations and our smaller population, have been examined by only a few thousand miners since their discovery less than a hundred years ago.

In Australia gemhunting has never been prompted by economic necessity to the extent that it has in Asian countries, so that while jobs have been abundant little prospecting or mining for gemstones has been undertaken unless boom conditions in the industry have attracted more than the usual share of interest. Such sporadic mining has done little to further gem-mining, with the result that many potentially lucrative areas have lain idle for years. Gems will not be found if they are not sought after. The contrary also is true, as witnessed by the discovery recently of valuable sapphires in Central Queensland probably because people have gone forth to look for them again.

There is no certain knowledge, geologically, of the method of occurrence of sapphire, for, unlike most gemstones, sapphire crystals have never been found embedded in their parent rock. Clusters of quartz crystal, amethyst, beryl and tourmaline, to name a few gemstones, have been taken from the ground in conjunction with their matrix, which has indicated beyond doubt the manner in which they were formed. Sapphires, however, are invariably found as single stones, generally rounded by wear though sometimes still retaining traces of their crystalline shape.

The hardness of sapphire is probably the reason why it still exists at all. If the stones had been formed in a rock matrix, this original surrounding rock must have been of inferior hardness, and it has long since decomposed, liberating the sapphires into the streams and drifts where they are found today. It is true that sapphires have been found embedded in basalts and other volcanic rocks, as on the Anakie field, but this is not a common occurrence. At the time of the discovery of these sapphires 'in matrix', basalt was thought to be the parent rock, but it was soon realized that this could not be so and that the stones had merely been caught up in a later volcanic flow, after having been weathered out of the original sapphire-forming material. Whatever it was, we may be sure that the sapphire rock was extremely ancient and that it decomposed long ago.

Australian sapphires are of many colours. At one time, it was the practice to call only the blue variety sapphire and to use the names of other gems, prefixed by the word 'Oriental', for stones of other colours. Thus:

Yellow sapphire	=	'Oriental topaz'
Purple sapphire	=	'Oriental amethyst'
Green sapphire	=	'Oriental emerald'
Red sapphire	=	'Oriental ruby'

Of these, the red variety is still referred to as ruby. However, for the sake of simplicity and because the use of names such as emerald is misleading, stones of all other shades are now called yellow sapphire, green sapphire, and so on.

Sapphires of several colours other than those already mentioned occur on the Australian fields, though they are rather rare. These are pink sapphires, white sapphires and ruby sapphires. The last term is a local one and is not strictly correct. The stone—which is very rare—is actually a reddish-blue, or purple, colour, very attractive. The pink sapphires are really light-coloured rubies and the white sapphires are colourless. The extremely rare orange-coloured sapphire, once called 'padparadsha' (although one scarcely ever hears this involved term nowadays), has been found on the Australian sapphire-fields.

The colour of the Australian blue sapphire is quite distinctive, usually being of a rich, deep velvet hue, although stones are often found resembling closely the lighter, royal-blue gems from southern Asia. In earlier days, at the turn of the century, overseas gem-dealers were not favourably disposed towards these darker Australian stones and great difficulty was experienced by the diggers in disposing of their production. Possibly the dealers felt that it was hardly worth their while to introduce small quantities of a new type of sapphire and did not foresee that such a flood of stones was to pour from Australia as to make the Australian sapphire a permanent feature of the gem world. Skilful and exact cutting techniques helped to bring forth the hidden beauty of the stones, so that now the Australian 'blue' enjoys the popularity it richly deserves. The green and yellow colours from the Australian fields are superb and unsurpassed by any sapphires from other parts of the world. The Anakie field, in particular, has produced some of the largest and most brilliant 'yellows' ever mined. This field has also been the origin of some of the world's most valuable black and deep-blue stones. Details of a number of these sapphires are given at the end of the section on the Anakie field in the next chapter.

Deep-red rubies have not been found in any quantity or size. Specimens have been reported from as far north as the Jordan's Creek goldfield, south of Herberton, and a few have been taken from the Anakie field, as well as from the Gippsland district of Victoria, but they are rare.

Australian sapphires do not occur alone in the gravels but are found with a variety of other gemstones and mineral fragments, all of which should be kept, as well as the sapphires. The gems that are generally encountered with sapphires are: zircons (red, brown, yellow, and white), garnet (pyrope: red), spinel (black—pleonaste—and red), topaz (colourless, blue, green, sherry tint, and yellow), quartz (colourless, smoky, yellow, brown, and purple—amethyst), corundum (opaque black, blue, and blue-black), and ilmenite (not a gem but titanic iron—a heavy black mineral).

At the time of the discovery of the Anakie field, sapphires were actually lying on the surface of the ground. Benjamin Dunstan (1902)* records that 'at about the year 1875 Mr Richardson, a railway surveyor, found some red zircons on

* *The Sapphire Fields of Anakie.* (*Queensland Geological Survey Publication*, No. 172.)

Retreat Creek and sent them away to be tested, thinking they might be rubies, but the sapphires which were present with them failed to attract his attention'. As a matter of interest, Mr Richardson later rectified this omission and became one of the partners in the company which worked the field for sapphires. Today, gemhunters also sometimes mistake the red zircons or spinels for rubies, and the red garnet can also be deceptive. The inferior hardness of these stones, as well as their response to other gemmological tests, will serve to distinguish them from the more valuable rubies.

Interest in the sapphire-fields of eastern Australia has quickened during the past five years or so, owing largely to the frequent Press reports of important finds on them. Prior to this, very few of us realized the immense possibilities of these fields, which lie only a comparatively short distance from the capital cities. As a result of the efforts of the late Mr E. A. Heiser, a prominent Brisbane gem-dealer, a great deal of attention has become focused on the New England fields near the towns of Glen Innes and Inverell. Mr Heiser was firmly of the opinion that the stones from these areas were equal to anything from any part of the world and indicated that important finds would be made there. His own operations were reported to have yielded many fine stones a few years ago. As a result, some professional miners and scores of week-end fossickers are finding that there are, in fact, sapphires of fine quality to be recovered with a little work.

The Anakie area is experiencing a revival with an influx of tourists and gemhunters, especially to The Willows section of the field. This most interesting locality has yielded large quantities of sapphires in the past, particularly 'yellows', as already mentioned, and several valuable finds have recently been reported. Undoubtedly, even more exciting discoveries are yet to be made, and for the enthusiastic gemhunter the possibilities are limitless, because there is yet a vast area to be prospected. These areas are dealt with in more detail in the next chapter.

The Sapphire-fields of Australia

The Anakie Field of Central Queensland

This area is by far the most important of the Australian sapphire-fields and could probably rank amongst the world's best. Although called the 'Anakie' field, there are few precious stones to be found near the town of Anakie itself. The main fields centre around Rubyvale, the town of Sapphire, The Willows and Tomahawk Creek.

Anakie is about 196 miles west of Rockhampton on the main Longreach road and Rubyvale is about 12 miles north of Anakie. The roads are quite trafficable, although some difficulty may be encountered during the wet season, especially on the black-soil stretch between Anakie and Emerald and on the roads beyond Rubyvale. Visitors to the field should ensure that they take with them sufficient drinking water, for the area is normally quite dry, even in the creeks, and bores are few and far between. Ample food should also be taken, because there are few stores in the country beyond Emerald.

The sapphires occur in a wash, or layer of gem-bearing gravel, found at varying depths. The thickness of this wash varies considerably over the field. In some places it is only a few inches thick whilst in others it goes down several feet. It rests on slates or a reddish clay although, on occasions, another richer wash has been found below this clay layer. Sieving with a $\frac{1}{8}$-inch mesh sieve brings the best results; it must usually be done in the dry state because there is little or no water available. The sapphires are generally worn to rough rounded and elongated shapes with none of the original crystal shape evident. The wash is likely to contain also pleonaste (black spinel), corundum (including possible star material), garnet, zircon, ilmenite, quartz, etc. The blue sapphires, being dark as well as rough, may at first be mistaken for black pebbles by the beginner, but a little practice in holding suspects to the light will soon separate 'blues' from the rubbish.

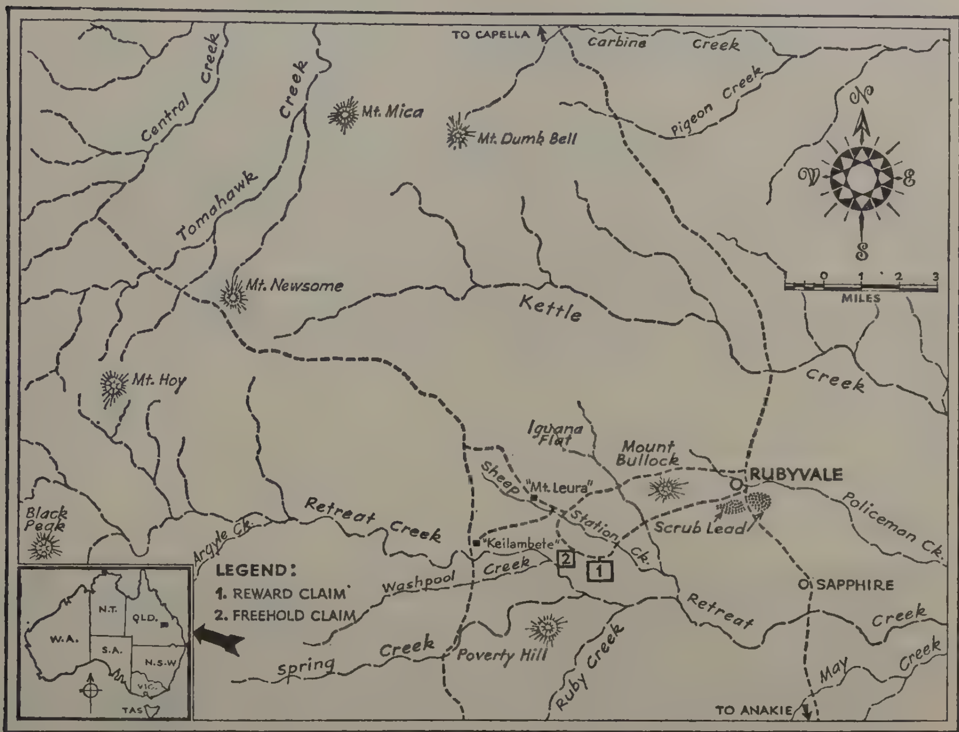
About 7 miles from Anakie, on the way to Rubyvale, many diggings will be seen on the site of the old Sapphire town, now consisting of a few old houses and shacks. This was a very productive area in earlier days, hence the name, and generally it has been well mined in the vicinity of the settlement. Still, the occasional stone may be picked up in and near the old diggings. Further search of this area could result in the recovery of good stone. There is a reasonably stocked small store and post office at Sapphire.

The gemhunter is now in sapphire country and patient search from here onwards could bring its reward.

Rubyvale. About one mile before reaching Rubyvale, a large area of old heaps will be seen on both sides of the road, stretching into the bush for a quarter of a mile or so. This is the Scrub Lead, which has been the location of an enormous quantity of sapphires, mainly of a distinctive blue of the best grade, called 'Scrub blue'. There is still a great deal of ground to be examined here, although care should be exercised near old mine shafts which, in places, extend down to 40 feet. The Scrub Lead is currently the scene of operations by professional miners who do not, naturally, welcome diggers on their own claims. However, plenty of ground is still available to newcomers.

Near and around the town of Rubyvale (where there is a 'Pub with No Beer') are a great number of holes and pits, some old and abandoned and some still being worked. Fossicking in these areas often pays dividends.

The permanent population of Rubyvale is now about thirty, consisting mainly of the survivors of the boom sapphire days. These are all now well-matured men and women, quite helpful and friendly to newcomers who do not know their way about the field. A courteous approach to these good folk generally brings assistance and advice. Most of them will show you sapphires and tell you where to find some.



The Anakie district, Central Queensland

The largest and most valuable of the claims was the Reward Claim, about 7 miles from Rubyvale on a road running from the hotel. The claim is 200 yards or so in from the left of the road about one mile after crossing Sheep Station Creek, and the track into it may easily be seen. This was the site of the original discovery of sapphires in about the year 1875; the site was worked by the Withersfield Sapphire Company from 1891. The main sapphire wash here is on top of the ridge and extends down both sides and along some of the spurs, resting on a bedrock of slates and schists. Worn and rounded quartzite boulders ('billy boulders') are abundant here and were regarded by the miners as indications of the presence of sapphires. The workings cover about 200 acres, but the sapphire-bearing gravels are considerably larger in area than the claim. Extensive digging has taken place, but a good deal of untouched ground still remains. Perseverance with further digging in existing holes could reveal good stones. The ground underneath the heaps has never been dug and is especially interesting to the gemhunter.

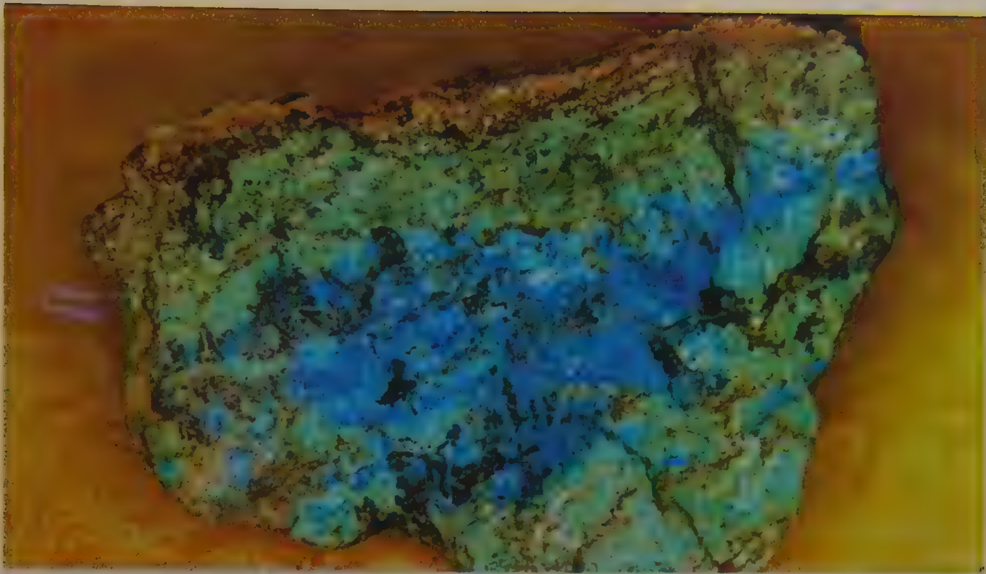
About one mile farther along the same road is the Freehold Claim of about 100 acres. This is similar to the Reward Claim except that the sapphires are also found in the black topsoil. Generally, deeper digging and a great deal more work is necessary here and surface fossicking is not satisfactory. Water is available a short distance away in Retreat Creek for separating small stones from the rest of the wash. It was once thought that this claim was geologically a part of the adjoining Reward area but recognition of older formations between the two indicates that they are two distinct deposits.

The Willows Field. The Willows is the most recently opened field (discovered in about 1918) and is the source of very fine sapphires, including the best yellows. The 'Golden Willow', a 322-carat golden-yellow sapphire, was dug on this field in 1951, and as recently as July 1964 a large yellow sapphire weighing 84 carats in the rough was discovered here by an amateur digger. Many other superb sapphires have been found on The Willows field and undoubtedly many more will yet be dug from these deposits.

The gemhunter will easily find this field. A new road leaves the main road about 6 miles from Anakie and runs right into it. The gem area is extensive and the sapphire wash lies quite close to the surface, in places less than 2 feet deep. A report on the field in 1953* stated that two claims

were being worked on surface wash, to a depth averaging 18 inches and over an area of some half-acre. Wash, 6 in. to 12 in. deep beneath

* *Queensland Government Mining Journal*, 20th Aug. 1953, pp. 570-1.



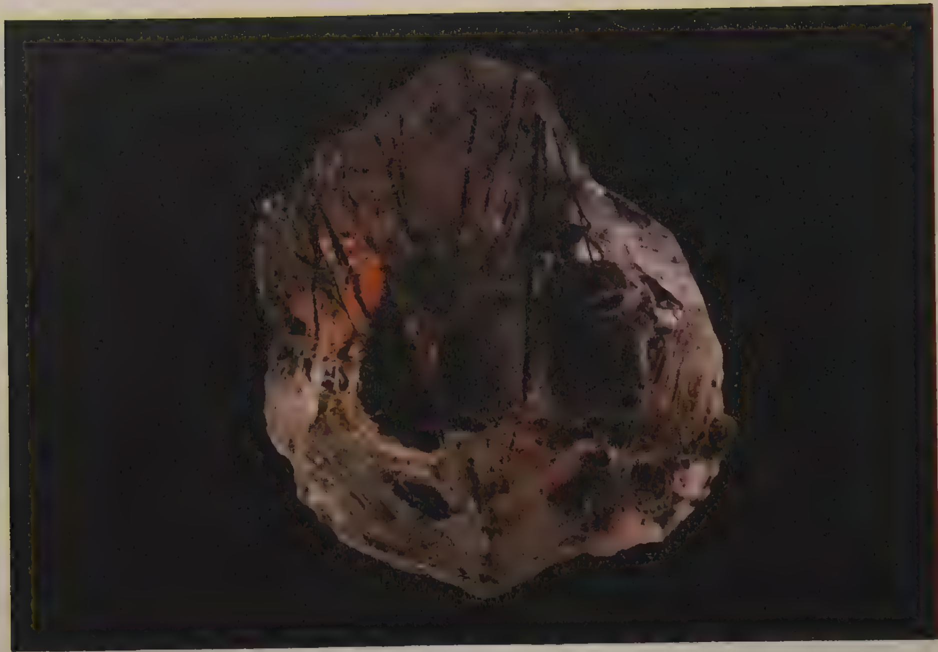
Azurite and malachite, showing the attractive colour contrast of the two minerals
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Apatite. Good specimens come from Broken Hill, but are scarce elsewhere in Australia
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

These opalized shells are millions of years old and have been completely opalized. Property of H. Makowski, East Malvern, Victoria
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Prase is a form of green chalcedony. This specimen is agatized prase found in Western Australia
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Chrysoprase, a beautiful quartz gem with a wide colour range. Found in Queensland and Western Australia
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz



Rutilated quartz with fine needles of rutile imprisoned within. Found at Tingha, N.S.W.
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Banded chert. This variety is brightly coloured and is used widely in jewellery
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

shallow soil cover, carries sub-angular boulders of 'billy' quartzite and red jasperoid up to one foot in diameter and lies on a clay bottom. No attempt has been made to test below the clay and nowhere are the workings greater than 3 ft in depth. In this area the occurrence of pebbles of reddish-brown and black chert is regarded as a favourable indicator of sapphire-bearing wash. Although good blue stones are found occasionally, predominant colours are green, yellow and parti-coloured. The gems are recovered by dry-screening, hand sorting and washing, after removal of boulders. . . .

Good quality green and yellow stones have been obtained at the surface on sandstone ridges on Glenalba and Southernwood stations between The Willows and Withersfield but no serious attempt has been made to work the shallow wash in this extension of the field.

A good deal of digging has taken place on The Willows field, but a lot of ground is still left to be examined. A number of claims are pegged out and newcomers should be on the look-out for these to see that they do not trespass. There is a dam on the field, which makes water less of a problem. Recently, also, a provisions store has been established at The Willows.

All the ridges and the area between The Willows and Anakie are worthy of investigation, particularly the country around Glenalba and Southernwood stations, and the fringes of the previously worked areas which have not been prospected.

Tomahawk Creek. This area is about 24 miles by road from Rubyvale, via Mt Leura station, in the direction of the Zig Zag Range, and it is probably the most interesting and untouched location on the entire Anakie field. Since its discovery only sporadic fossicking by a few prospectors has been done, probably because of its isolation and the ready availability of stone in more central areas.

Benjamin Dunstan in his report *The Sapphire Fields of Anakie* (1902)* stated:

Regarding the prospects of the field, there is no doubt whatever in stating that they present a most favourable aspect. Miners are always arriving on the fields, discoveries of sapphire country are con-

* *Queensland Geological Survey Publication*, No. 172.

stantly being reported, and, what is perhaps of more importance, there is an ever increasing demand for the stones. Although fresh discoveries of sapphire country are being made, yet the western fields of Tomahawk and Central Creeks, where the most extensive areas exist, have not been prospected to any extent. Natural conditions here are unfavourable and because of the undeveloped state of the country, progress is greatly impeded. The country is badly watered, a great inconvenience to prospectors both in getting to the fields and afterwards in exploring them, and the distance from Anakie, the source of supplies, is too far for prospectors to take rations unless they are provided with horses, a provision which is out of the question with most of them.

Despite Dunstan's comments little work has apparently been done at Tomahawk Creek, for the 1953 report already quoted mentioned that 'Recently a track was blazed from Rubyvale to Tomahawk Creek a distance of about 24 miles as a preliminary to re-opening the road and some interest was being shown in the prospects in that section of the field. A party from the Willows was preparing to visit the area to assess possibilities.' However, inquiries show that only isolated parties have since visited this part of the field so that it remains virtually the same as when Dunstan first mentioned it in 1902.

The sapphire wash at Tomahawk Creek is in high terraces above the watercourses and is of great thickness, the actual depth not being known. The deposits are up to a mile in width and a number of miles long, extending from Mt Hoy to near the junction of Tomahawk and Central creeks. Dunstan in his 1902 report wrote:

The whole of some of the ridges separating Tomahawk Creek from Serpentine Creek are composed entirely of wash, so that the deposits must be of great thickness. These huge deposits have been prospected in places by sinking shallow trenches, but the area so prospected is exceedingly small when compared to its vast extent. The top end of the Tomahawk deposits, near the foot of Mount Hoy, are the highest in the district, being 1,400 feet above sea-level, and nearly 600 feet above the sapphire deposits at the lower end of Retreat Creek. . . . The total distance along which the deposits are found from Mount

Hoy to Central and Tomahawk Creek junction is altogether about fifteen miles. Further than this the deposits have not been traced. It is extremely improbable, however, that the deposits do not occur still further north and, on the information supplied by Mr H. Monk, who knows this part of the district very well, sapphires have often been found by station employees when mustering cattle in the neighbourhood of Bevandale, an out-station of Peak Vale.

The Tomahawk Creek area is particularly recommended to those who are willing to travel some distance off the beaten track and really willing to put some work into getting first-class sapphires. Blues and yellows are found here, as elsewhere on the Anakie field, but greens predominate. Some of these green sapphires are of such an excellent shade that they have become a standard known as 'Tomahawk greens'.

Because of the isolated nature of the area, sufficient time should be allowed for travel in both directions, as well as for the stay at the location, and water, provisions, petrol and oil should be carried. The road to Tomahawk Creek is rough and entails a number of sharp, narrow creek crossings. The journey should not be undertaken unless the vehicle is in sound mechanical condition and has good tyres, for it is a long walk back to a service station.

Other locations on the Anakie Field. As well as in the main localities described above and shown on the accompanying map, sapphires have been found on the Anakie field at the following locations:

Retreat Creek
Iguana Flat
Argyle Creek
Washpool Creek
Policeman Creek
Sheep Station Creek
Kettle Creek
About 2 m. NE. of Borilla railway station
Poverty Hill
Glendarriweil
Keilambete station
Near Anakie railway station

Production of Anakie. The Anakie mineral field was first proclaimed on 3rd September 1902 and the area defined covered 18,385 acres or 28 square miles. Prior to this, sapphire-mining had been conducted for a number of years but it had been thought that the deposits were confined to the Reward and Freehold claims held by the Withersfield Sapphire Company. However, search by prospectors revealed that sapphires were to be found over a wide area outside these claims. In 1892 and 1893 the value of production was about £9,000, representing a huge quantity of sapphires, for some of the sales brought as little as 6s. per ounce. These low prices were no incentive for the diggers and many of the mines were closed down towards the end of the last century. Later, renewed activity took place as the result of the establishment of a regular market for the stones, and for 1907 the value of production was £40,000. The total value of stones mined on the field up to 1912 was stated to be £226,302, but one report of the time remarked that 'estimating quantities and values is very difficult and stones are being taken away from the field of which no record is made. Probably the value of the output is much larger than the amount given.'

The field was by this time established and production continued during the First World War although many overseas markets were cut off. After the end of hostilities Anakie experienced a new boom, with several hundreds of miners in the area, until the recorded value reached the peak of £65,831 in 1920. This prosperity continued until the collapse of the Sapphire Buying Scheme in the 1920s. A number of miners left the field and from then on it went into a gradual decline until the value of production reached an all-time low of £20 in 1957.

For the whole of the period from 1892 to 1957 the Anakie field produced sapphires valued at £696,565, a quantity of gemstones weighing literally tons when it is remembered that the extremely low prices of a few shillings to £1 an ounce were paid in the earlier days.

Because of the present demand for sapphires and the realization that the area is far from exhausted, Anakie is, as has already been mentioned, now experiencing yet another revival. Several important finds have been made and large quantities of sapphires of a marketable grade recovered. In an expanse covering probably 400 square miles, largely consisting of suitable country with sapphire wash, only a comparatively small area has been mined, or even prospected, so that the newcomer has every chance of success. Sapphires have been found in a great number of widely separated localities on the field, sometimes on the surface, and gemhunters should also be on the look-out on ridges and in gullies everywhere, particularly after heavy rain. A number of fine stones have been picked up in these locations.

Notable Anakie sapphires. It has already been mentioned that some large and valuable deep-blue, black and yellow sapphires have been found on the Anakie field. Details of some of these are now given.

In the blue and black group four stones were carved into a superb series of 'Heads of the Presidents' under the direction of the lapidary firm of Kazanjian Brothers of Los Angeles. The head of Lincoln was undertaken by N. Maness, and the heads of Washington, Jefferson and Eisenhower were carved by H. B. Derian; these are now on display in California.

Head of	*Rough weight*	*Finished weight*	*Measurements*	*Colour*
Abraham Lincoln	2,302 car. (*c.* 15⅛ oz.)	1,318 car.	Height 2 9/16″ Width 1¾″ Depth 2″	Blue-black star
Dwight Eisenhower	2,097 car. (*c.* 14 oz.)	1,444 car.	Height 2½″ Width 2 1/16″ Depth 2¼″	Black star
Thomas Jefferson	1,743 car. (*c.* 11⅝ oz.)	1,381 car.	Height 2½″ Width 2¼″ Depth 2″	Blue star
George Washington	1,997 car. (*c.* 13⅓ oz.)	1,056 car.	Height 2 9/16″ Width 2 1/16″ Depth 1¾″	Blue star

Another of these huge sapphires was carved into the 'Madonna of the Stars'; it weighed in the rough 1,100 carats and when finished 545 carats. All of these stones were originally owned by the late Harry Spencer of Rubyvale.

The enormous 'Black Star of Queensland' is another Anakie stone with an unusual background. This fabulous 1,156-carat gem was picked up in 1934 on the surface by Roy Spencer, later a well-known Anakie gem-dealer, when he was a boy of twelve, whilst accompanying his parents on a gem-buying visit to the Reward Claim, Rubyvale. At the time star material was not recognized in Australia, and, being regarded simply as a large piece of corundum, this stone served as a doorstop for a number of years. A Queensland dealer on a visit to the field once generously offered £5 for it 'as a specimen'. Eventually it was sold to Kazanjian Brothers at a high, but undisclosed, figure, and cut to a 733-carat (about 5-ounce) black star sapphire valued at £93,000. It is now leased for display to the leading gem houses of the world by the Kazanjian Foundation. It is regarded as the most valuable star sapphire in existence, being almost 200 carats heavier than the renowned 'Star of India'.

Some other notable stones found at Anakie are listed below.

	Weight	*Found by*	*Notes*
Orange sapphire	32 dwt.	W. Dyer (1920)	
Orange-yellow sapphire	31 car. cut	W. Dyer (1925)	
Yellow sapphire	28 dwt. 3½ gr. (35·7 car. cut)	J. Anderson (1946)	Found at The Willows
Golden-yellow sapphire	21 dwt.	C. Donovan (1949)	Found at The Willows
Orange-yellow sapphire	19 dwt.	E. Russell (1924)	Found on the Freehold Claim
Golden-yellow sapphire ('Golden Willow')	322 car. (91·35 car. cut)	H. Clifton-Parr (1951)	Found at The Willows Renamed the 'Golden Queen'

	Weight	Found by	Notes
Black star sapphire	888 car.	H. Spencer	Measured $2\frac{1}{4}'' \times 1\frac{1}{2}'' \times 1\frac{1}{2}''$
Yellow sapphire	84 car.	Unknown finder (July 1964)	Found at The Willows

Other Sapphire Localities in Queensland

Sapphires have been found in a number of other localities in Queensland, usually associated with other gemstones, such as quartz, topaz, garnet, and zircon, in alluvials being treated for gold and tin. These localities are:

Broadwater Creek, Hunt's Creek, Kettle Swamp Creek, Cannon Creek, Spring Creek, Quartpot Creek, Severn River, Sugarloaf Creek, Pike's Creek — Stanthorpe	Ewan, near Ingham
South of Kingaroy	Emu Creek, near Kilcoy
Goomburra, near Warwick	South-east of Nanango
Herberton	Palmer River, near Laura
Don River, Bowen	Rocky Tate River, Chillagoe
	Jordan Goldfield, near Innisfail
	Agate Creek
	Nettles Creek, Mt Garnet
	Tully River, Herberton
	Annan River, Cooktown
	Percy River, Forsayth
	Gilbert River, Forsayth
	Kilkivan, near Gympie
	Logan River, near Beenleigh

DEPOSITS IN NEW SOUTH WALES

Although the Queensland fields became the more productive, the sapphire deposits of New South Wales were first discovered many years before Richardson picked up his coloured stones on Retreat Creek at Anakie.

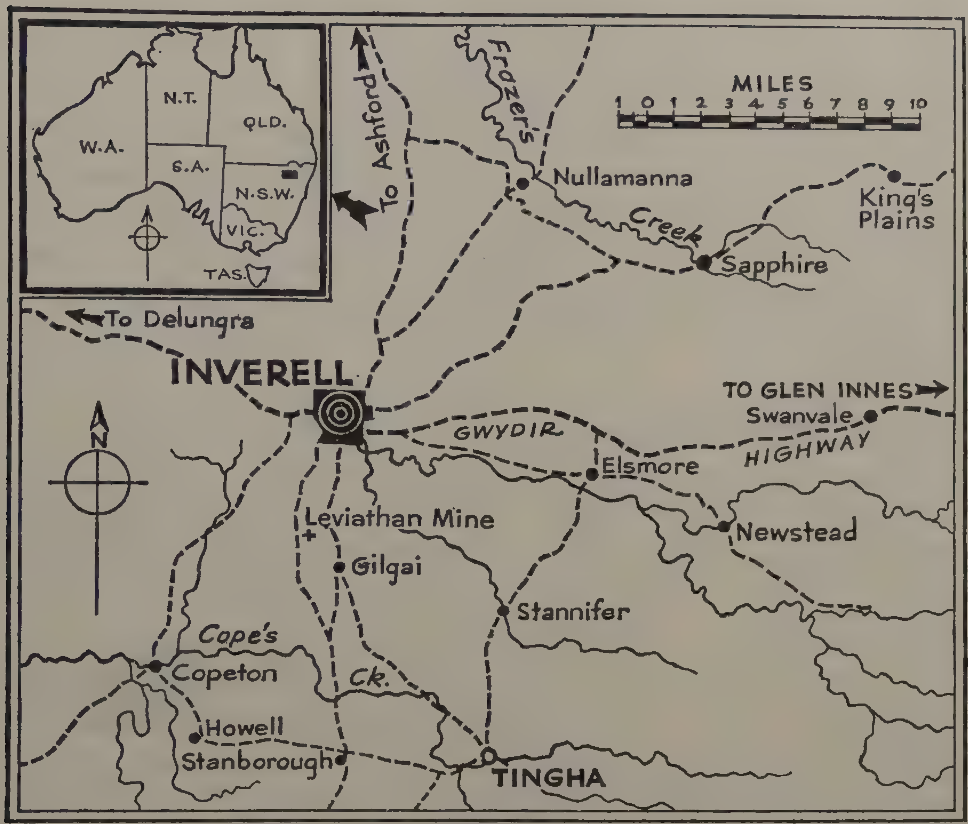
New England District

The first report of the occurrence of sapphires in Australia was made in 1851 and sapphires were again reported near

Inverell in 1853. However, the reports do not appear to have been taken seriously, possibly because there was little demand for sapphires at the time or because the colours were too dark. Sapphires were again noted at Puddlecock Creek near Armidale in 1869 but aroused so little interest that the eminent geologist of the time, the Rev. W. B. Clarke, commented: 'I think our friends in New England would do better to seek for tin lodes.' Evidently his advice was taken, for little was heard of sapphires again for many years unless they happened to turn up during tin-dredging operations, which they did quite frequently and in some quantity. During this twilight period of the sapphire-mining industry in New South Wales, large quantities of the gemstones were undoubtedly won from the tin-fields of New England, but, as no attempt was made to establish a market for them, the actual production must remain unknown.

However, despite the fact that little value was placed on these gems in New South Wales, and perhaps because he heard of the fabulous finds in Queensland, C. L. Smith commenced mining operations in 1919 at Swamp Oak, a few miles from Inverell. The recorded production for the first year was only 8 ounces, but soon new finds were made and the area became known as Sapphire. Mining continued during the 1920s, resulting in a production of several thousands of ounces annually, but it came virtually to an end at the beginning of the depression in 1929. A revival during the 1940s resulted in production figures approaching those of the field's heyday.

The gemstones are found mainly in old alluvial drifts composed of black, clay-like material containing pebbles and boulders, the wash having an average thickness of 2 to 4 feet. On top of this gem wash is a layer of black soil from 2 to 8 feet in depth. Very little sapphire is to be had from this black topsoil, which is usually discarded. Because of the tenacious nature of the wash, sapphires are often found adhering to the large boulders, so this material is removed and washed. Where creeks and streams have cut through this alluvium, the gem-bearing soils are often exposed on the sides of the banks and may be dug for treatment. Often, sapphires have been released by the action of water and thus may also be found loosely distributed in the creekbed near by.



The Inverell district, New England

Associated with the sapphires are zircon, garnet, pleonaste (black spinel), topaz and black and blue-black corundum. Although the corundum is usually too small to be cut into large star sapphires, some big specimens have been found. One such stone, found in about 1954, weighed 1,149 carats (about 7⅓ ounces) and it was estimated that three large black sapphires could be cut from it.

Stones of up to 40 carats in weight have been found in the New England district, but generally the stones are smaller, about 10 per cent exceeding 1 carat each. The colour of the best New England blue sapphire is, nevertheless, superb, and the larger stones are eagerly sought after, many dealers regarding them as equal in every respect to the Indian and Ceylon stones.

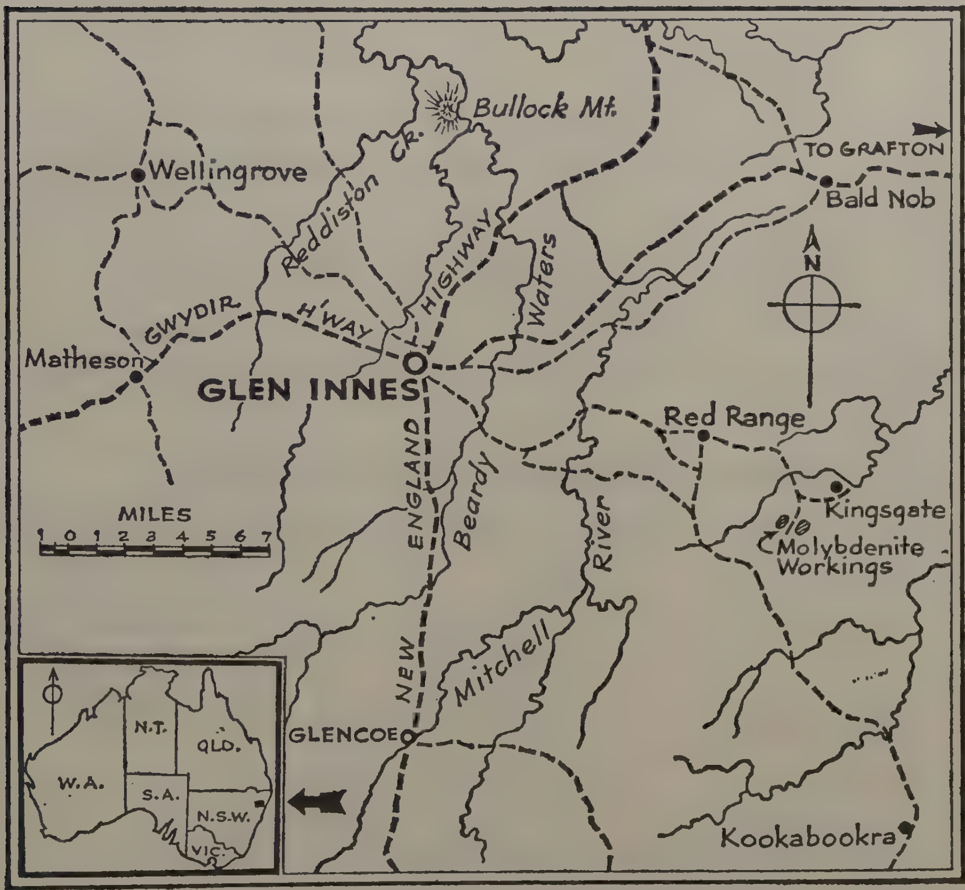
Frazer's Creek. This stream runs through an extensive area of sapphire-bearing country and gemstones have been found for a distance of more than 10 miles along its course, both in the banks as well as in the bed of the stream itself. In the vicinity of Nullamanna the creek has received special attention and some commercial sapphire-mining has been carried on for a number of years. However, quite a lot of this stretch is not under lease and is available to the gemhunter for his fossicking.

The Sapphire district (also known as Horse Gully). The Sapphire district, already referred to, is another vast sapphire-bearing area and is actually on Frazer's Creek. It was one of the earliest localities mined and is still producing plenty of good sapphires. There are a number of pegged-out claims here, so gemhunters should see that they do not intrude upon these. Some pulsating machines have been installed, bringing in good yields, but many of the sapphire-miners still use the sieve and dish with satisfactory results. There is usually some ground water available at Sapphire and this makes the sieving and treatment of the wash much easier and makes possible the recovery of stones that might otherwise be missed.

Beardy Waters and Bullock Mountain. These two areas are currently the scene of some rather large-scale mining operations and it has been reported that very fine and large stones are being taken out.

King's Plains area. This locality has produced some high-grade sapphires recently and, as there is so much acreage still to work, it is well worth examination.

Reddistone Creek. This is one of the most productive of several localities in the neighbourhood of Glen Innes producing good-grade sapphires. It lies about 8 miles west of Glen Innes. Stones similar to those found in the Sapphire area are being recovered from a similar type of gem wash.



The Glen Innes district, New England

Other localities. Sapphires have also been found in the following localities in New England:

Inverell area	*Glen Innes area*
Bingara	Scrubby Gully
Tingha	Mole Tableland
Inverell	Vegetable Creek

Inverell area	*Glen Innes area*
Cope's Creek	Rose Valley (Emmaville)
Elsmore	Oban
Newstead	Ben Lomond
Swanbrook	Glen Innes
Borah Creek	Dundee
Swanvale	Glen Elgin
Gwydir River	Bald Nob

There are undoubtedly innumerable localities in New England not yet discovered or reported where sapphires exist. The gems have been found over such a vast area, extending from Stanthorpe in Queensland to beyond Armidale, that practically any creek or river, large or small, is worth examining; especially deserving of attention are the gravels if the stream has cut through the black-soil areas which overlie the old gem drifts.

Deposits Elsewhere in New South Wales

Other localities in New South Wales where sapphire has been found are:

Tumbarumba	Cudgegong River (Two Mile Flat)
Nundle	Peel River
Mann River	Mt Werong
Near Mittagong	Berrima
Namoi River	Shoalhaven River
Crookwell	Wingecarribee River
Abercrombie River	Oberon district

The total recorded production of sapphires in New South Wales from 1919 to 1949 was over 26,000 ounces. In 1963 the value of production was £24,343.

OCCURRENCES IN VICTORIA

Sapphires are known at a number of localities in Victoria, generally being found in the alluvial gravels of goldfields together with zircons and occasionally garnets. The stones are small. Sapphires have also been found with zircons on the beaches in a few places. An occasional small ruby has turned up in several localities, and these are marked with an asterisk in the list below.

Steiglitz Creek	*Traralgon Creek
Donnelly's Creek	*Beechworth
Rutherglen	Point Leo
Daylesford	Tullum beach
Trentham	Phillip Island
Yarra Valley, Dandenong Ranges	

OCCURRENCES IN OTHER STATES

In Tasmania small sapphires are often found in alluvial deposits associated with tin and zircons, especially on the tin-fields of the north-east. Another locality is at Table Cape.

South Australia does not seem to be well endowed with gem-quality sapphires. Small quantities have been reported from Mt Painter and the Barossa Ranges.

Gem sapphire does not appear to exist in Western Australia.

Emeralds in Australia

Although the mineral beryl (a silicate of beryllium and aluminium) is of widespread occurrence in Australia, only a small proportion of it is suitable for use as gems. The mineral itself is the principal source of beryllium, which has been called 'the metal of the future' because of its properties of great strength combined with extreme lightness (exceeding even that of aluminium).

This commercial form of beryl is quite opaque, of a milky shade of yellow or green with a curiously mottled appearance, and may occur in large masses or in giant crystals. One such crystal mined at Albany, Maine, U.S.A., measured 27 feet in length and weighed over 25 tons. Another recovered in the Ural Mountains of Russia was of 18 tons in weight.

The transparent form of beryl, the gemstone, is generally found in smaller hexagonal crystals, although larger masses of gem quality have been found from time to time. One of these, the largest aquamarine crystal known, was mined in 1910 in the district of Minas Gerais, Brazil. This monstrous stone was in the form of a greenish-blue crystal, perfectly transparent, measuring 19 inches by 16 inches and weighing 243 pounds.

Gem beryl may occur in any one of several colours:

Colourless: Goshenite.
Pale pink to deep rose: Morganite.
Greenish-blue: Aquamarine.
Golden yellow: Heliodor.

Grass green: Emerald.
Paler green: Green beryl.
Paler blue: Blue beryl.

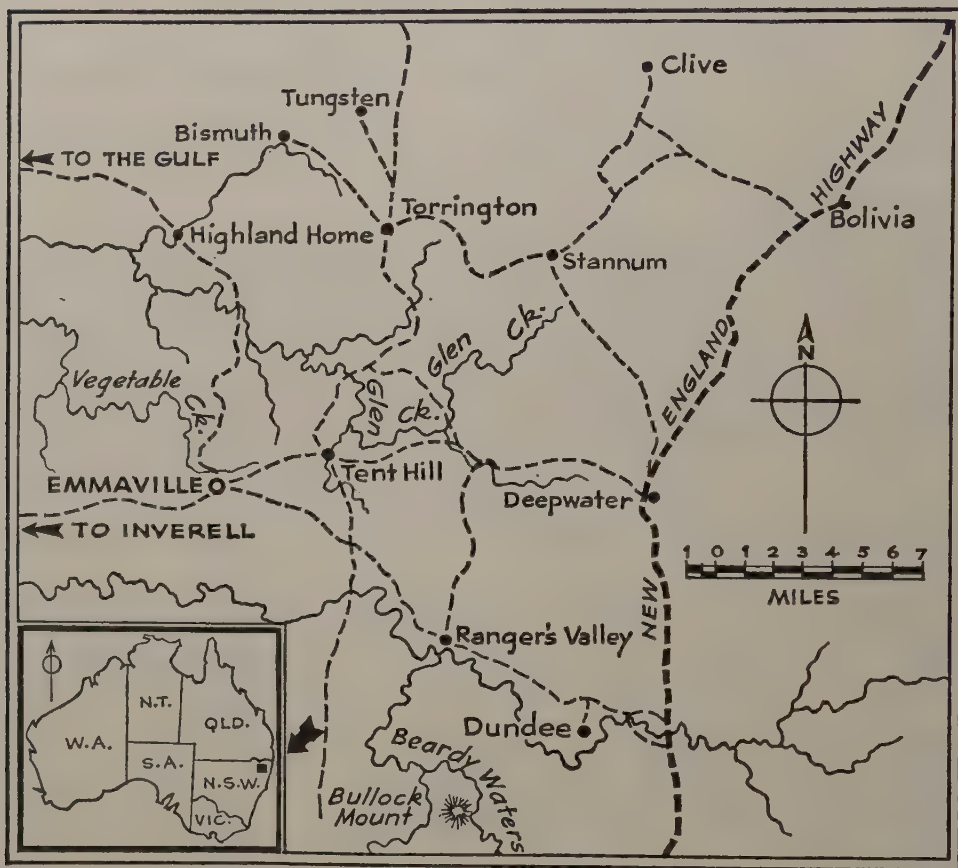
When in its pure form, beryl is colourless. Curiously, the presence of impurities enriches its colour, as it does with many gemstones, and results in delicate shades and tints. The colour of aquamarine is caused by a minute amount of ferric iron; the pink or red morganite contains a little lithium; yellow beryl is the result of a trace of uranium; whilst chromium is responsible for the shade of the coveted grass-green emerald.

Of the various colour forms the emerald is the most sought (although morganite is probably the rarest shade) and may easily be the most valuable of gems if of a large size, of good uniform green colour and free from flaws. Beryl (or emerald) is extremely brittle and, consequently, most stones recovered contain flaws. This especially applies to those stones taken from alluvial gravels, which are generally badly fractured as a result of the harsh treatment they have received amongst the stones in the drift.

Beryl usually occurs in granite localities in pegmatites with other gems and minerals such as topaz, cassiterite, wolframite and fluorspar; sometimes it occurs in metamorphic rocks, such as schists or altered limestones. Often it will be found embedded in quartz or calcite. If in quartz, great difficulty is often experienced in freeing the gems from their hard matrix without shattering them. If in calcite, they may quite easily be removed by the application of acids which will dissolve the calcite.

No enormous crystals of beryl such as the Brazilian find have yet been discovered in Australia, but quantities of fine emeralds have been mined at two important localities, separated from each other by the entire width of the continent. These are Poona in Western Australia and a locality near Emmaville, New South Wales.

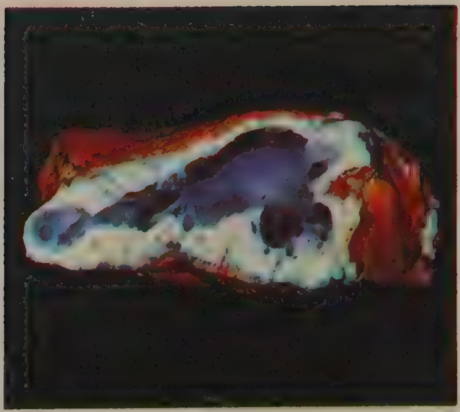
The New South Wales deposit was the first to be discovered, in 1890, at a site about 6 miles north-north-east of Emmaville, a small town 24 miles north-east of Inverell. This location, known as de Milhou's Reef, had originally been mined for tin, and emeralds were later observed in the old



The Emmaville district, New England

mine dump. Thereupon, a company was formed to mine the deposit and shafts were sunk in an endeavour to follow up the emerald-bearing veins. In the first year 2,225 carats were won and in both 1891 and 1892 about 25,000 carats. However, difficulties were encountered, not only in extracting the stones from the quartz but also in marketing them overseas

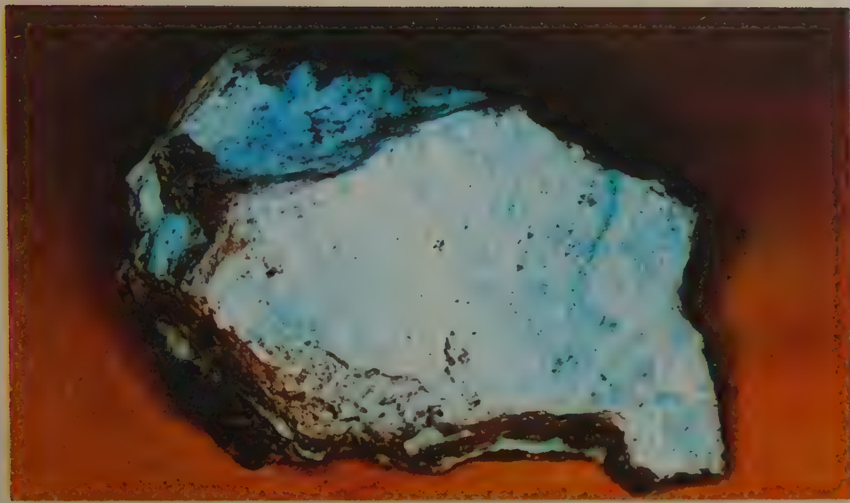
Black opal, known and admired throughout the world. This setting shows the fire and depth of the stone, and is in the possession of Nicholas Heiderich, Healesville, Victoria
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz



Opalite with chalcedony from Norseman, Western Australia
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Rose quartz, a beautiful shade of pink, has been found as a crystal, but generally only in massive form
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

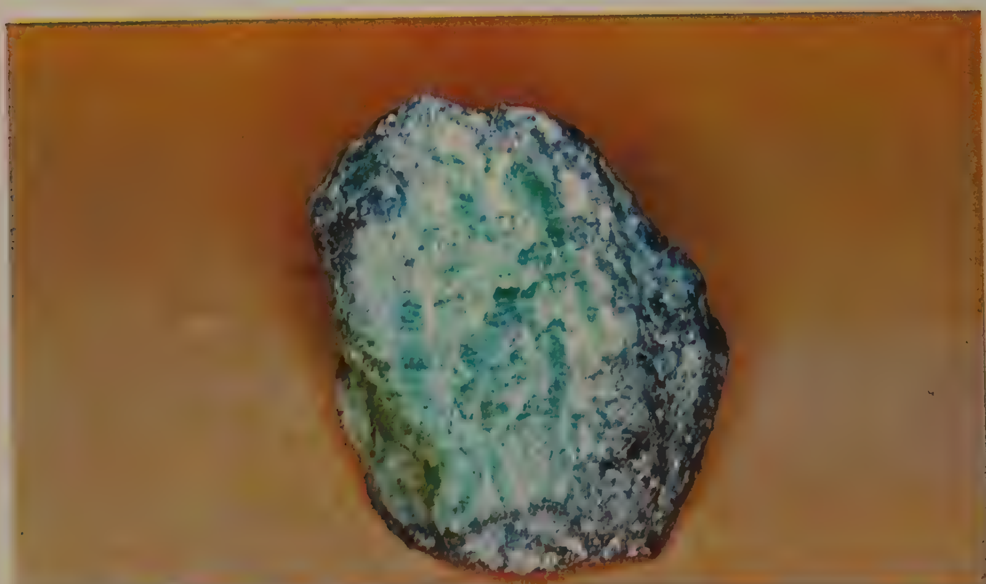
Tourmaline. This giant specimen, 8″ x 6″ was found in the Harts Ranges, Northern Territory
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz



Chrysocolla resembles turquoise in appearance, but is much more fragile. This specimen is on thomsonite
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Zebra stone, mainly used in the lapidary trade for carving
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Chalcedony, a semi-clear quartz gem found in cavities in volcanic rocks, also in massive layers like this specimen. Usually white or colourless, more rarely in this delicate shade of blue with white bands
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz



Feldspar from Broken Hill. Feldspars are extremely widespread and found in many colours and forms
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

(how often was this the lot of the Australian gem-miner!), and the mine was closed. Another brief attempt at working it was made in 1908, resulting in the recovery of 1,000 carats; some of the stones were reported as being of good quality, the largest weighing 6 carats cut. Some intermittent fossicking has since taken place, and the late Mr Schumacher, the owner of the pastoral property on the site, had in his collection some extremely fine beryls and emeralds obtained at this mine. A deep-green cut beryl, verging on emerald quality, slightly flawed, and weighing 88·5 carats, is now in the collection of the Australian Museum. It came from the Emmaville district.

At Poona, about 40 miles north-west of Cue in Western Australia, emeralds were discovered in 1912 by tin-miners. Some of the stones were of extremely fine quality, of good colour and comparatively free from flaws, the largest measuring 28 by 6 by 4 millimetres; the total production was 21,871 carats. However, much of the beryl in the Poona district, contained in the pegmatite veins in greenstone, is flawed and milky. The Melville area, east of Fremantle, is thought to contain marketable emeralds. Aquamarines are also found in the Poona and Melville localities. In the other Beryl locations of Western Australia very little material has been found to be of gem quality, but continued search may result in small quantities of the gems being recovered.

The beryl-bearing areas of the Harts Range, north-east of Alice Springs in the Northern Territory, have been found to contain large aquamarine crystals, but these have invariably been flawed. However, here again stones suitable for use as gems may eventually be won.

Beryls, some of gem quality, have been found in other areas of northern New South Wales. Some of a pale yellowish-green hue were found in Heffernam's wolfram mine, about 3 miles west of Torrington (north-east of Emmaville), in the early 1920s, whilst slender pale-blue crystals were recovered from The Gulf area, about 21 miles north-west of Emmaville. A large pale yellowish-green cut beryl of 73 carats from

Heffernam's mine may be seen in the Australian Museum gem collection. Other gem-quality beryls have been found in the gem gravels of Tingha, Cope's Creek, Torrington and Elsmore, associated with the alluvial tin.

In South Australia aquamarines have been taken from the Williamstown area, where they occur in quartz reefs, whilst others have been found in a similar type of rock at King's Bluff near Olary.

In Queensland the alluvial tin deposits of the Stanthorpe area have produced beryl, including aquamarine, as an associate of the tin, topaz, sapphires, garnet and quartz, but emerald has not been reported. The Herberton and Chillagoe areas yield occasional stones from similar deposits, but these are usually waterworn and fractured and of little use as gems. No gem-quality beryl has yet been reported from the Mica Creek or Galah Creek pegmatites on the Mount Isa mineral field in north-west Queensland.

Beryl (not necessarily of gem quality) has been found in Australia at the locations listed below. It has not been reported from Tasmania.

NEW SOUTH WALES

Emmaville	Frazer's Creek
Torrington	Cooma
The Gulf	Black Range
Broken Hill	Cope's Creek
Elsmore	Glen Eden
Tingha	Wunglebung
Ophir	Kiandra
Tumbarumba	Paradise Creek

WESTERN AUSTRALIA

Poona	Wodgina	
Londonderry	McPhee's Hill	
Dalgarango, near Yalgoo	Strelley	Pilbara goldfield
Melville	Mt Francisco	
Yinnitharra (Gascoyne)	Tabba Tabba	

QUEENSLAND

Chillagoe	Ballandean
Herberton	Mica Creek
Stanthorpe	Galah Creek

SOUTH AUSTRALIA

King's Bluff, near Olary	Williamstown

NORTHERN TERRITORY

Eastern Macdonnell Ranges	Harts Range

Agate Creek

Of all the gemstone deposits in Australia, the most fabulous is undoubtedly the area known as Agate Creek in North Queensland. No other name could possibly have been given to this creek, for, in parts, its bed and the surrounding country are literally carpeted with agates of all sizes, shapes and colours. For decades these immense deposits, there since the dawn of time, lay unnoticed and quite undisturbed, and many stockmen must have ridden over the area during the last century unconscious of the treasures underfoot. Indeed, little notice was taken of them even when it became known that the stone was actually agate and that thousands of tons of the stuff lay around for the taking.

To allay some of the wonderment that this statement arouses, it should be said that little value was placed on agate in the last century, and the agate-cutting centre of the world at Idar-Oberstein, Germany, was then quite amply supplied by the apparently inexhaustible Brazilian deposits. Such inaccessible deposits as those at Agate Creek, in a remote corner of the colony of Queensland, were of little interest. The age of popular jewellery and of the amateur lapidary had not arrived, and, what is perhaps more relevant, the horse transport of the day was slow, cumbersome and costly. So the deposits at Agate Creek remained practically as they had always been.

In the latter part of the century, during his travels around Australia, Nehemiah Bartley happened to stumble across this quite fantastic part of Queensland. His praise was extravagant and, realizing what treasures he saw lying all around him, he called the place 'Sinbad's Valley'. Let him tell you in his own words what he saw:*

And how shall I describe this Sinbad's Valley, where the agates are, the only *real actual* treasury of this kind on the face of the earth? It lies at the head of the Gilbert River, in tropical Queensland . . . here we have the central valley itself, walled with cliffs, and grass-grown in places, and, in the centre, filled with agates of every size, shape, and colour, with more and more of them if you only choose to dig under the grass and soil at the sides, and unearth the buried treasures; while in the middle of the dry channel, where water runs in wet seasons, you may wade in tons of agates, sardonyx, onyx, and carnelian; and *such* ones, too! The sardonyx, to vie with those in the Roman Emperor's tomb, at Halicarnassus, or the priceless ones at the Vatican; and the agates, from the size of a ham, or a horse's head, down to a hazel nut calibre; and the colours, well! I can only describe *some* of them, the variety is too bewildering. Here we have wide, concentric and numerous rings of transparent red, white, and blue, alternately, in a large specimen. Then we have a marvellous imitation of prettily mottled, and parti-coloured Castile soap, and spotted all over with lovely 'eyes'. Anon, we pick up a splendid piece of transparent lavender, with equally transparent *cerise* in the pod-shaped centre of it, the whole formed like a huge mussel shell. And, now, we have the same lavender and cerise again, but opaque this time, and beautifully blended in layers and cushions, with the suggestive hues of a red sun, rising or setting, in, and through, a warm-tinted, gray cloud lining. Now, again, we have a clear, tawny amber, in whose liquid depths the eye can follow, from the surface, the pure white bands, or lines—some wide, others almost microscopic in size, but all of symmetry and regularity—which light it up. Here is another, with its opaque red, white, and blue, arranged almost like the 'Union Jack'; and another, where the purple, red, blue, lavender, and white are delicately laid on, as if a dainty-hued flower were painted in a lady's album by a deft hand. And I must not forget the priceless sardonyx, with its clear meat-coloured red, and its pure dead white, in broad alternate bands; and another gem, also. You have, no doubt, in childhood, bought, at a 'lolly' shop, a stick, or pipe, of white, encircled with spirals of brilliant yellow, red, and blue colours, all sugar, and in startling contrast. Well! all this is reproduced on hard, pure, white

* *Opals and Agates*. Gordon & Gotch, Brisbane, 1892.

agate at the Gilbert River, and is lovely and imperishable, which the 'lollipop' is not.

Here is another, clear as water, and full of bands and drops of unmistakeable opaque red sealing wax; here are square pink and white concentric lines, alternately, in a square agate; here is a clear, golden, yellow 'sard', full of circular, opaque, white 'eyes'; deep-red, pure carnelians; all these polish gloriously. But, perhaps, the most charming of all is to get a section of the green basalt itself, stuck full of tiny pink, or crystal, agates, like plums in a pudding, and to cut it across, and polish each face, where the half-sections of each agate and crystal gleam out (like stars in the sky) from its back ground of dark green basalt matrix.

The reader may be forgiven if he is sceptical, for those who read Bartley's book in earlier days made no attempt to visit the area to see for themselves whether he had exaggerated. And so Agate Creek lay neglected for another half-century.

It was not until the 1950s that a small group of enthusiastic Brisbane collectors, inspired by the reports of 'Sinbad's Valley', set out to make the journey to this remote locality. Little was known of the terrain or the roads into the deposit, and there were no guides. Only by practically making their own road were they able to reach their destination. But the agates they took out and the stories they told, backed up by photographs, convinced even the most cynical that here, indeed, was a treasure-house of gemstones.

Since then, many hundreds of collectors have successfully made the journey to this Mecca of all gemhunters, but, from the latest reports, there are still immense quantities there, with no sign of the deposits becoming exhausted. The area is so rich in the stones that several leases have been pegged out, still, however, leaving a vast area to be picked over.

Agate Creek is a branch of the Robertson River, which itself runs into the mighty Gilbert, eventually emptying into the Gulf of Carpentaria. The country it waters is extremely isolated and rugged, consisting of great masses of igneous material drained by a network of creeks and gullies, the location of the Agate Creek Volcanics, up to 4,000 feet in thickness. The agates originally occurred in cavities in the basalt and may still be seen embedded in this parent rock. However, weathering has liberated huge quantities, which are now found lying on the surface in and near the creek and adjacent gullies and pockets.

The agates vary in size from one inch in diameter and less to giant nodules six and eight inches in diameter. Most of the whole agates are covered with a thick, pock-marked layer of silica, resembling a kind of skin, and this conceals the internal markings until the nodules are sawn and opened. Gemhunters should not use their prospector's hammers on these nodules, as many a fine agate has been ruined by doing this. Agate cracks and crazes under a heavy blow, and likely specimens should be taken away whole and later sawn or ground with the aid of proper lapidary equipment.

The bandings of the Agate Creek agates are magnificent, many qualified gemhunters considering them equal to anything in the world. As well as the banded form, practically every variety of agate (and chalcedony) may be found: the fascinating inclusion agate, pipe agate, eye agate, carnelian, sard, onyx, sardonyx and chalcedony.

The area is remote and difficult of access, but the gemhunter willing to make what can become a long, arduous journey will find superb material to reward his effort. Naturally, the journey should not be approached lightly and all normal precautions for a trip of this nature should be taken. The vehicle should be absolutely sound (extra spare tyres are recommended), and a first-aid kit and adequate provisions are essential. Generally, a four-wheel-drive vehicle is preferable, especially for long sandy crossings, although many two-wheel-drive vehicles have successfully made the journey.

No attempt should be made to travel to Agate Creek during the wet season. Even if the adventurous gemhunter managed to reach Forsayth and to cross the Robertson River before the 'wet' set in, it is quite unlikely that he would get out again. The creeks and rivers in this locality, although usually dry, sandy beds, fill rapidly during heavy rain and become impassable. Any marooned gemhunters would find conditions most uncomfortable and quite probably extremely dangerous. The dry winter months are the best period for this trip. The heat, then, is also not quite so intolerable.

Agate Creek is about 350 miles south-west of Cairns and 45 miles south of Forsayth. The route from Cairns to Mt Garnet (about 110 miles) is the most direct, although the road is mainly gravel and rough. The roads from Ingham and Charters Towers should not be taken, for they entail long crossings of the Burdekin and Clarke rivers, which may cause difficulties. At the Lynd, a small centre between Mt Garnet and Hughenden, petrol and provisions may be obtained at a small store. From there to Forsayth via Einasleigh is about 90 miles along a road that is rough but quite trafficable if care is taken. Provisions should be bought at the Lynd or at Einasleigh, since there is no store at Forsayth. Petrol, however, is obtainable there.

The road from Forsayth to Agate Creek crosses the Robertson River about 38 miles from the township. This crossing may be difficult: the river at this point is a wide expanse of sand, affording little traction for the two-wheel-drive vehicle. A four-wheel-drive vehicle is handy here, although many gemhunters have managed to get across without one by laying their own tracks in the sand as they went, with wire mesh, etc., brought with them.

A further 17 miles brings the track to the first crossing of Agate Creek. The gemhunter is now in agate country and he may either continue on to further crossings or examine the area he is in. There is a great deal of agate lying around here, but most of the good surface material has been removed. What is left on top of the ground is generally fractured and useless, so that the gemhunter must either dig for fresh, unexposed material or walk farther up the creek. If he decides on the latter course, he will have to take haversacks and bags for specimens and, weight having become a consideration, will have to load himself only with material that is worth the carrying. A walk right up to the head of the creek to the original deposits in the volcanic rocks will bring the gemhunter to agates which are perfect and flawless, but some work is required to free them from the surrounding basalt.

Some of the finest agates in Australia have been taken from Agate Creek, as is illustrated by the magnificent displays of ground, sawn and polished gems in the possession of private collectors all over the country. Their fame has spread overseas, where many collectors, particularly in the United States, are now aware of their quality and are eager to add specimens to their collections.

A trip to Agate Creek may require a great deal of time and planning to accomplish. Nevertheless, gemhunters will continue to be undismayed by the difficulties in their search for material of the very first quality, suitable for display anywhere in the world.

Gemstones:

Gemstone and crystal system	*Composition*	*Specific gravity*	*Hardness*	*Colours*
AGATE (Crypto-crystalline)	Silicon dioxide (quartz)	2.60	7	
ALMANDITE, *See* GARNET				
AMAZONITE, *See* FELDSPAR				
AMETHYST (Hexagonal)	Silicon dioxide (quartz)	2.66	7	Mauve to deep purple
ANDALUSITE, *See* CHIASTOLITE				
ANDRADITE, *See* GARNET				
AQUAMARINE (Hexagonal)	Beryllium aluminium silicate	2.71	7½ to 8	Bluish green
AVENTURINE (Massive)	Silicon dioxide (quartz)	2.66	6½ to 7	Yellow, brown, green, red
BERYL (Hexagonal)	Beryllium aluminium silicate	2.71	7½ to 8	Bluish green, yellow, colourless, pink, green
BLOODSTONE (Crypto-crystalline)	Silicon dioxide (quartz)	2.66	7	Deep green with red spots
CARNELIAN	Silicon dioxide (quartz)	2.66	7	Red or brown
CHALCEDONY (Crypto-crystalline)	Silicon dioxide (quartz)	2.66	7	Colourless, white, and pale colours
CHIASTOLITE (Orthorhombic)	Aluminium silicate	3.20	7 to 7½	Grey with black cruciform markings
CHRYSOBERYL (Orthorhombic)	Beryllium aluminium oxide	3.70	8½	Yellow or green
CHRYSOPRASE (Crypto-crystalline)	Silicon dioxide (quartz)	2.66	7	Apple green
CITRINE (Hexagonal)	Silicon dioxide (quartz)	2.66	7	Yellow
CORUNDUM (Hexagonal)	Aluminium oxide	4.00	9	—
DIAMOND (Isometric)	(Crystallized) carbon	3.52	10	Colourless, yellow, brown, blue, pink, orange, green, black

Identification Table

Degree of transparency	*Lustre*	*Fracture*	*Other characteristics*	*Occurrence*
Translucent to opaque	Vitreous	Conchoidal		As nodules in igneous rocks or in gravels
Transparent	Vitreous	Conchoidal	Colour often pale or uneven	Massive or as crystals in geodes
Transparent	Vitreous	Conchoidal with basal cleavage	Variety of beryl	In pegmatites
Translucent to opaque	Pearly	Hackly	Spangled with mica or haematite	In pegmatites
Translucent to transparent	Vitreous	Conchoidal with basal cleavage	In well-formed prismatic crystals	In pegmatites, limestone and schist
Opaque	Waxy	Conchoidal or hackly	Green and red jasper	In igneous rocks and in gravels
Translucent	Vitreous or waxy	Conchoidal	Coloured chalcedony	As nodules in igneous rocks and gravels
Translucent	Vitreous or waxy	Conchoidal		As nodules in igneous rocks and gravels
Transparent to translucent	Waxy	Uneven	In circular prisms	In schists
Transparent to translucent	Vitreous	Conchoidal	As crystals often vertically striated	In pegmatites and mica schists
Translucent to opaque	Vitreous to waxy	Conchoidal	Green chalcedony	In veins, normally associated with serpentine
Transparent	Vitreous	Conchoidal	Good-quality, natural citrine scarce	Associated with quartz crystal, tin, etc.
Transparent to opaque	Almost adamantine	Conchoidal with basal parting		Usually as pebbles in gem gravels
Transparent	Adamantine	*Cleavage:* Perfect	Hardest natural substance	In gem gravels

Gemstone and crystal system	*Composition*	*Specific gravity*	*Hardness*	*Colours*
EMERALD (Hexagonal)	Beryllium aluminium silicate	2.71	7½ to 8	Grass green
FELDSPAR				
Amazonite (Microcline feldspar) (Triclinic)	Potassium aluminium silicate (like orthoclase)	2.56	6 to 6½	Bright green
Labradorite (Plagioclase feldspar) (Triclinic)	Calcium aluminium silicate, with sodium	2.67	6	Grey, brown, green, often with iridescence
Moonstone (Orthoclase feldspar) (Monoclinic)	Potassium aluminium silicate	2.57	6	Opalescent or pearly
Sunstone (Orthoclase feldspar) (Monoclinic)	Potassium aluminium silicate	2.57	6	White with red or orange spangles
FLUORITE (FLUORSPAR) (Isometric)	Calcium fluoride	3.20	4	Green, purple, blue, colourless
GARNET (Isometric)	Complex silicates	—	—	—
Pyrope	Magnesium aluminium silicate	3.80	7 to 7½	Red
Almandite	Iron aluminium silicate	4.20	7½	Deep red, brownish red
Spessartite	Manganese aluminium silicate	4.15	7 to 7½	Orange red, brownish red
Grossularite	Calcium aluminium silicate	3.60	7	White, green, yellow, brown
Andradite	Calcium iron silicate	3.80	6½ to 7	Yellow, green, black, brown
Rhodolite		3.80	7 to 7½	Rose red to purple
GROSSULARITE, *See* GARNET				
JADE (Monoclinic)				
Jadeite	Sodium aluminium silicate	3.40	6½ to 7	White, green, red, brown, yellow
Nephrite	Silicate of calcium, iron and magnesium	2.99	6 to 6½	White, grey, red, yellow' green, black
JASPER (Crypto-crystalline)	Silicon dioxide (impure quartz)	2.66	7	Brown, black, striped or mottled
LABRADORITE, *See* FELDSPAR				
MOONSTONE, *See* FELDSPAR				
NEPHRITE, *See* JADE				

Degree of transparency	*Lustre*	*Fracture*	*Other characteristics*	*Occurrence*
Transparent	Vitreous	Conchoidal with basal cleavage	Variety of beryl; often flawed	In limestones, schists and pegmatites
Translucent to opaque	Vitreous	*Cleavage:* Perfect	Often in very large crystals	In igneous rocks, often with orthoclase feld-spar
Translucent on fine edges, otherwise opaque	Vitreous to pearly	*Cleavage:* Perfect	Crystals rare. Usually massive	In basic igneous rocks
Translucent	Vitreous to pearly	*Cleavage:* Perfect	Usually massive	In igneous rocks
Translucent	Vitreous to pearly	*Cleavage:* Perfect	Usually massive	In igneous rocks
Transparent to translucent	Vitreous	*Cleavage:* Perfect	Found as cubic crystals or massive	With tin, topaz, etc., in pegmatites or lime-stones
—	Vitreous	Conchoidal or uneven		Volcanic rocks, meta-morphic rocks, in gravels
Transparent to Translucent			Often almost black	
Transparent to Translucent				
Transparent to translucent				
Transparent to translucent			Hessonite cinnamon variety	
Transparent to opaque			Green: demantoid Black: melanite	
Transparent to translucent			Mixture of pyrope and almandine	
Translucent to opaque	Almost vitreous	Splintery	Compact	Metamorphic rocks
Translucent to opaque	Almost vitreous	Splintery	Very tough and fibrous	Associated with serpentine
Translucent to opaque	Vitreous or dull	Conchoidal	May be massive	As lumps or nodules i igneous rocks or gravels

Gemstone and crystal system	*Composition*	*Specific gravity*	*Hardness*	*Colours*
OBSIDIAN (Amorphous)	Volcanic glass	2.45	5 to 5½	Colourless, green, brown, black
OLIVINE (PERIDOT) (Orthorhombic)	Magnesium iron silicate	3.40	6½ to 7	Green or yellow-green
ONYX (Crypto-crystalline)	Silicon dioxide (quartz)	2.66	7	Black and white bands
OPAL (Crypto-crystalline: cristobalite)	Quartz	2.15	5½ to 6½	(*See* p. 45)
PERIDOT, *See* OLIVINE				
PREHNITE (Orthorhombic)	Hydrous calcium aluminium silicate	2.80 to 3.00	6 to 6½	Green
PYROPE, *See* GARNET				
QUARTZ (Hexagonal)	(*See* p. 37ff)			
RHODOCHROSITE (Massive)	Manganese carbonate	3.70	4	Pink or red
RHODOLITE, *See* GARNET				
RHODONITE (Massive)	Manganese silicate	3.40 to 3.67	5½ to 6½	Pink, rose, red, often with black veins
RIBBONSTONE (Massive)	Silicon dioxide (quartz)	2.60	7	In striped ribbon effects of almost any colours
ROSE QUARTZ (*See* p. 39)				
RUBY				Red variety of gem corundum
SAPPHIRE (Hexagonal)	Aluminium oxide	4.00	9	Coloured variety of gem corundum
SERPENTINE (Massive)	Hydrous magnesium silicate (a rock)	2.50 to 2.60	5	White, green, yellow
SPESSARTITE, *See* GARNET				
SPINEL (Isometric)	Magnesium aluminate	3.60	8	Red, blue, purple, green, black
SPODUMENE (Monoclinic)	Lithium aluminium silicate	3.18	6 to 7	Purple, yellow, pink, green
STAUROLITE	Silicate of iron and aluminium	3.60	7	Brown or reddish brown
SUNSTONE, *See* FELDSPAR				
TOPAZ (Orthorhombic)	Fluo-silicate of aluminium	3.53	8	Colourless, blue, red, yellow, brown, brandy colour, green, pink

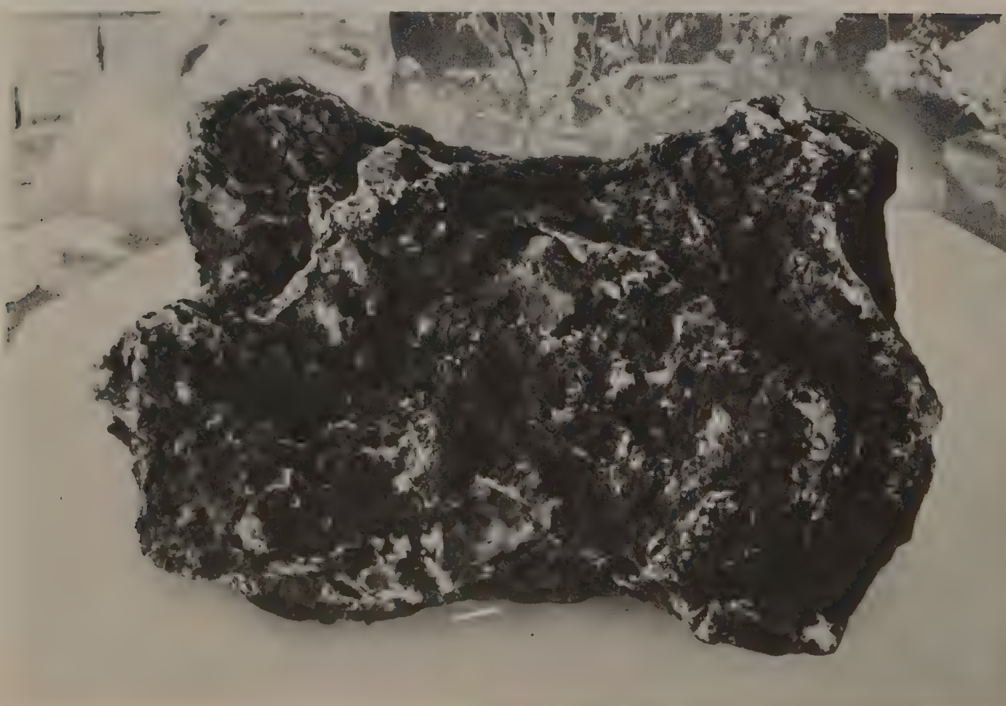
Degree of transparency	*Lustre*	*Fracture*	*Other characteristics*	*Occurrence*
Transparent	Vitreous	Conchoidal	No crystal structure	Volcanic rocks
Transparent	Vitreous	Conchoidal	Often as crystal encrustations	In basalts
Translucent	Vitreous	Conchoidal	Form of chalcedony	As nodules in igneous rocks and gravels
Transparent to opaque	Vitreous	Conchoidal	(*See* p.45-6)	As filling in cavities of igneous or sedimentary rocks
Translucent	Vitreous	Uneven	Encrustations and botryoidal formations	In volcanic rocks
Translucent to opaque	Vitreous	Granular	Will effervesce in hydrochloric acid	With manganese ores
Opaque	Dull	Uneven, granular	Crystals rare	With manganese ores
Opaque	Dull	Conchoidal	A variegated chert	Metamorphic rocks
Transparent, translucent, and opaque	Adamantine	Conchoidal with basal parting	Heavy for a non-metallic mineral	In gravels usually as waterworn gems
Translucent to opaque	Greasy	Splintery	Often mottled like a snake's skin	With magnesite
Transparent to opaque	Vitreous	Conchoidal	Black: Pleonaste	In gem gravels associated with sapphires
Transparent	Vitreous	*Cleavage:* Perfect	Pink: kunzite Green: hiddenite	In pegmatites
Opaque	Dull	Splintery	Often twinned crystals to form crosses	In schists often with garnets
Transparent	Vitreous	*Cleavage:* Basal	Similar in appearance to quartz	In pegmatites often with tin, fluorspar, etc.

Gemstone and crystal system	*Composition*	*Specific gravity*	*Hardness*	*Colours*
TOURMALINE (Hexagonal)	Complex silicate of boron and aluminium	3.05	7 to 7½	Red, blue, violet, green, yellow, black
TURQUOISE (Crypto-crystalline)	Hydrous copper-aluminium phosphate	2.75	5 to 6	Green or blue
ZIRCON (Tetragonal)	Zirconium silicate	4.00 to 4.70	7½	Colourless, yellow, red, green, blue, red-brown

Group of amethyst crystals in parallel growth, size 7″ x 6″, from Brazil
Photograph courtesy Australian Lapidary Supplies

Fine Australian black star sapphires showing well-defined six-rayed stars
Specimens courtesy D. A. Robinson & Co.

A large nodule of Queensland chrysoprase, size 18″ x 12″, weight 66 lb.
Photograph courtesy Australian Lapidary Supplies

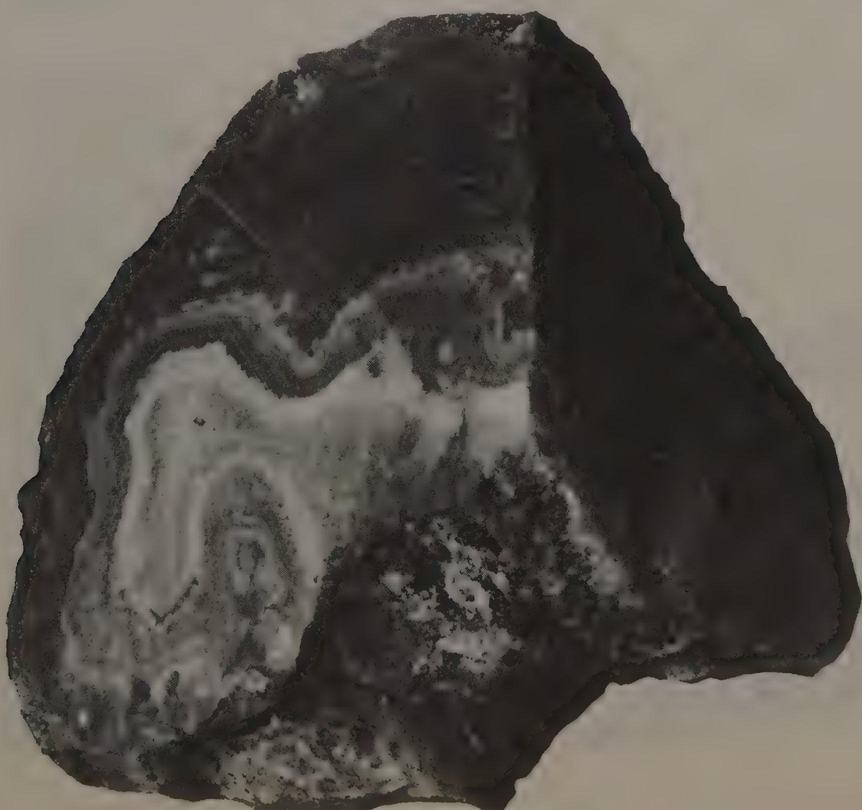


A pile of agate weighing about 1,500 lb. (Agate Creek nodules) . In the foreground is part of a large nodule which weighs 120 lb. The photo was taken in the yard of a lapidary supplier

Photograph Guenter H. Woyde, courtesy Australian Lapidary Supplies

A section of what must have been a very large agate. This wedge weighs 64 lb. It is a very good quality banded agate with a mossy area towards the top. Size 14″ x 11″. From Agate Creek, Queensland

Photograph courtesy Australian Lapidary Supplies



A facet head employing 64 notches, selected by means of the front lever, with a sapphire fixed on a-dop stick in the chuck and resting on the diamond-charged, scored copper lap. Angles of cut are provided by raising or lowering the head on the vertical post

Equipment courtesy D. A. Robinson & Co.

Close-up of a sapphire being ground on a diamond-charged, scored copper lap. Here the crown is being cut on a brilliant, although the table hasn't yet been faceted

Equipment courtesy D. A. Robinson & Co.

Degree of transparency	*Lustre*	*Fracture*	*Other characteristics*	*Occurrence*
Transparent to opaque	Vitreous	Uneven	Sometimes in multi-coloured crystals Black: schorl	Pegmatite, often associated with tin
Opaque	Waxy	Conchoidal	Sky blue to Prussian blue: most valuable	As veins in schist
Transparent	Adamantine	Conchoidal	Heavy for a non-metallic mineral	Gem gravels associated with sapphire

Part 2 How to Cut Gemstones

The Art of the Lapidary

Many lapidaries begin as gemhunters. As with all hunting, the seeking and finding of gemstones ranks as an achievement in itself and many a gemhunter has cause to congratulate himself on the fine array of natural stones he has collected in this manner. Some may be inclined to admire Nature in the raw and content themselves with building up a collection of rough, untreated stones and crystals. The natural beauty of some of this material almost defies improvement under the hand of the lapidary. In fact, many a newcomer to the hobby is quite astonished to learn that the symmetry of the natural quartz, amethyst or beryl crystal, with its flat shining facets, is entirely the work of unaided nature and is not, as may have been supposed, the result of careful grinding and polishing. Some dedicated collectors deplore the fact that many fine gemstone crystals, which may have been preserved as unique mineral specimens, have emerged from the cutter's hands as mere cut stones. An awareness of the scarcity of fine crystallized gemstones and the fear that, once cut, they have passed out of existence forever, no doubt fosters this attitude.

But not all rough gem material falls into this category. A great quantity of it exhibits little that is attractive until it undergoes some sort of 'beauty treatment'. A rough agate nodule is of little appeal until it is sawn and opened. A piece of petrified wood may show merely a weathered exterior until the lapidary saw reveals a finely-coloured grain within. Rough sapphires may appear to be a handful of dark pebbles until the faceter brings forth the sparkle of the jewel stone. Some of the most attractive materials, such as bloodstone, rhodonite or jasper appear to be lumps of drably coloured rock until they are ground and polished. Even the common rocks, quartz, granite and rhyolite, show an amazing transformation after having undergone this process.

Eventually then, the hobbies of gemhunting and collecting, with their many absorbing by-paths, direct the attention of the enthusiast to other fields besides that of the simple art of collecting. What is to be done with the stones that he has accumulated? How can they be improved in appearance? It is then that he finds himself considering entering the ranks of the grinding and polishing enthusiasts. The world of the lapidary begins to unfold itself to him and, with it, that incomparable satisfaction of being able to convert into gemstones the rough fragments and rocks he has uncovered in his travels. If you are new to the hobby, or are contemplating entering it, any lapidary will assure you that there is little to be likened to that moment when the ground and prepolished stone takes on its almost-instant final gleam. All the preparation in the acquisition of the stone, its shaping, grinding and sanding are but preludes to the final touch and it is found to be well worth all the effort.

Today the avenues to this popular pastime are, fortunately, open to all. In quite recent times it was customary for the layman to regard the lapidary with a feeling of near-awe. For his was a craft surrounded in mystery and its secrets were only rarely available to the uninitiated. This attitude probably sprang from the natural reluctance of the European diamond-cutting families (which often assumed the role of dynasties) to reveal the closely-guarded techniques which they had patiently acquired over generations, making their towns the cutting centres of the world. Knowing little of the properties of gemstones, the non-cutter concluded that all stones were alike, a lifetime of study was too long and wisely left the whole business to those who knew the trade. At the turn of the nineteenth and twentieth centuries a number of experienced European lapidaries migrated to Australia and became engaged in the cutting of sapphires and opals which were then pouring from the newly-discovered fields. Some of these cutters settled on the gemfields, where they bought for Australian and overseas gem merchants, as well as cutting the stones they purchased for themselves. Others were employed by large gem merchants and manufacturing jewellers and, in a number of cases, their descendants may be found today practising the same craft. These early lapidaries laid the foundation of the gem-cutting industry in Australia so that today it is no longer necessary to send large quantities of our gemstones overseas for treatment.

There is a great distinction between a gem-cutter and a diamond-cutter. It is customary to call the former a lapidary to distinguish him from the accomplished craftsman who facets and polishes the king of gems. Even today the lapidary does not often aspire to diamond-cutting, for this, the hardest of stones (which can be cut only by the diamond itself), is necessarily the subject of intense study and experience and therefore diamond-cutting is a highly specialized undertaking. The less-hard stones, however, such as sapphire, topaz, beryl, garnet etc. present no such difficulties so that the technique of cutting and polishing these appears relatively simple.

The extremely primitive equipment of former days made the treatment of all stones a formidable task. Loose emery grits necessitated long and patient grinding of even simple cabochons. The incredibly tedious mud-saw, with its messy slurry, meant long hours at the saw bench when slabbing even quartz minerals. The very sight of the huge, unwieldy sandstone grinding wheels of Idar-Oberstein, and other German cutting centres, was enough to deter even the most ambitious lapidary. Fortunately, man is naturally inventive and constantly looking for new and improved methods to replace the old. As a result, he invented synthetic silicon carbide, known as carborundum, as a grinding medium. The bonding of this hard material into grinding wheels made the task easier, whilst the introduction of wet and dry silicon carbide sanding papers and of new types of polishing compounds revolutionized the entire cutting and polishing processes.

Possibly the most important development in the entire history of lapidary achievement was the invention of the diamond saw. This event took place in the United States in 1934 (the inventor being a former Australian) and in itself was responsible for the greatest leap forward in the popularity of lapidary activity in that country. For the first time the amateur was able to saw neatly, cleanly and quickly the stones he wished to grind and polish. Further improvements in design and the availability of synthetic diamonds have resulted in the high-speed, efficient diamond saws in use today.

The modern amateur lapidary, therefore, no longer has to rely upon obsolete equipment of the old horse-and-buggy days. He does not even have to assemble his own units or to convert machine-shop equipment to lapidary use. The popularity of the hobby has ensured that a number of manufacturers have for sale equipment designed solely for lapidary work. These are quite within reach of the ordinary pocket and, in some cases, the enthusiast has only to add his motor and plug it in.

Perhaps a little of the earlier awe of the lapidary still lingers with us for, to some, the prospect of becoming an accomplished stone-cutter and polisher seems at first impossibly difficult. However, as many have discovered, it is not a difficult task and certainly not an impossible one. As with most new projects, the requirements are an open mind, some tuition and a lot of practice. Refinement of technique comes later. Some will find that the first stones they polish have a rather inferior look when compared with some of their more advanced efforts. Others will devise for themselves individual methods and short cuts. But whatever early difficulties are encountered in the modern application of this ancient craft, the outcome will certainly be a great deal of pleasure and satisfaction long after the initial effort has been forgotten.

Styles of Cutting

THE CABOCHON

Undoubtedly, the most popular form of cutting is that known as the 'cabochon'. This is the familiar domed shape and, for want of another name, might easily have been called the 'opal cut' for, with the possible exception of transparent fire opals, all of those gemstones are eventually shaped into one or other of the cabochon group. The name is derived from the French for 'like a bald head' (*en cabochon*), an apt description of its shape and appearance.

Although it is a style in common use and therefore easily executed, it is not to be despised on that account. To fashion a fine cabochon requires the application of some skill—in fact, as much in its way as producing a gem mechanically with a modern faceting head. The cabochon is usually the first style of cut attempted by the amateur lapidary. This is because it is the simplest form, the equipment is not expensive, and cutting material for the purpose is well within reach.

This style is usually applied to those stones which are opaque patterned, deeply coloured or (in the case of opal and others) exhibit sheen, opalescence or a play of fire. In the case of opaque stones, the cabochon is intended to display the surface layer of colour, enhanced by its polish. Translucent or transparent dark stones, such as garnet or coloured quartz, are cut *en cabochon* to provide a depth and richness of colour. In all cases, the ultimate beauty of the stone is provided by the combination of this colour with the symmetry of its shape and the smoothness of its dome. Pale or weakly coloured stones, such as colourless quartz or light shades of aquamarine, are seldom cut into this style as they do not possess the essential qualities of colour or pattern. They are, instead, faceted to take advantage of their optical properties.

As a design, the cabochon is of ancient origin and, no doubt, was originally suggested by the appearance of naturally waterworn pebbles. Most of the Biblical stones mentioned as being used for adornment of breastplates and other regalia were wrought into cabochons. The many stones which survived the Dark Ages and medieval times indicate that it was customary to set cabochon-cut precious stones in crowns, sceptres, golden drinking vessels and the many other examples of the jeweller's art of those times. Much later, the style became extremely popular in Victorian times, the era of the brooch and the pendant, and of turquoise and jet. Today, specimens of that peculiar product of the age, the 'carbuncle', are still to be seen mounted in antique jewellery. The 'carbuncle', a garnet cut in the form of a cabochon—sometimes with a concave back to lighten the colour of dark stones—has since been largely displaced by the modern faceted gem.

In the earlier days of the Australian opal-fields, it was customary for opal-cutters on those fields to fashion their cabochons on a simple hand grinder or one equipped with a treadle device in the manner of the obsolete sewing machine. Some gougers still use this method of facing, rough shaping and removal of sandstone and ironstone matrix from the opal. The more advanced lapidary, however, employs a power-driven wheel.

Stones displaying asterism (star effect) and chatoyancy (cat's-eyes) as well as moonstones, labradorite and those containing attractive inclusions such as rutilated quartz, are always cut into cabochons. Agate and other stones showing strong banded designs or mottled patterns are treated likewise.

Types of Cabochons

The cabochon may take a number of forms, designed to accentuate the colour of the stone, to provide a heavier gem, to qualify for a special role in jewellery setting or simply to conform to the mood of the cutter. The most common style is the *simple cabochon,* with a curved top and a flat base.

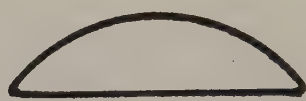


Fig. 4

Simple cabochon

The simple cabochon may be varied to provide a *high or a low cabochon*:

Fig. 5

High and low cabochons

The high cabochon is often used to accentuate the colour of the stone or to take advantage of any inclusions. It is generally employed with star stones so as to feature a sweeping curve of the star's rays down the sides of the gem. The low cabochon is suitable for deeply coloured stones—to lighten the colour—or for softer stones so that less wearing surface is projected. For valuable stones, such as opal, where only a thin layer of material is available for cutting, the low cabochon may be the only solution.

Whether simple cabochon, low cabochon or high cabochon, it may be designed in many ways: ovals, rounds, squares, hearts, drops, shields or any freehand style the lapidary may choose. Some of these shapes are illustrated in Figure 6.

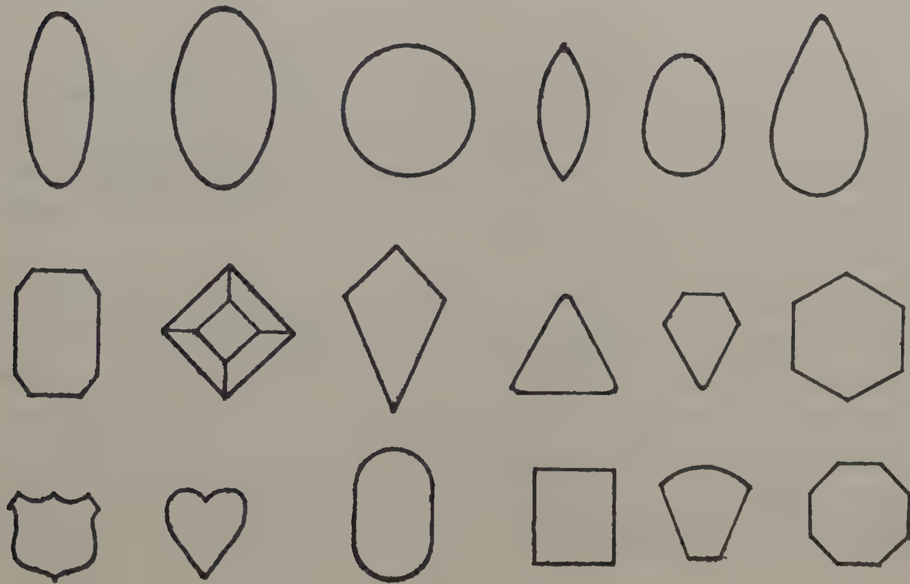


Fig. 6
Typical cabochon shapes: oval, drop, kite, triangle, octagon, shield, heart, lozenge, etc.

As most of the simple cabochons—high, medium or low domes—are cut from opaque or translucent stones, it is not necessary to sand and polish their backs, as they are not visible on display or when mounted in jewellery. They are therefore left flat, and unpolished. However, transparent stones such as citrine, cairngorm or grass-stones should be polished on the back to provide as much transparency as possible. Without this finish, the back appears frosted and mars the general appearance of the stone.

The cabochon cut may be varied slightly to provide a *double cabochon*, consisting of a combination of the simple cabochon top with a back slightly less curved than the dome:

Fig. 7

Double cabochon

This style is optional and is sometimes used when the design or pattern continues through the depth of the stone. Double cabochons should always be polished on the back to provide a fine finish. This style was formerly called the double (convex) cabochon.

The *lentil cabochon*—so-called because of its bean-like appearance—is actually a double cabochon with the difference that both dome and back are of approximately the same depth and curvature. This style may be used for a gemstone which is equally attractive from both sides, or one which is to be mounted in a pendant or (a pair) in ear-rings where both sides may be visible.

Fig. 8

Lentil cabochon

Yet another variation is provided by the *hollow or concave cabochon*. As mentioned previously, some of the transparent stones of dark colour are treated in this manner in order to lighten the colour. The hollow-backed cabochon presents some difficulty for the amateur lapidary, as special equipment and skill are required to obtain a well-formed and polished concavity.

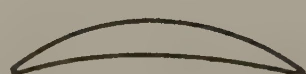


Fig. 9

Hollow or concave cabochon

Most cabochons produced by the amateur lapidary will be displayed in a collection, in which case he may content himself with producing a stone of any suitable dimensions and of pleasing shape. Possibly, some will eventually be mounted into jewellery pieces. If so, the stone intended for setting may have to be proportioned in a particular size, as made-to-order mountings are expensive. The lapidary should therefore acquaint himself with the sizes (in millimetres and inches) of the various types of ready-made mountings and cut stones for them accordingly. Templates, referred to elsewhere, are marked with these details and enable the cutter to size his stones without having to resort to measuring.

It is not desirable, however, that the lapidary should consider himself a 'gem factory' and use a template on every occasion, for this may tend to affect his judgment of the potential of his stones—and may even injure his amateur status! As explained in a later section, good freehand style is often cramped by the over-use of ready-made patterns. *Manufacturing* of gems for jewellery is best left to the commercial cutter or manufacturing jeweller.

Methods of cutting and polishing cabochons are dealt with in the chapter on grinding on p. 62.

FACETED STONES

Unlike the cabochon cut, faceted gemstones are designed to show a threefold effect: surface reflection, internal reflection and dispersion and body colour, if any.

The Brilliant

The faceted cut with which most of us are familiar is the 'brilliant', known by the stones in the many thousands of diamond rings we see glittering in the jewellers' windows. It is a style of cut utilized freely also for zircons, aquamarines, quartz, citrines and other colourless or pale-tinted gemstones. The total number of facets applied to a brilliant is fifty-seven: thirty-three on the top or crown and twenty-four on the bottom, or pavilion. Occasionally, a small extra facet, called the 'culet', is applied at the apex of the pavilion facets although this practice is now uncommon. The angles of the brilliant cut are devised to provide the maximum amount of internal reflection, or dispersion of light, so that the stone has a characteristic 'sparkle'. These angles vary according to the type of stone and are based on the refractive index. The proportion of the depth of the crown to the pavilion also plays an important part in whether the most brilliance or colour is required. If the crown is cut 25% and the pavilion 75% of the height, a more brilliant stone will be produced, but of paler colour. On the other hand, a proportion of 33 1/3% crown to 66 2/3% pavilion provides a richer hue, as the result of the light passing through a greater depth of colour before being reflected.

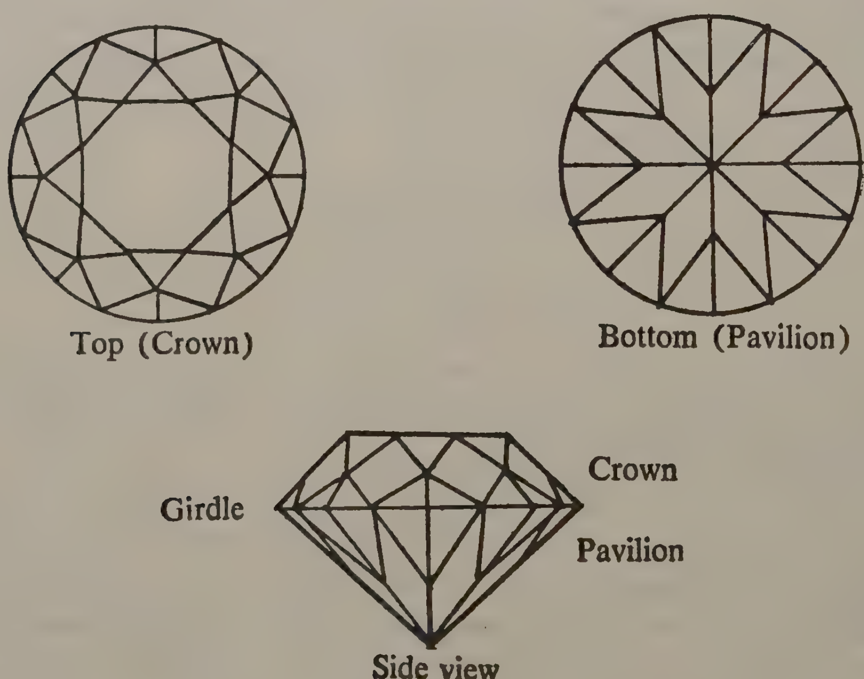


Fig. 10

The round brilliant cut

The standard round brilliant may be varied to provide a series of modified cuts, including the brilliant cut heart, and the brilliant with horizontal-split main facets or with vertical-split main facets.

The Step Cut

The step cut, or, as it is sometimes called, the 'trap cut', is so called because of the style of the facets—placed in 'steps'. Another name quite often used for this style is the 'emerald cut' as that valuable gem is invariably faceted in that manner. It is generally employed in cutting stones which depend more upon internal colour than 'fire', for instance sapphires, some garnets, beryl and, of course, emeralds. Some good quality flawless diamonds are faceted in the step cut as this method affords a clear view of the interior of the stone, quite unlike the brilliant which, because of its number of small facets, tends to obscure this view. Small, narrow step-cut stones used as shoulder ornaments on rings or set together to form groups are known as 'baguettes'.

Any number of steps may be cut in this style. In fact, it is the practice of some cutters, especially the Indians, to impose a multiplicity of facets, especially on the pavilion, but this does not always result in a more colourful or brilliant stone. Some of the older Indian-cut stones, particularly large citrines and cairngorms, are still seen with literally scores of rows of facets arranged haphazardly around the pavilion. However, in modern cutting, two or three steps on the crown and three to five or six steps below are employed with coloured stones. The proportions of crown to pavilion may be varied from 33 1/3% for crown and 66 2/3% for pavilion to 25% crown and 75% pavilion for pale stones where an illusion of deeper colour is required. The corners may be left cut at 90° but it is more usual to cut these off so as to form an octagon; this allows claws to be set without marring the appearance of the stone when set.

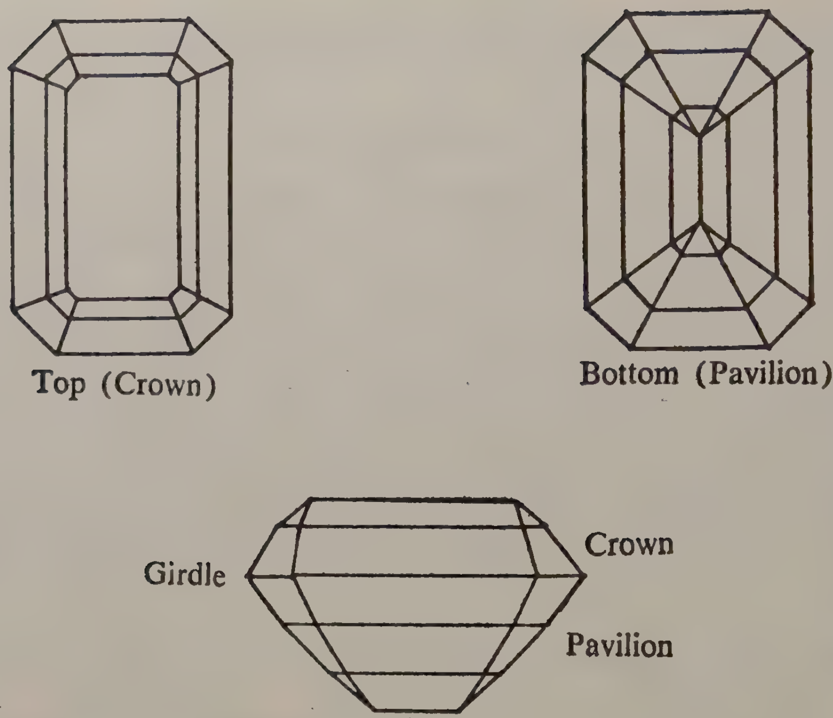


Fig. 11

The octagonal step cut

Other Faceted Stones

As well as the two predominant styles, the brilliant and the step cut, there are innumerable variations of faceted stones. Some of these are designed for special purposes, such as pendants, drops or beads, whilst others are simply the result of the application of a larger number of facets to enhance their appearance. Some of these are illustrated below:

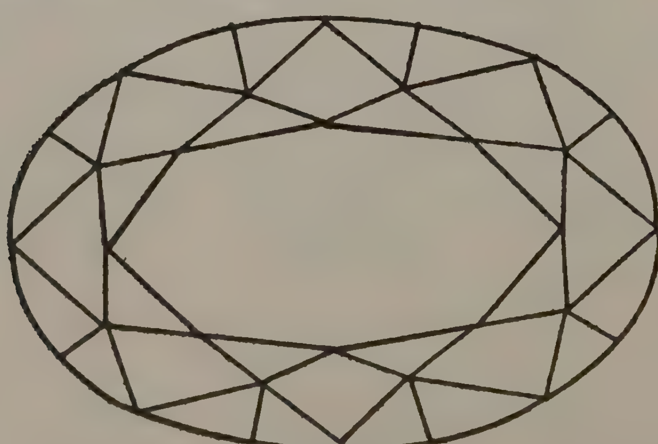


Fig. 12a

Oval brilliant cut

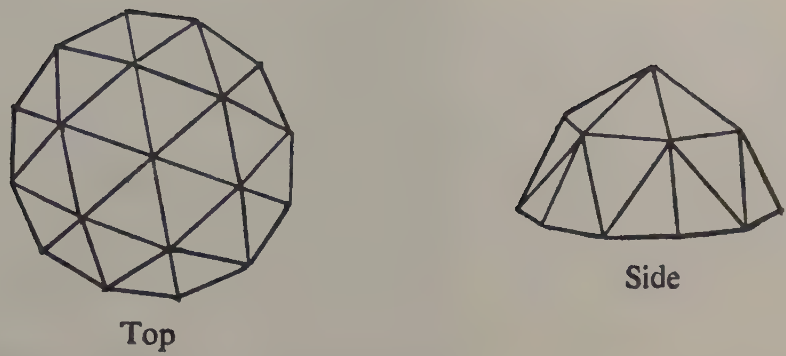


Fig. 12b

Dutch rose cut

Fig. 12c

French cut

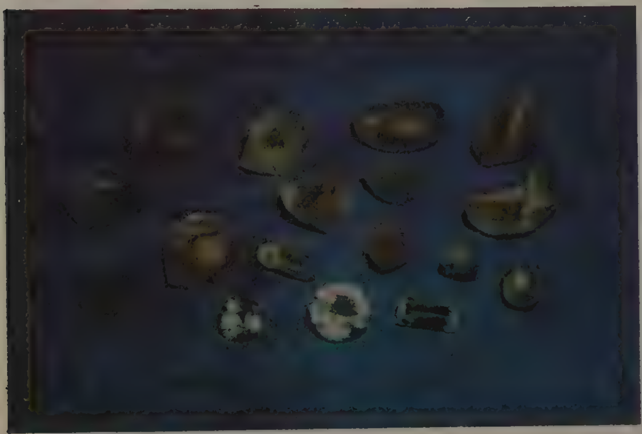
Fig. 12d

Brilliant drop or pendeloque, *left*, and briolette cut

Many of these styles, some of which are not illustrated, are beyond the scope of the normal amateur lapidary as they present peculiar difficulties in cutting, especially the drop and briolette styles. They are therefore better left to the professional lapidary until a high degree of proficiency is reached.

A full necklace of golden and brown tiger-eye, each piece ground and polished by hand before being drilled and strung

Specimen courtesy D. A. Robinson & Co.

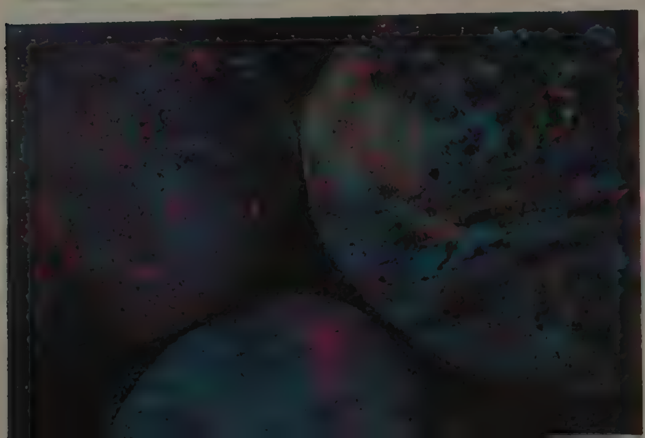


Rough topaz pebbles with three faceted stones in various styles

Specimens: author

A fine selection of faceted quartz; yellow citrine, colourless and smoky quartz

Specimens courtesy D. A. Robinson & Co.



Cabochons of high-grade black opal

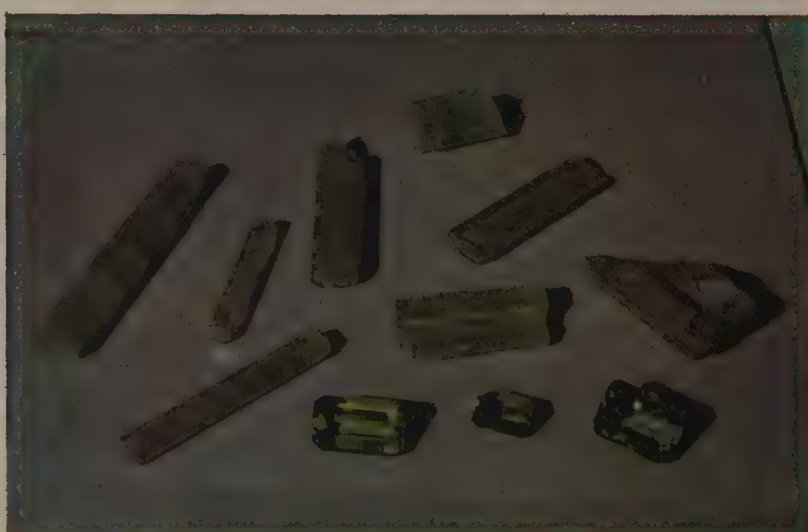
Specimens courtesy D. A. Robinson & Co.

A variation of the lapidary art: a butterfly shaped from three pieces of petrified wood and polished

Specimen courtesy C. Mandelkow

Queensland rough garnets with three step-cut stones

Specimens: author and D. A. Robinson & Co.



The art of the faceter is illustrated in these rough beryl crystals and the finished stones

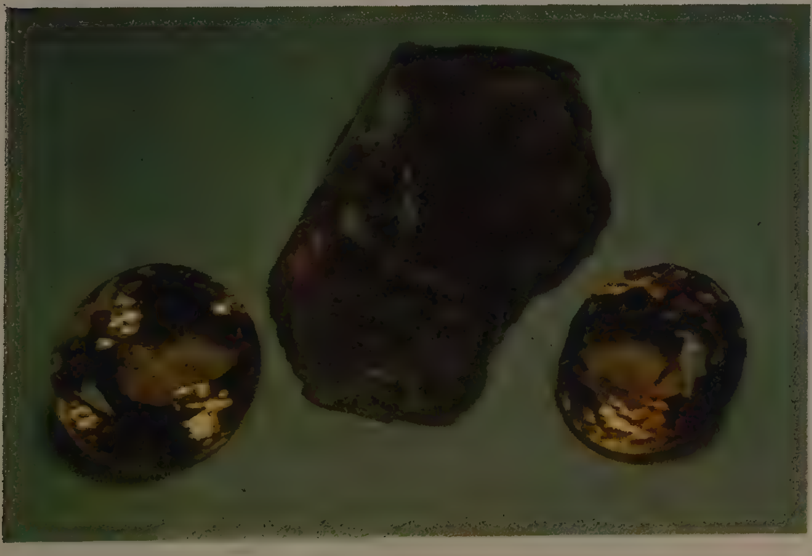
Specimens: author and D. A. Robinson & Co.

Australian amethysts in the rough state and faceted in oval brilliants

Specimens: author and D. A. Robinson & Co.

Gemstones from the laboratory: synthetic ruby, sapphire, and spinel 'boules'

Specimens courtesy D. A. Robinson & Co.



Two brilliant-cut specimens of citrine with some similar material in the rough

Specimens courtesy D. A. Robinson & Co.

Cameo carved from a solid piece of Coober Pedy opal: an aboriginal's head in green opal on a milky background

Specimen courtesy D. A. Robinson & Co.

Cut and polished cabochons of Queensland agate

Specimens D. A. Robinson & Co.

Cabochon Cutting

The Grinding Head

From the amateur lapidary's point of view, the action of cutting a stone has no relation whatever to the usual meaning of the term, such as 'cutting bread' or 'cutting' paint. In the lapidary sense, it is a grinding process carried out in several ways. However, in every case, it is the result of contact of the stone, under pressure, with an abrasive surface to remove unwanted material. The most rapid method of achieving this, in the first stages of the lapidary process, is with the grinding wheel. The grinding wheel, therefore, is one of the most important basic needs of the lapidary as, without it, progress would be long and tedious. Whether the gemstone is a lump, small fragment, nodule or sawn slab, the first requirement is to grind it to the desired shape.

The grinding wheel is mounted on a grinding head, a heavy-duty spindle running on watertight bearings and driven by a belt or pulley, powered by a petrol or electric motor. Because of the heat generated by the friction of the abrasive action, with the risk of cracking or shattering the stone, some form of cooling medium must be used when grinding. Water is quite suitable for this, as it also washes away the loose grits and thus prevents the wheel from becoming clogged. This water is contained in a splash tray or run directly on to the wheel through tubes or pipes and drained away below the wheel. The former method serves quite well and will be found to be economical in areas where lack of water is a problem. When not in use, however, the grinding wheel should not be allowed to stand for long periods in the water, which should be drained away. Failure to do this may result in a waterlogged section of the wheel becoming soft and flying apart when spinning. To prevent excessive splash during the grinding operation, the wheel is covered at the top, back and sides by splash guards. Care should be taken to see that this water does not reach the motor if it is mounted near the head.

As mentioned earlier in this work, it is preferable to use a *lapidary* grinding head, designed solely for that use, rather than converted equipment. One fault of the ordinary grinding heads used for sharpening tools is that their open bearings soon absorb the highly abrasive carborundum grits, especially when carried by water. This combination works itself into a cutting paste which rapidly wears away these bearings. The result is that the wheel is soon running off-centre and develops a 'slapping' action. Whilst this would have little effect upon metals, it tends to chip and crack the more brittle gemstones. Lapidary grinding wheels, because of the presence of this grit-laden water, feature sealed bearings to exclude the entry of this abrasive material. This gives long life to the unit and ensures true running of the wheels, an essential in gemstone grinding.

The most usual size for grinding wheels operated in lapidary work is 8 x 1 inches, although larger or smaller diameters may be used if required. An 8-inch diameter wheel should be run at 1,800 to 2,000 revolutions per minute, which may be arranged by the use of suitable pulleys on the motor and the grinding head. Smaller diameter wheels should be revolved at a proportionately higher speed and larger at lesser speeds to provide a similar amount of surface feet per minute. For the correct arrangement of pulleys on motor and on the driven shaft to provide requisite speeds, see table on p. 151. If the wheel is turned at too slow a speed, it will wear excessively in sections and develop an 'out of round' circumference, resulting in slapping and bumping of the gemstone. If at too fast a speed, it may fly apart from the tension. Always, therefore, ascertain the maximum speed the wheel will withstand—most wheels are marked with this information—and do not exceed it.

Grinding wheels are graded into degrees of fineness of grits, in lapidary work ranging from 80 grit to 320 grit or, on occasions, even finer. The grade of grit is based on a mesh size so that the larger the number, the finer is the grit and vice versa.

The centre, or arbor, hole of the wheel should match the diameter of the shaft. If it is too large, a metal or wooden 'bush' may be inserted to take up the difference; no attempt should be made to operate the grinding wheel swinging loosely on the shaft. Side flanges should be a close neat fit and should be well tightened up before starting the motor. The motor itself should have a rating of one-third to one-half horsepower. One-third horsepower is suitable for a single grinder but, if two wheels are being used at the same time by two operators, one-half horsepower is necessary to prevent stalling.

If only one grinding wheel is to be used, 120 or 180 grit is recommended. This is a good medium grade for commencement and will shape the stone quite rapidly without leaving deep scores and scratches to be removed in the sanding process. If a double head is used, one wheel may be 80 or 100 grit (for the first rough shaping) and the second 220 grit (for finer shaping). These grits, however, are not arbitrary and the individual lapidary may alter these to suit his own requirements and the types of gemstones he customarily grinds. For instance, if a lot of opal is to be ground, it may be more suitable to use only a 220 grit stone, which will grind the soft opal quite readily with less risk of over-grinding and consequent loss.

Although the carborundum in the wheel is harder than all natural gemstones, with the exception of diamond (carborundum hardness = $9\frac{1}{4}$), the bonding between the grains is much weaker. Abrasion therefore eventually loosens these grits so that the wheel gradually wears away. To prevent excessive wear, it is recommended that no attempts be made to grind down large, bulky stones. This will invariably result in a lumpy wheel with deep scores and ridges, because of the large surface being treated. The stone being ground should not be held rigidly in the one position but should be moved slightly from side to side. This will assist not only in obtaining a more suitable surface but will prevent excessive wear in the middle and the forming of ridges at the sides of the grinding wheel. These ridges, once formed, make subsequent grinding difficult, having a tendency to become sharp and cut into the fingers. If, therefore, they begin to form, they should be removed with a diamond wheel-dressing instrument. The stone being ground should be held about half-way down the front of the wheel which, of course, should be revolving *downward*. Some lapidaries prefer a hand rest but others feel that greater freedom of movement is available without it. At all times, the stone must be ground *with* the rotation of the wheel; grinding *against* the wheel's movement will result in jerking of the stone from the hand and cracking or chipping.

Individual Technique. There are very many opinions, each expressed by individual lapidaries, on the best methods to use for grinding and polishing, and the suitable speeds at which the various items of equipment should be run. Many lapidaries have found, upon comparing notes with others, that these techniques vary widely and, of course, those who have the temperament and time to experiment will discover many more modes of treatment. These variations and the results that can be obtained from them are well summed up by V. I. Gan-Timur, founder of the First Lithophilic Society:

> My personal opinion is that there is no such thing as the *best* way to grind or polish. You can get a great deal of advice on how to grind and how to polish and the best speeds for each machine—but each lapidary will devise his own methods. The success you will have depends upon the technique you develop yourself. One instructor has not the right to say that the advice of another instructor is wrong, for the lapidary who follows the advice of the other instructor may,

in the same time, produce a stone of equal or perhaps better quality. During the years, I have used so many methods and some of these I found to be the best . . . but *best for me!*

Grinding the Cabochon

If the gemstone has already been slabbed—that is, sawn into a slab with the diamond saw, much of the preliminary work has been done and it is necessary only to mark out the shape required and proceed directly to form it into a cabochon. If, however, the stone selected for cutting is a small nodule or fragment, and a simple flat-based cabochon is required, it will first have to be ground to the finished overall thickness, flat on both sides, in the same manner as a sawn slab.

The stone is therefore held against the grinding wheel, after turning on the water supply or ensuring that there is sufficient water in the splash pan, with the object of removing any projections or hollows on the first side. As the wheel is curved, care will have to be taken that the side being ground does not become slightly concave instead of flat. A little practice in working the stone to and fro across the width of the grinding wheel will ultimately achieve this flat face. When this side is satisfactorily ground, the stone is reversed and the other side is also ground flat, ensuring that the stone does not become too thin to provide a well-shaped dome in the later stages. On completion of this grinding stage, to provide a flat slab, the stone should appear as in Figure 13. The depth is optional, depending upon the type of dome to be ground—that is, high, medium or low.

Fig. 13

If the stone has originally been slabbed, this preparatory work is not necessary, except perhaps for a little gentle grinding to remove any saw marks, and the work of cutting will commence at this point. From this stage, the stone may still be held between the fingers or, to provide greater freedom of movement, it may be fixed to a dop stick or 'dopped' (see 'Dopping'). Until now, the actual shape of the stone has been immaterial although it may have been convenient to remove any sharp points or projections around its perimeter to prevent chipping. The lapidary has now to decide which portion of the stone he wishes to retain and which sections will be ground away. Lapidaries who own a trim saw are able to saw excess material rather than grind it away. In the case of a mono-coloured stone, the matter is relatively simple especially if the stone is uniformly coloured throughout. If there are any deep pits, discolorations or flaws, these may have to be removed, and the size and shape of the finished stone will depend upon the remaining suitable material. Some figured stones, such as banded agate, ribbonstone etc. may have to be dealt with a little differently as their design plays an important part. It may be unwise, in such cases, to cut a large stone containing uninteresting sections when a smaller one could be obtained with a striking design or a well-centred motif. This is a problem encountered often by lapidaries—whether to cut for size or for quality. The ultimate decision is always left to the individual. If, in the early stages, he is uncertain how to proceed, there is always the consolation that the large stone may later be recut when he has had more experience in designing.

The swirls and bands of agate often suggest a free-hand (or baroque) style to make the maximum use of these markings, with the result that there will be a certain amount of natural character in a cut stone of this kind. Fortunately, not all lapidaries wish to cut every stone into a geometrically perfect oval or square; some stones simply do not lend themselves to such fashioning. This is the point where the lapidary's individuality enters and imagination has the opportunity of expressing itself. Contrary to the opinions of some lapidaries —principally overseas—every stone should not be 'manufactured' to dimensional specifications down to the last millimetre. The amateur lapidary is not in the business of turning out jewellery stones in bulk, but is engaged in the pursuit principally as a hobby to give him some personal satisfaction and a sense of achievement. The accomplished lapidary does not find it difficult to assess, by looking at and handling a rough stone, just what he can get out of it. And what he can get out of it depends upon its size, shape, design, colour and his own ingenuity.

Having, then, decided upon the ultimate design of his finished stone, the cutter may continue with a freehand style or he may wish to cut it into a more symmetrical outline. In the latter instance, he will mark out its shape on the blank which he has sawn or ground. This can be done by hand, or with the aid of a template. These templates are made of aluminium or plastic and feature a wide range of sizes and shapes, including ovals, drops, rectangles, crosses, hearts, rounds etc. The most satisfactory method of marking is with an aluminium, rather than a lead, pencil; the former will not wash off during handling. Such a pencil may quite easily be made by sharpening a short length of thick aluminium wire or a thin strip of the metal. After marking the design, the stone is once more rotated on the wheel, until all the unwanted material outside the line is ground away, ensuring that the resulting edge is just *outside* the pencil line. This permits further removal of stone by fine sanding without altering the original size required. As mentioned above, this waste stone may be carefully sawn off by means of the lapidary saw, ensuring that the saw cuts are also just *outside* the pencil line. Some lapidaries run saw cuts into the edges of the marked design and then break off these pieces with pliers; this is known as 'nibbling' but it is not recommended for it often results in breakage inside the marked line. If an oval shape has been selected and the stone has been properly ground, it will now have the appearance of a chemist's tablet as in Figure 14.

Fig. 14

Next, rotate the stone edgeways on the wheel at an angle of about 20 degrees so that a bevel runs completely around the perimeter as in Figure 15.

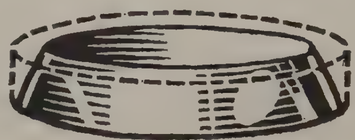


Fig. 15

Proceed now to grind a further bevel at a more inclined angle of about 30 degrees above the first bevel and overlapping it so that the stone appears as in Figure 16.

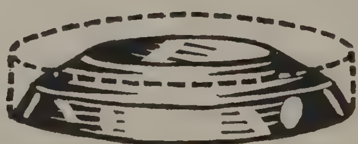


Fig. 16

Now, twirling the stone in a circular motion around the edge and over the top, grind the straight bevelled edges gently into a curved effect, as in Figure 17.

Fig. 17

This is probably the crucial point in the whole grinding process as the contours of the stone depend upon its being well done. Most new lapidaries experience difficulty at this stage in rounding off the dome and find themselves with a stone with flat surfaces or a slight depression on the surface. This may have been caused by the slab being too wide or too thin, or perhaps is merely the result of faulty grinding. The presence of these defects will result in difficulty in the later stages as the sandpapers cannot reach these sunken areas to remove the scratches left by the coarser grinding wheel. The sanding discs are not designed to remove a great deal of excess material, their function being to provide progressively finer abrasion and thus to remove surface scratches. If, therefore, the stone is not correctly shaped or contains 'flats' on its surface when it leaves the grinding wheel, it may be necessary to return to the grinding process at a later stage when these defects have become very evident. If the grinding has been carried out on a coarse wheel such as 80 or 100 grit, the stone may now be finally shaped on a 200, or similar, grade before proceeding to the sanders.

Finally, a *narrow* bevel is ground at the edge, at the back of the stone, sloping at an angle of about 45 degrees so that it is not visible from the front. This is to prevent chipping and to provide a seat for a mounting should it be later set into a jewellery piece. After bevelling in this manner, the formed cabochon will have the general appearance of the stone in Figure 18. It will have a frosted and scratched surface but this will be removed on the sanders.

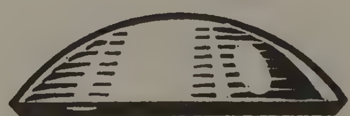


Fig. 18

Disc and Drum Sanders

The sanding process is carried out by means of wet and dry sandpapers mounted on wooden or metal discs—or occasionally drums or belts—backed with rubber or cork, rotating at speeds of 500 to 700 revolutions per minute. These rates of speed, as with the grinding head, are obtained by the use of suitably proportioned pulleys on the motor shaft and the sanding spindle. For variable speeds, step pulleys may be used and the motor mounted on a movable spring base to allow for the shortening or lengthening of the driving belt during change-over. Disc sanders usually have a threaded flange on the back to permit their removal and replacement.

Some lapidaries prefer drum sanders to the discs. Wet and dry sandpapers are fixed to the perimeter of the drum which may be of wood or metal. Drum sanders have several advantages in that the entire area of the sandpaper is used and, because of their curvature, the abrasive reaches every portion of the stone, occasionally removing even flats and depressed scratches.

In the case of both discs and drums, the papers are fixed with 'peel-'em-off' cement, permitting the worn paper to be removed and new sandpaper attached.

The grades of sandpaper used range from 120 or 180 grit to 600 grit. Some lapidaries, in order to obtain a super-finish on their stones, work through the entire range of progressively finer papers but this entails the use of a large number of discs, is time-consuming and is not entirely necessary. For practical purposes the amateur lapidary, providing the initial grinding has been well carried out, may proceed directly to a medium sanding paper without having to use an intermediate grade and, later, to a fine paper without the aid of a medium-fine. This is another of the decisions left to the individual's judgment and depends upon the finish of the stone at any particular stage.

Depending upon the grit of the last grinding wheel used, he will move on to the next finer grade of sandpaper to remove the marks still on the stone. The table on p. 72 illustrates the progressive stages to be followed. It will be noted that the use of two grinding wheels, for instance an 80 and a 220 or 320 grit eliminates the need for the extra coarse sanding stage, as the cutter is able to move directly to the nearest grade of paper.

SUGGESTED GRINDING AND SANDING TABLE

Last grinding wheel used	*First sanding*	*Second sanding*	*Third sanding*	*Fourth sanding*	*Polishing*
80 grit ..	180	240	400	600	Tin oxide or cerium oxide on thick felt or leather*
100 ,, ..	240	320	400	600	
120 ,, ..	240	320	400	600	
220 ,, ..	320	400	600	—	
320 ,, ..	400	600	—	—	

* There are some exceptions to these compounds and discs, as outlined in section 'Special Cutting Techniques'.

The finer papers, such as 600 grit, contain extremely fine mesh abrasive and, after a little use, will impart a fine pre-polished finish (if the stone has been correctly ground and sanded) even before the actual polishing process has been reached. These wet and dry papers are ideal for lapidary use, their backing being of tough composition. Their ability to withstand water permits wet sanding, not only reducing friction but actually providing a more satisfactory cutting action.

Dopping the Cabochon

Because of the difficulty of holding the stone on the rotating discs or drums, it is necessary to provide a holder for it. This allows greater ease of movement and the application of pressure when necessary. The process of dopping actually means only attaching the stone with wax to a handle. Although many different methods of 'dopping' are used by lapidaries, the result in all cases must be that the stone is quite securely fixed to the stick. If it is not, it may fly off, with consequent injury to the operator or possible damage to the stone. From the very many different approaches to dopping, the following is recommended: For the dop stick for cabochons, a piece of thin dowel or a butcher's skewer (minus the sharp point) may be used. Some sealing wax is melted in the flame of the spirit lamp or heated in a container above it, and then twirled around the end of the dowel. It is then rolled on a piece of cold metal or stone so that it adheres to the stick and assumes a conical appearance. The end is pressed down immediately so that it presents a flattened surface as in Figure 19.

Fig. 19

It is good practice to apply a little melted shellac to the stick and to warm it before waxing, to provide a more secure grip. The dop stick is then temporarily laid aside. The stone is held in a pair of tweezers *above* the flame of the lamp so that it becomes warm—*do not overheat*. Melt a little stick shellac in the flame and apply a thin film of this to the back of the stone while it is still warm. Quickly reheat the waxed dop stick slightly over the lamp and press down firmly to the back of the warmed, shellacked stone. While the wax is still warm, but not hot, mould it with the fingers around the back of the stone and around the stick so that it presents a neat appearance. During this, care should be taken to avoid dropping hot wax on the hands. Too much wax or an untidy application not only looks a bad job but makes it more difficult to manipulate the dop stick. Ensure that wax does not extrude around the edge or on the face of the stone; this will retard the abrasion and clog up the sanding papers.

Fig. 20

Sanding the Cabochon

The first sanding disc, finer than the last grinding wheel used, is now moistened with a wet rag or sponge. The dopped stone is held firmly in the hands and moved over the sanding disc with a rotary motion, turning over and over so that the sandpaper comes in contact with every part of the surface of the stone, down to the edge. If the stone is not continually turned but held too long in the one position, it will develop flat faces instead of a smooth, curved surface, especially on the first coarser sanding papers.

The rounded edge of the stone should always be presented towards the direction of rotation of the disc. If held in the opposite direction, the sharp base of the stone may drag it from the dop stick and tear the paper. Keep the sandpaper moist during this operation, so that the stone does not begin to heat. If it does, as the paper dries, it may begin to slide on the stick as the wax melts, or it may come off altogether. If the stone does become slightly heated, place it aside until it cools and hope for the best. Heat can be fatal to some stones, especially opal which has a tendency to crack and craze. Do not plunge a heated stone in cold water for quick cooling; this will only make matters worse.

At this stage, if careful inspection reveals that the sandpaper is not reaching depressions and that heavy scratches are still visible, it may be necessary to reshape the stone on the grinding wheel before beginning the sanding over again. If the lapidary ignores these imperfections and continues on to the next sanding, he will find that they are still there and he will have to go back to the beginning in any case. If well done, the stone will now have assumed a frosted appearance, but without visible scratches.

It is then time to move on to the next sanding process which will be carried out with sandpaper of the next grade of fineness. A similar technique is used on this sanding disc as with the first. At the completion of this stage, the stone should be quite even and present an all-over smooth appearance.

If a fine grinding wheel, such as 220 or 320, has been used, one of the sanding stages may be eliminated and the third will take place on the fine 600 grit paper. This will leave the stone practically polished over the entire surface of the dome. If rotated under a light, it will show a reflection which travels evenly over the area of the stone without bumps or fuzziness of any kind.

In all the sanding stages, it will help if the paper is allowed to dry out just before the end of each process. This slows down the abrasive action and tends to give a smooth, semi-polished effect. Between each sanding, the stone should be washed clean of any grits so that specks of coarse grade do not contaminate the finer paper. After the final sanding, carefully wash the stone as before, as well as the dop stick and the hands to remove all grits and sludge. The gemstone is then ready to receive its final polish.

The Polisher

This disc is usually covered with a hard thick felt or leather and is run at a speed of 400 or so revolutions per minute. The polishing compounds in general use for amateur lapidary work are tin oxide and cerium oxide. Of these, tin oxide ('putty powder') is the least expensive so that most lapidaries conserve the more costly cerium oxide for polishing work which the other powder will not accomplish. There have appeared on the market other 'secret' polishing compounds which are a great deal cheaper than the orthodox powders. Some of these have been found quite satisfactory and, of course, have the additional advantage of being economical.

Polishing is the end-goal of all the preparatory grinding and sanding, so that great care should be taken to ensure that the whole project is not spoiled at this stage. The polishing disc itself should be kept scrupulously clean so that no foreign matter whatever can contaminate it. Even the smallest speck of grit may score the stone. Especially on a felt wheel, it is extremely difficult to remove these grits once they become embedded and it may mean the entire replacement of the felt covering. Advanced workshops have this unit completely isolated for this reason, but extreme cleanliness will take care of this problem. The disc should be put away when not in actual use, in a plastic bag or similar container. If left uncovered, even atmospheric dusts (mainly silica) will settle upon it and cause scratches to the stones.

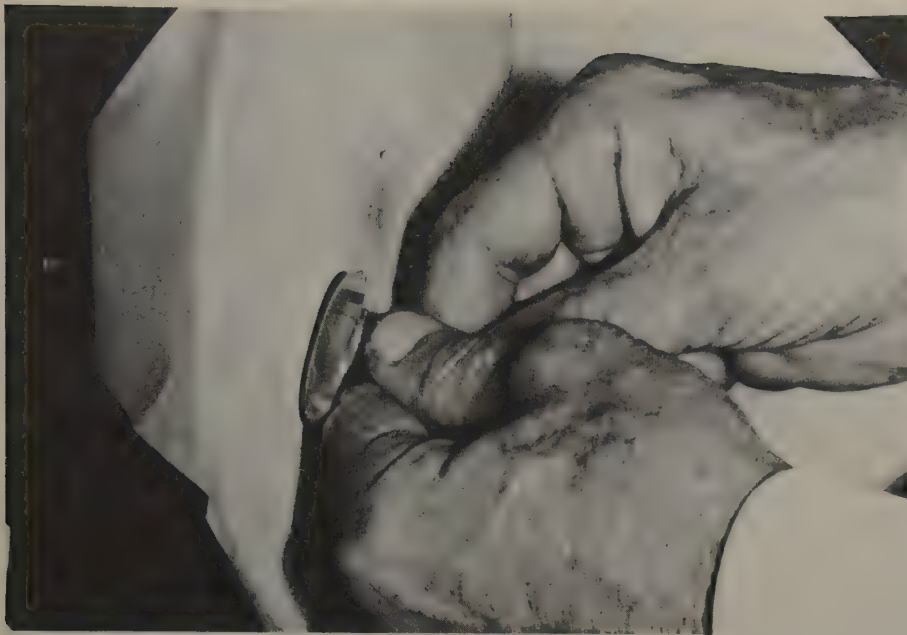
Polishing the Cabochon

The tin oxide or cerium oxide is first mixed with water into a paste or slurry and brushed on to the face of the polisher whilst it is in motion. A screwtop jar is recommended for this mixture so that it can later be stored and used again without contamination; for brushing, an old toothbrush or shaving brush is quite suitable, but ensure that they are used for nothing else but brushing on of polishing paste.

The cabochon, on the dop stick, is held firmly against the direction of rotation of the disc and, in this process, some pressure may be applied. It is not necessary to rotate the stone as quickly as in sanding, as there is no abrasion in this process. In fact, one section may be held to the buff for quite long periods to ensure a high polish before overlapping the next. If the earlier stages have been correctly carried out and the compound is of the correct consistency, a polish should appear almost instantly. Lapidaries who have left scratches on the surface of the stone will find that they will not polish out but will remain visible and mar the whole effect. The stone should be periodically wiped clean for examination to see that all portions are receiving a polish. If not, return to the disc and complete until a uniform finish is obtained.

The disc should be kept well supplied with polishing paste and allowed to become neither too wet nor too dry. If too wet, it may not polish effectively and, if too dry, it may scorch the stone.

When the cabochon has been polished to the operator's satisfaction, it is removed from the dop stick. It is not necessary to re-heat the stone to do this. If it is immersed in ice water or placed for a few minutes in the freezing chamber of a refrigerator, it will fall off the dop stick as the wax contracts. A razor blade is then used to scrape off any surplus wax or shellac adhering to the back of the stone. The rough stone has now become a gemstone and, after being rubbed with a soft cloth, is ready to join the others in the tray or display case.

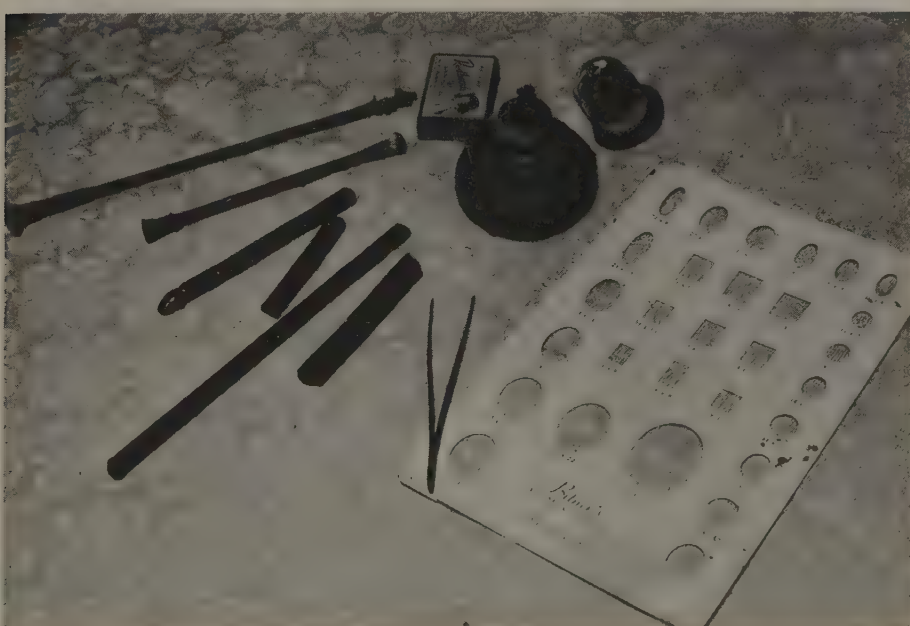


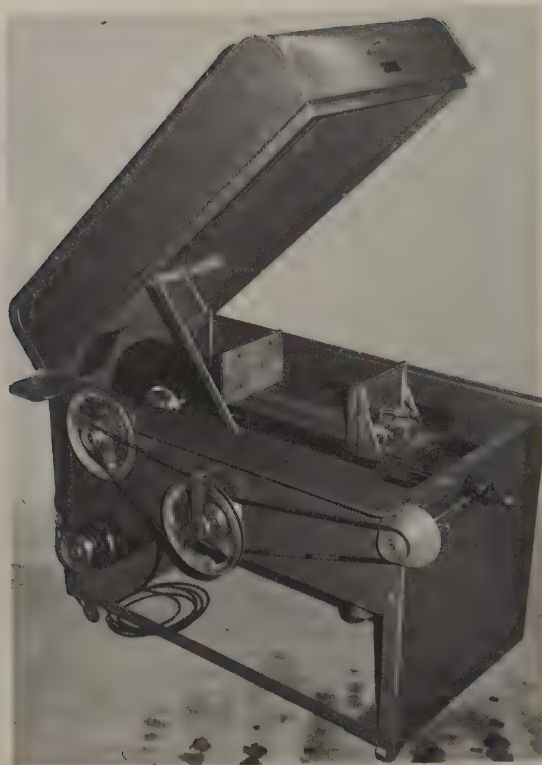
Polishing the cabochon. The polishing buff being used is leather with tin oxide. This cabochon is mounted on a dop stick for ease of manipulation. Note the angle at which the stone is held to the buff which is rotating anti-clockwise

Equipment courtesy Mr and Mrs V. I. Gan-Timur

Accessories for cutting cabochons. Pictured here is a spirit lamp for dopping, dop sticks, tweezers, sticks of sealing wax and shellac, and a template showing ovals and squares in millimetre sizes

Equipment by the author



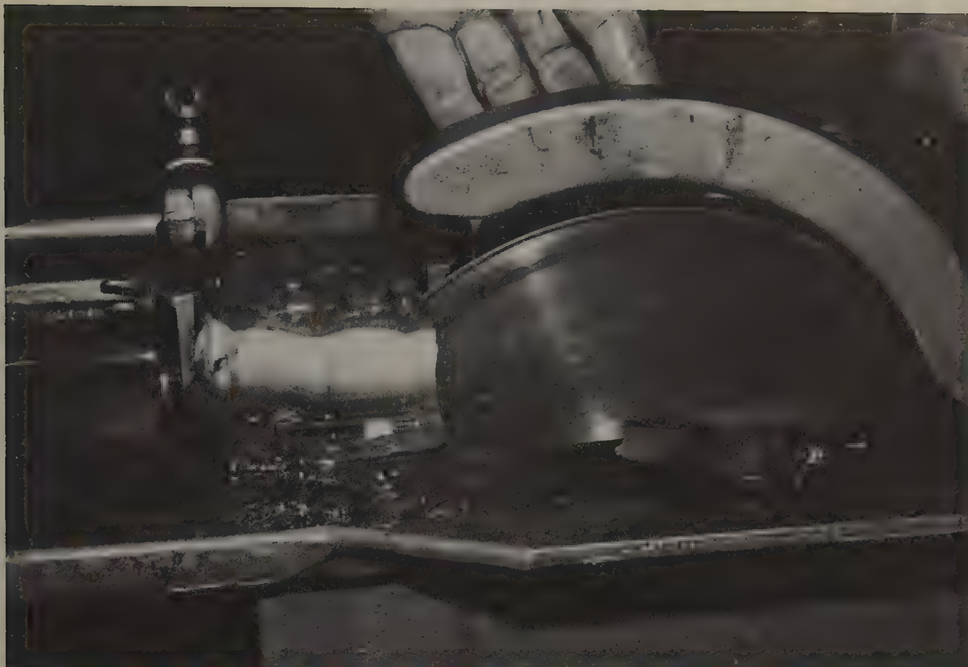


Slabbing saw

Photograph courtesy Thompson Lapidary Supplies

A 36-inch-blade automatic diamond saw especially made for export, powered by a 2-h.p. motor with automatic cut-off when the cut is completed. The unit weighs 15 cwt. and can saw to a depth of $14\frac{1}{2}$ inches. The stone in the vice is a 100-lb. agate

Photograph courtesy Thompson Lapidary Supplies

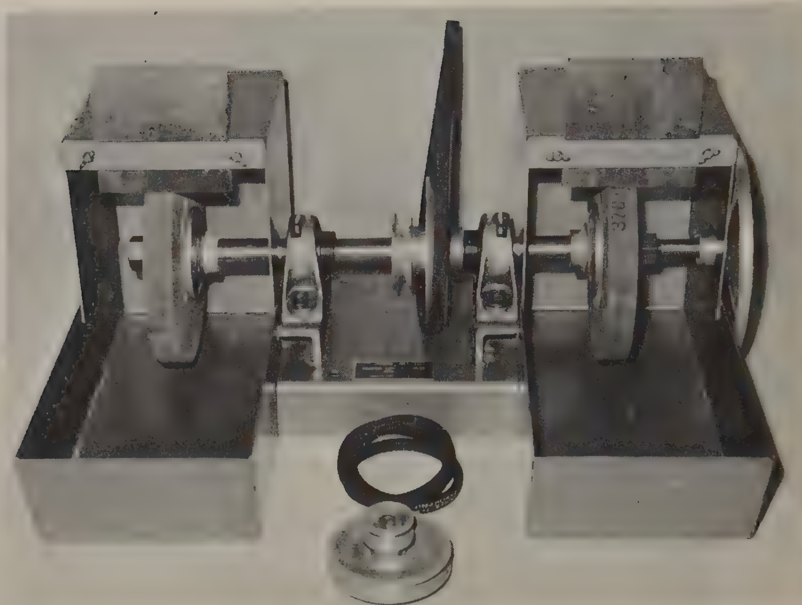


The diamond saw in action. The blade is biting into a piece of banded agate which is securely clamped in the vice. The metal splash guard has been lifted clear to provide an unobstructed view

Equipment by the author

Combination slabbing and trimming saw

Photograph courtesy Thompson Lapidary Supplies

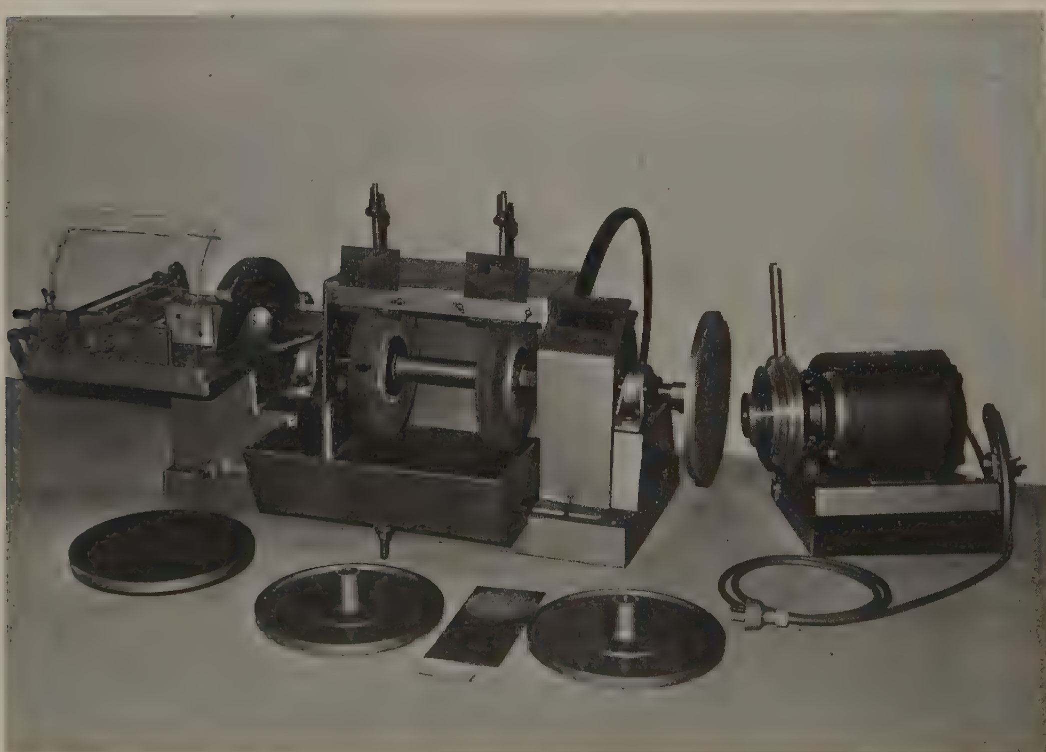


A grinder, sander and polisher. Sanding and polishing discs are screwed to the right-hand end of the shaft

Photograph courtesy Thompson Lapidary Supplies, Brisbane

A combination grinder, sander, polisher and saw

Photograph courtesy Thompson Lapidary Supplies



Faceting

To many lapidaries, the art of faceting is the end-goal of all their aspirations. Some of them reach that goal, whilst others do not. There are a number of reasons for the failure of most amateurs to become faceters. Probably the main one is the cost of the essential equipment so that, unless one intends to undertake a great deal of work with it, it may well become a little-used luxury. Also, the gemhunter usually does not accumulate a large quantity of high-class transparent gem material (with the possible exception of the quartz group) and faceting grade material in the rough is expensive. He is therefore more inclined to pay a professional cutter a fee for faceting his few sapphires, zircons, beryls and the like. These charges range from about $2.00 to $3.00 or so per carat finished weight, depending upon the size and type of the gem. Naturally, in some cases, the amateur discovers that the cost of cutting his prize gem barely covers the ultimate value of the stone, especially with topaz, garnet, zircon, quartz or amethyst. But the dedicated gemhunter is not in the hobby to make a profit; he is quite content to display a beautifully cut stone which he, personally, salvaged in the rough from Nature.

Some gemhunters will be in the fortunate position of living in areas where good faceting material is comparatively abundant. This may urge them on to greater efforts when they look upon their hoard of rough sapphires, beryls or topaz and visualize them in their sparkling facet-cut state. Others may simply be ambitious and thus wish to include the whole range of activities in their lapidary work—from cabochon cutting to faceting.

Since its inception long ago, the art of faceting has remained unaltered in principle, although the designs and methods have changed. Simply, it consists of the grinding and polishing of flat faces upon a gemstone. In these days of the realization of the behaviour of light, these faces (or facets) are applied to the gem to take advantage of the bending and dispersion of the light rays, thus enhancing the appearance of the cut stone. At other times facets were, however, applied for quite different reasons. Some of the Indian gem-cutters found that polished facets, if ground over a flawed section of a gemstone, would effectively hide these imperfections as well as giving the stone a more attractive appearance. These crude attempts at faceting were carried out entirely by hand, resulting in no symmetrical pattern but merely a haphazard arrangement of irregularly placed facets.

In more recent times, the method used by professional cutters employed what was known as the 'jamb peg'. This consisted of a wooden post or pillar containing a number of holes bored at different angles. The rough gem was mounted on a dopstick which was then inserted in the hole providing the required angle with the flat lap. The use of this peg, naturally, required great skill in manipulation, and many years of apprenticeship were needed before the lapidary became proficient. Because of the very difficulty of this method, really good cutters developed amazing skill and have been known to cut and polish practically *freehand*. There are a number of professional gem-cutters in Australia still using the 'jamb peg' and it is understood that it is widely used in Europe and the United States by some of the older lapidaries.

The introduction of the modern faceting head and the amateur faceter were almost simultaneous, for the invention of the equipment made the other possible. However, it is not quite correct to suppose that this is an automatic machine which cuts stones. If this were so, we would all be faceters. A modern faceting head is not merely another mechanical device but a precision instrument relying upon the skill of its operator to fulfil its role.

It has been claimed that faceting may be mastered within a few hours with the aid of fine equipment. It is correct that, with a top quality facet head and all the accessories, it may be possible to *cut facets* on a stone and polish them after short tuition. But this, in itself, does not constitute the whole art of faceting. Fine gem material can be irretrievably ruined by a beginner who enters upon faceting too impulsively. Often we see the 'fish-eye' stones: those with a thin rim of light around the edges but devoid of any brilliance in the centre; or colourless topaz or quartz with the dead look of cut glass.

Such examples are not cited to discourage the reader from the prospect of faceting but merely to indicate that it is not an impossible pursuit—merely a specialized one. If faceting, at the outset, is regarded as a separate branch of lapidary activity and therefore the subject of some study and practice, there will be fewer disappointments. After all, good gem material is scarce and expensive and it would be a pity to waste it.

If under the guidance of an accomplished faceter, the task for the beginner is made much easier, for he will be shown the pitfalls to avoid. The professional knows that he may cut either 'for weight' or 'for quality'. If 'for weight', the finished gem may suffer in brilliance, colour or quality for it may have been necessary to cut it in a shape and in such a manner that it does not yield these best colour and reflective effects. If cut 'for quality', it may be a smaller gem but this will be compensated for by the greater brilliance and finer colour, often necessitating the removal of a greater amount of waste stone. This gets down to the crux of the matter. How is it possible always to cut 'for quality'? To do this, the stone must be examined and assessed for its natural optical and physical properties. These properties are discussed in the chapter 'The Nature of Gemstones'. After studying these properties a little, it will be understood that it is not quite sufficient to get a lump of gem material and proceed to saw it into sections before fixing it to the faceting head and commencing to grind. Each stone should be studied individually on its merits for type, shape, optical properties, colour, flaws etc.

The Faceting Head

This ingenious device works on the same principle as the obsolete jamb peg with the exception that, because of its rigidity and method of selecting cutting angles, most of the human error is eliminated. There are two main types of modern heads:

The Freehand Facet Head. This consists of the stone-holding arm set into a flat metal plate (usually octagonal) resting at an angle upon a platform which may be raised or lowered. It permits the cutting of a considerable number of facets simply by turning the plate and adjusting the height of the platform. The 'step-cut' stone is quite easily produced by this method. To provide variations of angles, the holder is often provided with additional adjustment notches, permitting its rotation to any desired direction and thus imparting a wide range of cuts. This, the simplest of the modern types, is also often called the 'O'Brien' head.

The Variable Index Facet Head. This type is a more complex instrument, featuring a notched or slotted wheel at the top of the stone-holding arm, permitting rotation of the arm to any desired direction, which is then fixed. This type may be 'indexed' with any number of notches or slots, but usually incorporates 32 or 64. The angle of cut is then provided by raising or lowering the arm upon its post. The better of these types feature a 'cheater' device which permits slight adjustments between index numbers without altering the reading of the fixed index.

Irrespective of the type used, it must be correctly mounted at the side of the flat lap, at *right angles* to the surface of the lap. It should be treated with care at all times for even slight damage may put it completely out of adjustment.

Silicon carbide (carborundum) may be used on the lap for cutting stones below Mohs' hardness of $7\frac{1}{2}$ or 8: quartz, citrine, amethyst etc. However, cutting becomes slower with carborundum as the hardness of the stone increases. Topaz and sapphire should be ground on laps containing diamond grits. For the sake of speed and simplicity, some lapidaries prefer diamond laps for all of their stones.

Diamond Laps

Up to the present time, 'charged' (or treated) diamond laps are not available in Australia but they may be imported, mainly from the United States. Diamond powder, however, is available and the enthusiast who does not wish to buy his diamond lap ready-made may prepare his own. The diamond powder itself is available from lapidary suppliers (remember that a carat is only 1/141 of an ounce, so do not expect too much for your money). A little of this diamond dust is mixed with oil or kerosene and rolled firmly on to a copper or steel disc. For rolling, a polished rounded piece of agate cannot be bettered. All of the diamond will not become embedded and the excess should be carefully scraped off and saved for later use.

The meshes of diamond suitable for the flat lap are:

100, 200, 400 grit—for extremely rough work
600 grit—for the first rough cutting
1,200 grit—for fine cutting, before polishing
2,400 grit—for smooth cutting to give a pre-polish
3,200 grit—for polishing
6,400 grit—very fine, best for a super-polish.

A recommended combination is a copper disc with one side charged with 600 grit, the other side with 1,200 or 2,400 grit. Another disc—kept separately—is charged with 3,200 or 6,400 grit for polishing. It is essential, of course, to keep all of these uncontaminated by foreign matter.

The scope of this book does not permit a complete description or treatment of all faceted stones. Clearly, this would not be possible in an introduction to gem-cutting. It is not practicable, for the same reason, to give instructions for faceting of the many 'fancy cuts' as some of these require considerable experience. Neither is this necessary, for very detailed information is already available in a number of excellent specialized publications on faceting, mainly from the United States. A list of these is given at the end of this volume. The amateur faceter is therefore urged to consult these works for additional information should he have become sufficiently interested, as a result of this book, in furthering his activities in the faceting field.

As an introduction, however, it is intended to indicate the principles of faceting and the method of going about it, with an example of the faceting of a trial stone. We will suppose that the amateur has acquired his equipment and all accessories, has a particularly nice piece of quartz crystal and wishes to facet it in the brilliant cut.

The Preform

The first step is to make a 'preform'. If it is a small piece it may be taken directly to the grinding wheel; if it is a clear section in an otherwise cloudy crystal, it may have to be sawn out. Or, on the other hand, perhaps only a portion of the piece may be required. The selected piece is then ground on the wheel; in the case of quartz, 220 grit will be sufficient. This 'preform' may be of several shapes but it must be of a generally round appearance. The recommended shape is a 'bullet' shape with curved bottom as illustrated below; this permits cutting back and adjustment if necessary. A shape approximating the finished brilliant may be ground but this does not always allow for error and may result in a much smaller stone than originally intended.

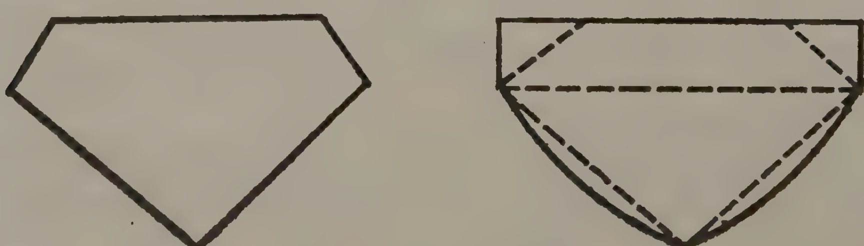


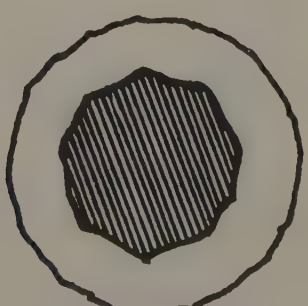
Fig. 21
Preforming a brilliant. *Right*, the suggested shape of preform. *Left*, this shape may be used but does not permit extensive cutting back

There is no rigid rule governing the order in which the crown and pavilion of a brilliant should be cut. Some faceters begin by cutting the pavilion and then the crown. Others facet the crown initially, cutting the table first but leaving it unpolished. This allows later adjustment of the table by further fine grinding if it is found that it is slightly 'out'. Practised lapidaries often cut and polish the table first. In this example, the crown is to be cut first, the facet head being used containing 64 notches or divisions.

Faceting the Crown

The preform as in Figure 21 is fixed with wax to the metal dopstick by inserting the pavilion end into the hollow of the holder. Ensure that the top of the stone is at right angles to the length of the dopstick. If it is not, the table will be cut lopsided in relation to the rest of the stone and a great deal of extra grinding will be necessary to adjust the stone to its proper shape.

Cutting the Table. For cutting the table, 1,200 mesh diamond is recommended, although with a comparatively soft stone such as quartz (hardness 7), fine silicon carbide grits are suitable, though they are slower in their cutting action. This may be carried out by hand or with a special 45° dopstick attachment. When satisfactorily ground to the correct depth, the table may be completed by polishing—or left unpolished. Because of the rough nature of the rest of the stone, it will now appear as in Figure 22.



Cutting the table

Fig. 22

Cutting the Main Crown Facets. Raise or lower the faceting head on its mast to 40°, touch the stone to the lap and commence cutting the first main facet at index 32. Continue to grind this facet until it covers the area from the table to the girdle of the stone.

Turn the indicator to number 64 and grind another main facet, opposite to the first one, as in Figure 23.

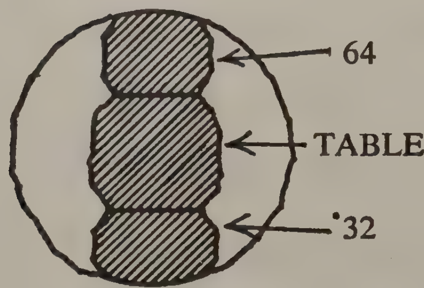


Fig. 23

First pair of main crown facets cut

Cut another pair of mains at indexes 48 and 16. When these are completed, the table will have a somewhat square look as in Figure 24.

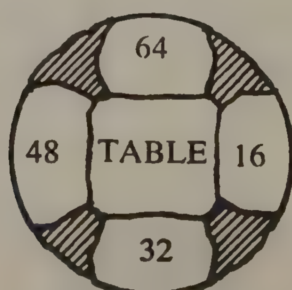


Fig. 24

Second pair of main crown facets cut

Cut in the first of the four remaining main facets, in the same manner as before, at index 8.

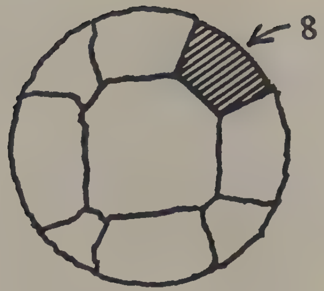


Fig. 25

Main crown facet cut at index 8

Cut in the remaining three main facets at indexes 24, 40 and 56, making a total of 8 main facets.

Fig. 26

All main crown facets cut

Make sure that all the main facets are cut to the same depth as the first facet. Take care that none of these is overcut, if using a facet head without an automatic stopping device. If it is found that any have this defect, the whole of the facets will have to be recut regularly. At the completion of the cutting of all the crown main facets, the table will have assumed a regular octagonal shape.

Cutting the Crown Star Facets. These are the small triangular facets bordering the table. The facet head is now raised on the mast to 25°. The first star facet is cut at index 4. When applying this facet, touch down lightly and cut so that it appears as a small triangle with its apex exactly between the two main facets. The other two points of this facet should extend half-way along the main facets it touches. Cut another star facet at index 12 to form a pair. Care should be taken that these facets, like all others, are not overcut, that is that they are all of the same size. Figure 27 shows the appearance of this first pair of star facets.

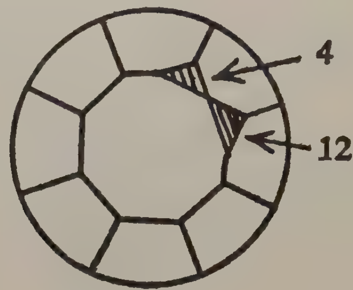


Fig. 27

Two crown star facets cut

Complete the series of star facets by indexing at 20, 28, 36, 44, 52 and 60 ensuring, as before, that they are all cut to the same depth. The crown of the stone will now appear as in Figure 28.

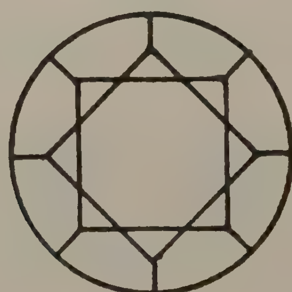


Fig. 28

All star facets cut

Cutting the Crown Girdle Facets. These should be cut carefully by touching down lightly at an approximate angle of 43° elevation. Try the first girdle facet gently at index 2. When completed, it will touch the apex of star facet 4 and extend half-way along the girdle on main facet 64. When satisfied that this facet has been cut to the correct depth, cut adjoining girdle facet at 6 to make a pair, as in Figure 29.

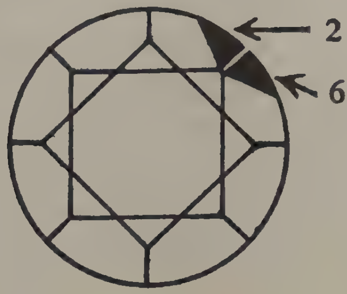


Fig. 29

Two crown girdle facets cut

Complete the girdle facets by indexing at 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 50, 54, 58 and 62. The crown is now fully cut and ready for polishing.

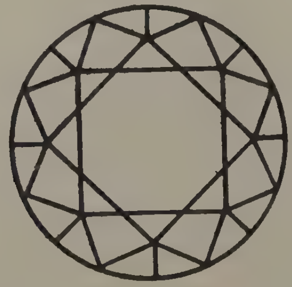


Fig. 30

Crown fully cut

Grinding and Polishing the Girdle. The girdle, or widest perimeter of the stone, is now ground and polished by lowering the head so that the dopped stone may be rotated freely with the girdle against the surface of the lap. If desired, grinding and polishing of the girdle may be left until completion of the pavilion.

Polishing the Crown. A variety of laps and powders may be used in the polishing process. Recommended for this particular quartz stone is a smooth perspex (lucite) lap with cerium oxide, to provide a brilliant finish, or a 3,200 or 6,400 mesh diamond-charged copper lap. Begin by polishing the star facets by turning to the same indices as used for cutting. Examine the first of these facets after polishing to see whether the entire surface is polished. If not, the index may have to be adjusted slightly by means of the 'cheater' device. When the stars have been completed, polish the main facets and then the girdle facets. Finally, if the table has been left in the rough state, check to see that it needs no further fine grinding before polishing. Now that the crown has been completely faceted and polished *do not remove the stone from the dop stick.*

Transferring the Stone. The pavilion now has to be cut. The stone will therefore have to be removed from its dop stick, as the pavilion section is, of course, still obscured by the wax holding it. However, a fresh dop stick will first have to be attached to the finished crown before exposing the pavilion section, as that portion will have to be aligned with the crown to avoid producing a distorted stone. It is necessary, therefore, to transfer the stone from one dop stick to the other without disturbing its position. The most usual method of transferring is by means of a pair of 'V' blocks. The dop stick, with the partially cut stone still adhering to it, is screwed into one side of the transfer block. The new dop stick is screwed into the other side and brought up to the crown of the stone. It is then fixed securely with wax to the crown. The stone is then separated from the first dop stick by heating the wax (ensuring that it does not shift on the fresh dop stick whilst doing so). The stone is now firmly attached by the crown to the new dop so that the pavilion section is exposed, ready for faceting.

Cutting the Pavilion

The Pavilion Main Facets. For the first cut, the index is set at number 64 and the angle indicator raised or lowered to ensure that the final cutting angle will be 43°. The stone is lowered gently upon the lap (1,200 diamond recommended) and grinding commences. However, at this stage, it is necessary to see that the pavilion facets will be perfectly aligned with the facets already placed on the crown. A mark should therefore be made to indicate where the point of one of the crown girdle facets touches the girdle. This mark should correspond exactly with the centre of the first pavilion main facet cut, as it touches the girdle. If this is exact, all the other pavilion facets will align themselves during the cutting. The first pavilion main facet should be ground until its outer edge reaches the position of the girdle as in Figure 31. Again ensure that it is not overcut.

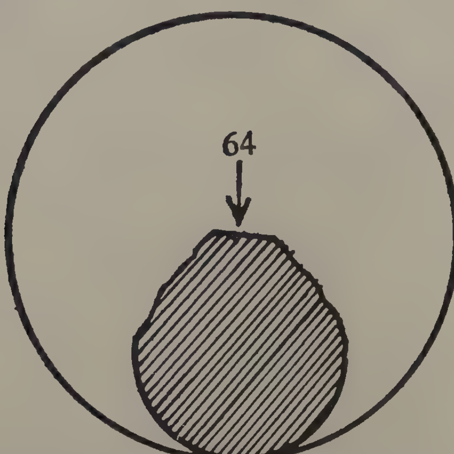


Fig. 31

First main pavilion facet cut

Next, turn the index around to number 32 (opposite the first facet) and grind to the same depth as the first. The pavilion will now appear as in Figure 32.

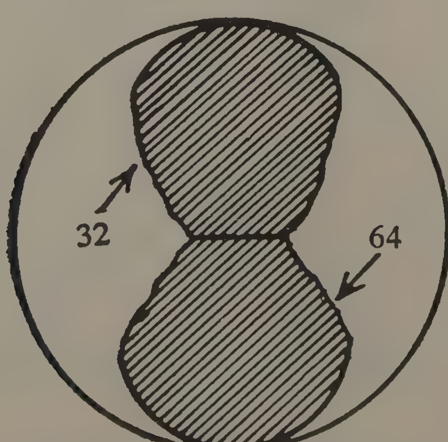


Fig. 32

Two main pavilion facets cut

Then to number 16. Grind to the same depth when it will be found that this facet meets at a point with the first two as in Figure 33.

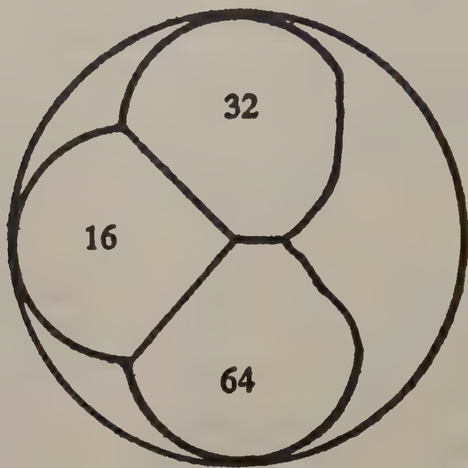


Fig. 33

Three main pavilion facets cut

Next, to number 48 (opposite 16). Grind to the correct depth. When this main facet is completed, all four will meet at a point as in Figure 34.

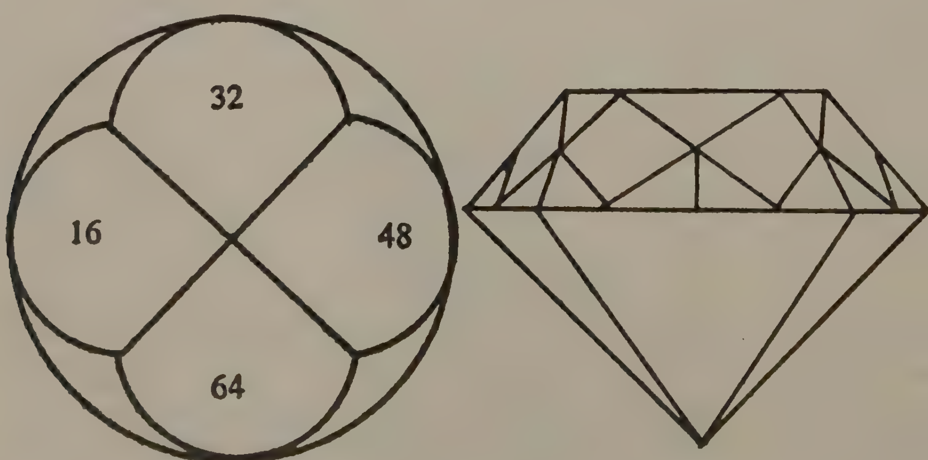


Fig. 34

Four main pavilion facets cut. The figure on the right shows a side view of the cut brilliant

Further indexing and grinding in the order of 8, 24, 40, 56 will give 8 facets to the pavilion as in Figure 35.

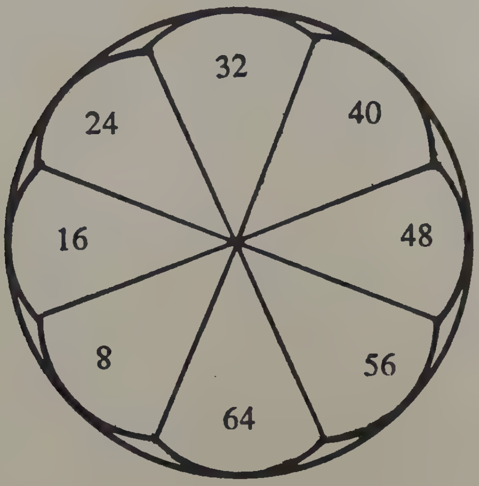


Fig. 35

Eight main pavilion facets cut

Cutting the Pavilion Girdle Facets. To cut the pavilion girdle facets, the head will be adjusted to 45° or 46° and the first facet applied gently to index number 62. This facet is not to be completed until it is examined to see how wide it is at the base. If it is too narrow, the head will have to be lowered on the mast; if too wide, the head is raised by $\frac{1}{2}$° or so. When satisfied that the width is correct, grind this facet.

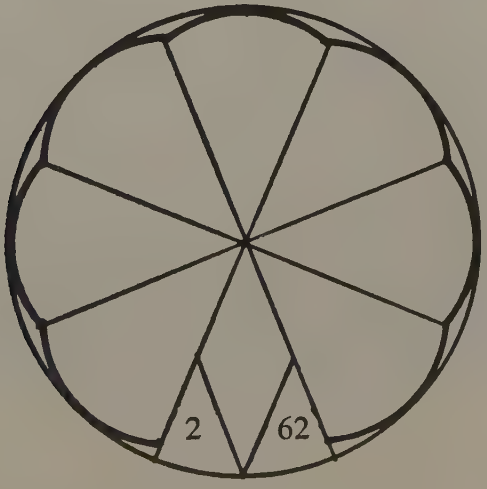


Fig. 36

Two pavilion girdle facets cut

Then grind another facet at index 2, thus completing a pair of pavilion girdle facets on the origin pavilion main facet as in Figure 36.

Proceed then to grind in pairs on the remaining pavilion facets at 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 50, 54 and 58 (actually two indices on either side of the numbers of the main facets). The faceting of the pavilion of the gem is now complete and will appear as in Figure 37.

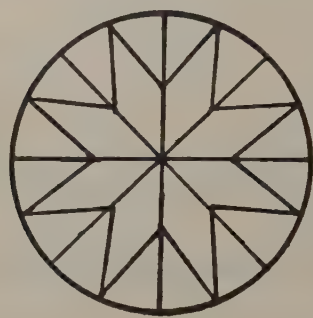
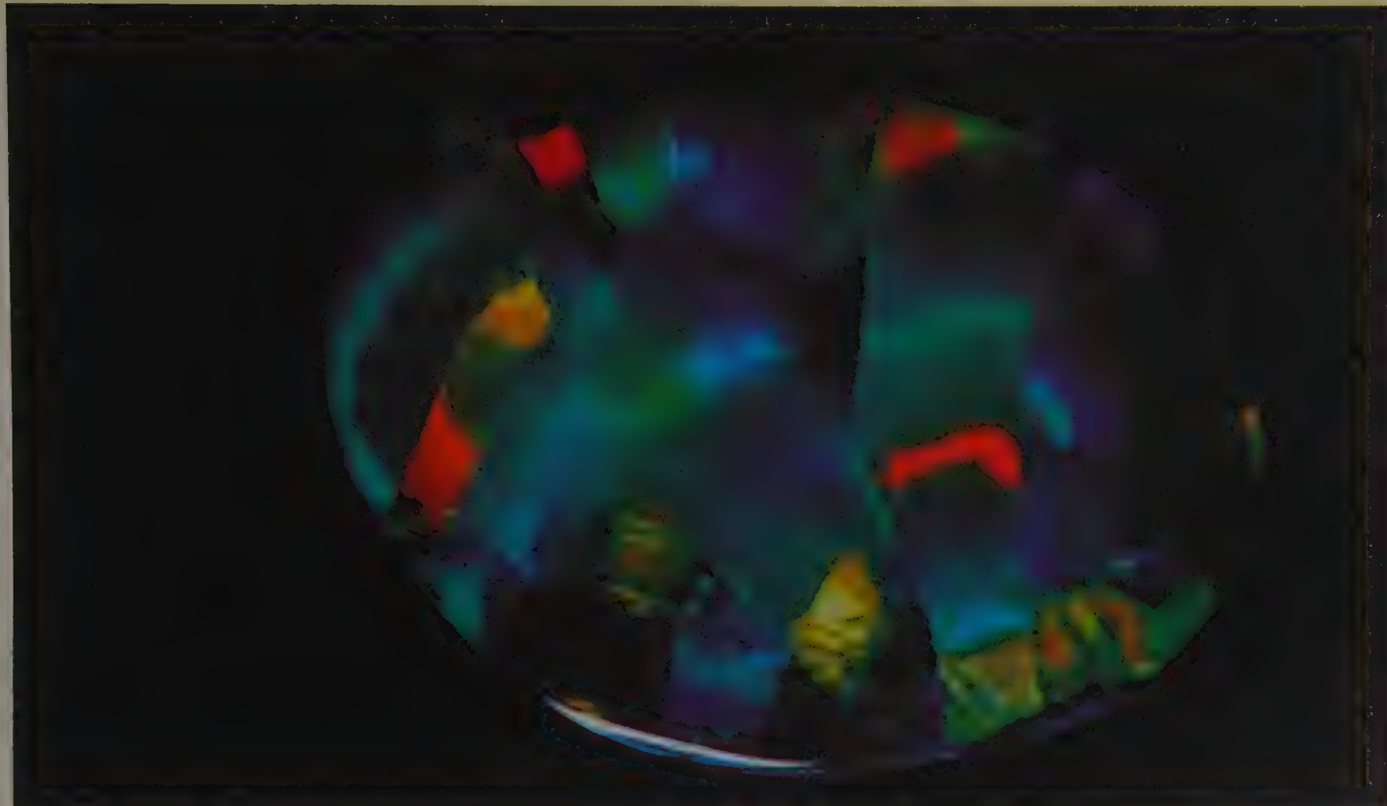


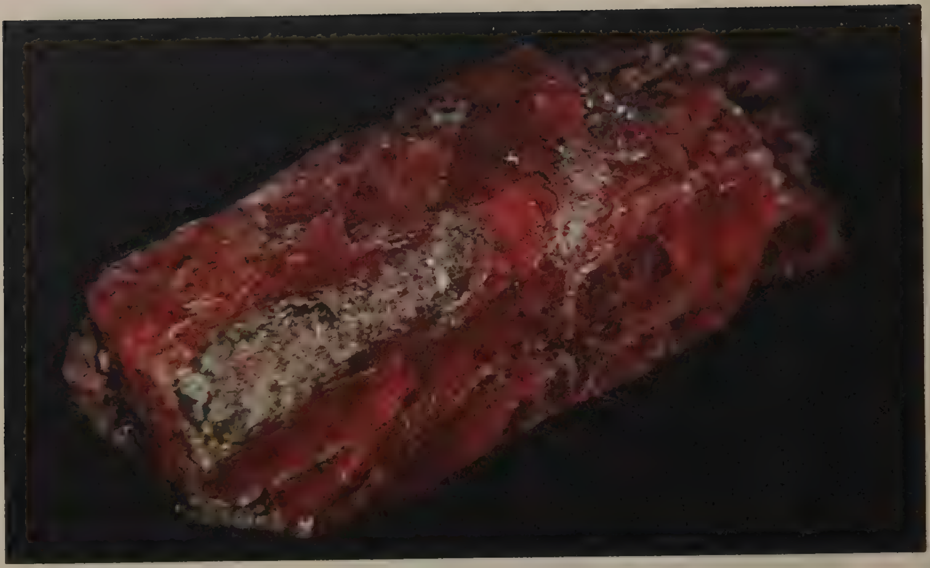
Fig. 37

Pavilion fully cut

Polishing the Pavilion Facets. Using the polishing lap as with the crown, proceed to polish the facets cut last, the girdle facets in order, indexing each number in turn. Then polish the main facets in their order. Before proceeding to the next facet, examine the facet just polished to see that it is uniformly polished. When the pavilion has been completely polished, the stone may be removed from the dop stick.



Beautiful colours are revealed in this piece of opal. In cabochon form it will become the focal point of a piece of jewellery
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz



Rhodonite found at Broken Hill
howing perfect crystal formation,
lthough it is very flawed
*Photograph courtesy Dawn L.
Hibbert, Tony Lea, Fritz Kurz*

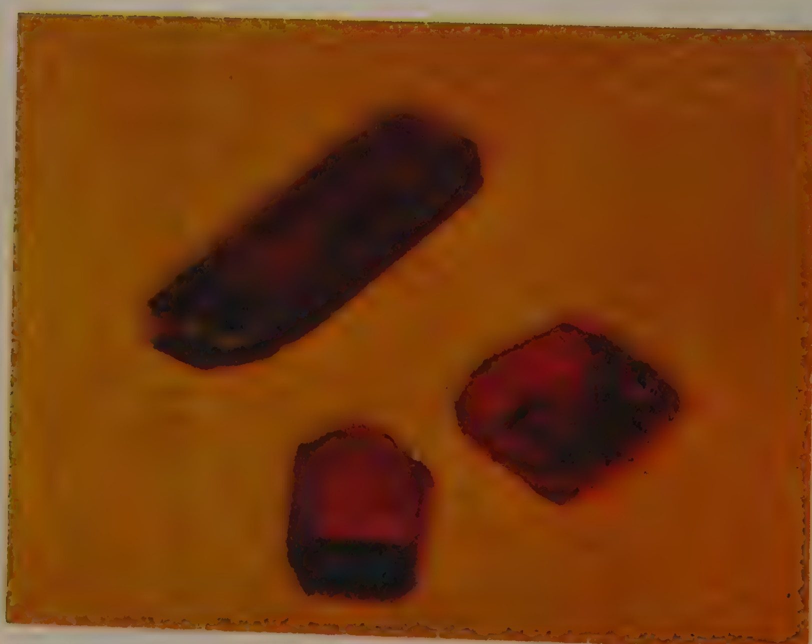
White opal, probably equally as popular as black opal. Most white opal is found at Coober Pedy and Andamooka; the specimen comes from Coober Pedy
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Quartz crystals. Specimens from the 'Crystal King' mine, Tallangallook, Victoria
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Opalized wood, two perfect examples of complete opalization. Specimen found in Queensland where this material abounds
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Topaz is frequently found in perfect crystals, with a brilliant lustre. These small specimens from Flinders Island
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Rhodonite (crystals) from Broken Hill. The larger one is ½″ long
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz



Tumbling

The mechanical tumbling and polishing of stones is a comparatively recent development in Australia; nevertheless, it enjoys considerable popularity and it is probable that millions of polished 'gems' have emerged from this process during the past few years. It is perhaps unfortunate for the hobby that a number of operators look upon this method as the ultimate, and are not inclined to progress to other aspects of the lapidary art. If, however, tumbling is regarded solely as a means of treating pebbles, off-cuts and pieces which would otherwise not warrant the trouble and time of hand-cutting, it takes its proper place in the long list of lapidary activities. When placed in this perspective, the time taken for its completion does not become a waiting period but is regarded as a secondary consideration whilst more individualistic and active lapidary work is being undertaken.

In the strict sense, tumbling is not a craft (except perhaps where some performing is carried out). It is actually the employment of a miniature grinding mill for the purposes of mass production. The process is conducted according to a series of recipes so that, after the stones have been placed in the barrels, the operator has little or no control over their shaping or finishing. To many lapidaries, gem-cutting by this 'remote control' has little appeal; to others, it constitutes a complete hobby.

Generally, the action of a tumber is similar to that of Nature with her relentless water- and sand-wearing treatment, on sea shore and in stream. Most of us, at one time or another, have picked up a rounded stone on the beach or from a river and marvelled at its contours. The tumbler accomplishes this treatment in an infinitely shorter time than it takes patient but inexorable Nature.

The Tumbler

A tumbler consists of two parallel rollers on which the drums or barrels rotate at very slow speeds. This extremely slow action is provided by a gradual reduction (by ratio of diameters of pulleys and rollers) from the motors to the drums. The bearings carrying the rollers may be sleeve- or ball-bearing. If mounted correctly, the process is not a noisy one and may quite conveniently be conducted in closely populated areas without incurring the wrath of neighbours. This is one item of equipment which can be readily made by the home handyman, although the smaller, ready-made units are not expensive.

The motor used may be from $\frac{1}{4}$ to $\frac{3}{4}$ horsepower and of a continuous duty rating (remember that the machine has to run for many days or weeks). The size of the barrels being used will determine the horsepower of the motor. For instance, a $\frac{1}{4}$-horsepower motor will quite easily cope with two one-gallon containers; four barrels of the same size will need a 1/3-horsepower motor, whilst larger containers, holding a considerable weight of stones, may require a rating of up to $\frac{3}{4}$ horsepower.

The barrels or containers themselves may be of several types: one-gallon plastic jars with *wide* mouths are extensively used. These are economical, turn quite easily on the rollers with little wear, and have the advantage of being practically noiseless. Wooden octagonal barrels, with or without rubber lining, are the most efficient but are also the most expensive. The shape of the octagonal containers allows the stones to be drawn up the sides and rolled back during rotation, thus permitting a more satisfactory tumbling action than round containers which tend to cause a certain amount of the stones to remain on the bottom.

Paint tins are often used. These, of course, are noisier than plastic and may wear thin more quickly. A tendency not to turn on the rollers may be remedied by fitting a thick rubber band on each end. These bands are also sometimes used on the plastic jars to give a better grip. The speeds at which the various types of containers should be operated are listed at the end of this chapter.

TUMBLING PROCEDURE

Rough Tumbling

For a very fine ultimate finish, some operators first grind their stones on the wheel to remove sharp edges and pits. This 'preforming' is useful for some of the stubborn varieties such as agate which may otherwise require prolonged treatment in the first roughing-out tumbling. Any depressions should also be ground out, for these will not grind or polish satisfactorily in the containers. The ideal shape is that of completely flat or slighly curved surfaces. Some lapidaries will first slab their material on the diamond saw, trim it to shape and feed it into the barrels; others feel that this is a waste of good stone and prefer to cut and polish by hand. Where naturally worn pebbles are to be processed this initial work is, of course, not necessary.

A quantity of from seven to eight pounds of stones of various sizes (some small, others larger up to an inch or more) are placed in a one-gallon container. Add about one pound of 80 grit silicon carbide together with about $1\frac{1}{2}$ pounds of granulated plastic or a quantity of leather strips or wood chips (to prevent the stones from knocking and chipping each other). Add water to a level of 2 inches or so above the stones but *not enough to fill the container* to the brim. Leave a space of a quarter to a fifth of the depth of the container.

Barrels of other sizes should be filled in the same proportion. Rough tumbling may take up to six weeks of practically continuous operation, although the contents may be examined after several weeks to note their progress. During the tumbling, the barrels should exhibit a kind of 'rhythm' to the ear. The ideal, which shows that all is well, is a soft whirr of the stones gently tumbling over each other. If, on the other hand, they can be heard to collide with each other with a sharp hitting sound, it means that one or more of these errors has to be remedied:

1. barrel contains too large a quantity of stones;
2. insufficient buffer material (plastic, chips etc.);
3. not enough water in the container;
4. barrel is rotating too fast.

Some words of caution at this stage. Ensure that the motor is not completely enclosed but that it is well ventilated at all times. Because of the continuous running it will tend to heat, but a suitable, auto-cooled motor will not overheat provided the air can circulate freely within it. On the other hand, if denied this passage of cooling air, it may catch fire. The top of the container should be removed every 24 hours or so during all of the grinding processes. The chemical action of the water with silicon carbide produces acetylene (carbide) gas which must be released to prevent bursting of the barrel. Ensure also that grit-laden water does not find its way into the windings or bearings of the motor.

Medium Tumbling

When the rough tumbling stage has been completed, the stones will have lost all of their rough points and edges and should be of more or less rounded, irregular (baroque) shapes. They will be scratched because of their abrasion by the extremely rough grade of grit. When the operator is satisfied that their general shape cannot be improved by further rough tumbling, they are removed from the barrel, sorted and washed. A new barrel is recommended for each stage, if possible, but the same one may be used for all the grinding stages if it is thoroughly cleaned each time. The stones selected for further treatment are then placed in the barrel together with one pound per gallon of 220 grit silicon carbide with water, as before. These may be tumbled for one week.

Fine Tumbling

Remove stones and wash as before. Place selected stones in the barrel (after thoroughly cleansing it of 220 grit) together with about $\frac{3}{4}$ lb. of 400 grit silicon carbide per gallon, with water. Operate this mixture for about one week. At the conclusion of this stage, if all the previous processes have been satisfactorily carried out, the stones will be nicely rounded, with no scratch marks and will look as if polished when wet.

Polishing

Remove stones and wash thoroughly. Remove those which will be unsuitable for polishing but which may have to be subjected again to one or more of the previous stages. A special barrel should be reserved solely for polishing. The faintest speck of silicon carbide grit will contaminate the polishing compound and scratch and score the stones. When the stones are scrupulously clean, without a particle of grit adhering to them, place in the polishing barrel. Add enough tin oxide to make a creamy slurry, and some leather strips or a new supply of clean plastic granules. Run the barrel from four to seven days. The stones may be inspected every few days and may be removed when they have acquired an all-over, uniform polished finish. They are then taken from the barrel, washed and sorted. What is then to be done with the tumbled stones is left to the inclination of the individual enthusiast. Some will be satisfied to keep them as they are; others may be inclined to arrange them into floral patterns and designs. Artistic and imaginative creators may wish to incorporate them into miniature indoor garden settings. The amateur jeweller may, on the other hand, intend to mount them into personal pieces such as pendants, brooches, fobs, bars, rings or clasps. However, whatever is to be the ultimate fate of the tumbled, polished stones, it is not strictly in the realm of the lapidary, whose work has ended with the completion of the process. From there on, the arts and jewellery crafts take over.

The polishing compound may be left in the final barrel which should be securely capped, to exclude dust and grits, ready for future use.

Providing the rollers are sufficiently large, several barrels each containing a separate tumbling stage may be operated at the one time. For instance, when the first rough grind is completed, another new lot of stones may be treated in that way whilst the first lot undergoes the medium grind. A multiple tumbler, holding four containers, will thus permit simultaneous grinding and polishing of different parcels of stones.

Hardness of Tumbled Stones

For the best results, stones of different hardness should not be tumbled together. If this is not observed, the softer stones will grind away more rapidly than the harder ones and will also undoubtedly become chipped and bruised. Crystalline stones should not be mingled with micro-crystalline types. For instance, although the hardness is the same, agate, chalcedony etc. are more compact than crystalline quartz, amethyst and citrine. For convenience in assessing which types may be tumbled together in the same barrel, the following table of hardness groups will be of assistance. This list does not comprise every known gemstone but includes material which is likely to be used for tumbling.

HARDNESS LIST FOR TUMBLING

Hardness = $2\frac{1}{2}$
Amber
Serpentine ($2\frac{1}{2}$-4)

Hardness = 4
Malachite
Azurite
Fluorspar
Rhodochrosite

Hardness = 5-6
Obsidian (5)
Opal ($5\frac{1}{2}$-$6\frac{1}{2}$)
Opalite ($5\frac{1}{2}$-$6\frac{1}{2}$)
Sodalite ($5\frac{1}{2}$-$6\frac{1}{2}$)
Turquoise
Lapis lazuli
Rhodonite ($5\frac{1}{2}$-$6\frac{1}{2}$)
Goldstone (5)

Hardness = 6-6½

Feldspar:
- Labradorite
- Amazonite
- Moonstone

Zircon
Andradite garnet
Olivine (peridot)
*Nephrite jade
Haematite
Prehnite
Petalite
*Ribbonstone
Tiger-eye
*Prase
*Bloodstone
*Carnelian
*Sard
*Chrysoprase
Rose quartz
*Quartzite
*Jadeite
Staurolite
Tourmaline

Hardness = 7

*Agate
Amethyst
*Aventurine
Cairngorm
Citrine
*Chalcedony
*Chert
Quartz crystal
*Jasper
*Petrified wood

Hardness = 7½

Grossular garnet
Pyrope garnet
Spessartite garnet
Zircon (high type)
Beryl
Almandine garnet
Andalusite

Hardness = 8

Topaz

* Indicates micro-crystalline or compact material which should not be tumbled with crystalline gemstones.

RECOMMENDED SPEEDS FOR TUMBLERS

	Grinding	*Polishing*
Round one-gallon containers	30 to 35	28 to 30 r.p.m.
Octagonal one-gallon containers	25	25
Four-gallon round containers	25	20
Four-gallon octagonal containers	18	15

TUMBLING GRITS AND TIMETABLE

Type of grind	*Stage*	*Silicon carbide grade*	*Period*
Rough	First	80 grit 1 lb. to 1 gallon	6 weeks
Medium	Second	220 grit 1 lb. to 1 gallon	1 week
Fine	Third	400 grit ¾ lb. to 1 gallon	1 week
Polishing	Final	Tin oxide ¾ to 1 lb. per gallon	4—7 days

Setting Up the Lapidary Workshop

Although the enterprising 'do-it-yourself' enthusiast may find it possible to assemble some sections of his own equipment, he is advised, for the reasons set out in the separate sections, to first study closely the design and operation of these. Badly assembled units of equipment may gradually prove unsatisfactory, will produce inferior work and will eventually have to be replaced.

With a little care, quite serviceable spindles and bearings for sanding may be purchased separately and assembled by the home mechanic. Discs, whether of metal or wood, should be well turned. If warped, they tend to slap and buffet the stones being sanded or polished. Plywood discs should be of the waterproof type to prevent damage during wet sanding. Polishing units may be similarly assembled. A little experimentation with sanding and polishing discs may prove interesting and rewarding. A wide range of polishing buffs may be made in the home by fixing on to discs such diverse materials as canvas, leather, leatherette, linoleum, felt or carpeting. Some of these materials, in combination with various compounds, will be found to give the best results for some stones —others for other stones. Even the old thick type Edison disc record has been used for polishing although, of course, the stone should be kept moving across its surface to prevent the formation of grooves and ridges.

The individual items of lapidary equipment are especially designed for the purpose and though they may seem to be costly, will be found to be economical in the long run. For the amateur lapidary with restricted space, as in flats or the smaller houses, it may be necessary to install one of the combination units featuring grinding wheels, diamond saw and sanding/polishing discs on the one item of equipment. These, however, have several disadvantages in that the saw is rotating when not in use and the removal and installation of the grinding wheels may involve the removal of the entire shaft.

The lapidary who has the use of a garage, a shed or a room beneath the house may be able to build up his workshop gradually by the purchase of single items of equipment from time to time. An ideal beginning is a good grinding head, comprising one or two wheels, with a sanding and polishing spindle on to which the discs can be screwed. At a later stage, as the workshop grows, the sanding and polishing section may be removed, if desired, to a separate location away from the grinders.

The advanced lapidary will soon find that he is in real need of a diamond saw. A slab-trim saw is the answer to this, preferably with at least an 8-inch or 10-inch blade; it should have a sturdy, serviceable vice to provide clean cutting and to give the blade long life. It is more convenient to have the saw installed separately and connected to its individual motor, rather than to have to uncouple belts and adjust the rates of speed when changing from one process to another. If possible, it is preferable to have the power switch for the saw placed near it, so that it may be switched off immediately. One of the more usual faults is binding of the blade if the stone moves in the vice. If the motor is not switched off immediately, the blade may twist and become dished. The ideal is a foot-pressure switch similar to those on electric sewing machines, but these are an extra expense; a well-placed tumbler switch will suffice. Most lapidary saws of the slab-trim type cause little vibration and therefore do not require bolting to the bench or table. Large wood screws are usually sufficient.

The next unit of equipment acquired after a grinder and a saw is usually a flat lap. This may be fixed to the same bench as the other equipment but requires a separate motor because of the nature of the shaft which is vertical. This lap will probably eventually be used in combination with a facet head so that it may be advisable, at the outset, to mount it on a separate bench away from the flying grits of the grinding head and sanding discs. A level solid bench top is essential for faceting as the head must be fixed with the mast at exactly 90° to its surface. Ideal for the faceting unit is a small desk or typist's table, allowing the operator to sit close to his work whilst using the drawers at the side for his laps, dops and accessories.

The facet head should be chosen with great care, ensuring that it incorporates all the modern features, including a 'cheater' or adjustment device. It should be checked to see that there is no movement of the arm when fixed into position and that it can be easily moved up and down the mast.

If a tumbler is to be installed, this may be fixed in a convenient position, either on the same bench or on a separate assembly. The later is preferable as this equipment has to run continuously for some weeks and is best kept away from equipment which is being used manually.

Storage should be provided for the lapidary accessories which will be required. Drawers and pigeonholes are suitable for this. Protection from contamination is essential, especially for polishing laps and buffs. These should be kept in clean plastic bags when not in use.

During all stages of lapidary work, good lighting is essential. Much bad workmanship stems from bad lighting rather than from lack of skill. Imperfections not noticeable in a dim light show clearly in the light of day. Lights of suitable wattage should be installed in strategic places so that they will illuminate the work but do not throw their beam into the eyes of the operator. They should not, however, be subjected to any water spray from the grinders.

Storage boxes or bins should be used for the larger rough material rather than leaving it lying on the benches. The actual arrangement of the various items of equipment is left to the lapidary. The number of operators, perhaps other members of the family, who will be using the equipment may have to be taken into consideration. The heights of the tables and benches should be calculated on this basis. Ease in moving from one unit to another for the various stages should also be taken into consideration when designing the layout.

It is a good practice to have a series of power points properly installed, each with separate switches, for each item of equipment. Complicated arrangements of double-adapters are not only confusing, but may be dangerous, particularly if the drain of current tends to overload the house circuit. Power leads should be neatly placed rather than allowed to develop into a tangle of wires. Any worn or frayed leads should be repaired or replaced to prevent accidents, especially if the workshop is at ground level.

Whether the workshop is simply a corner in a spare room or a fully-equipped workshop, a great deal of satisfaction and ease in operation will be afforded by some planning at the beginning.

Motors

In localities where electricity is available, the motor should be of continuous duty type of at least a quarter horsepower and 240 volts, where applicable. The recommended horsepower for each item of equipment is dealt with in the separate sections dealing with lapidary work. The motor should be fitted with a serviceable flex and plug and earthed for additional safety. It should be securely bolted or screwed to the bench to prevent vibration and sufficient length of belt used to prevent grits or water entering the armature or windings. However, it should not be covered so as to block ventilation as an excessively overheated motor may catch fire.

New motors are expensive but a number of used or reconditioned motors are generally available from dismantled electrical appliances. When purchasing these, have them checked for electrical faults and jiggle the shaft to see if the bearings are badly worn. In areas where there is no electricity, satisfactory arrangements may be made with a wide variety of used petrol motors which may be selected and modified to meet the lapidary's needs.

Pulleys

The lapidary, not always being a mechanic, is not able to devise an elaborate system of gears to provide the driving speeds he requires. Nor is this necessary, for a wide variety of speeds may be obtained by the proper use of pulleys, either on the motor or on the driven shaft. Briefly, the whole basis of these speeds depends upon the relative circumferences of the pulleys (diameters are used as these are proportional to the circumferences). For instance, a 2-inch motor pulley driving a 1-inch pulley on the shaft will drive it at double the speed of the motor. The reverse also applies so that if a lesser speed is required than that of the motor, a smaller pulley is fixed to the motor and a larger one to the shaft. In this way, it is possible to obtain greater speeds or extremely slow ones with the same motor. Step pulleys are often used, incorporating two, three, four or more diameters which may be adjusted as desired to give the required speeds. In assessing the correct diameters of pulleys to be used to provide the speeds required, the table on page 151 will no doubt be of assistance.

Recommended Further Reading

Many readers may enjoy pursuing their hobby into specialized fields such as gemmology, mineralogy or possibly more advanced lapidary work. Others may wish to keep abreast of events in the gem and lapidary world by subscribing to a journal dealing with their favourite aspect of the hobby, or perhaps to proceed from cutting and polishing to jewellery-making or the advanced lapidary arts. The following is a selection of journals and books recommended to the reader.

JOURNALS

Australian

Australian Lapidary Magazine (monthly), Jay Kay Publications, Croydon, N.S.W.

Australian Gemmologist (monthly), Gemmological Association of Australia.

The *Australian Amateur Mineralogist*, Specimen Minerals (Aust.) Ltd., Adelaide (ceased publication 1960).

Overseas

Journal of Gemmology (monthly), Gemmological Association of Great Britain.

Lapidary Journal (monthly), Box 518, Del Mar, California, U.S.A.

Gems and Minerals (monthly), Box 687, Mentone, California, U.S.A.

The *Mineralogist* (bi-monthly), Mineralogist Publishing Co., 329 S.E. 32nd Ave., Portland, Oregon, U.S.A.

Rocks and Minerals (bi-monthly), Box 29, Peekskill, New York, U.S.A.

BOOKS ON GEMSTONES

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Zim, H. S. and Shaffer, P. R., *Rocks and Minerals,* Simon and Schuster, New York, 1958.

BOOKS ON GEM-CUTTING

Buchester, K. J., *The Australian Amateur Lapidary,* Ure Smith, Sydney, 1967.

Dake, H. C., *The Art of Gem Cutting,* Mineralogist Publishing Co., Portland, Oregon, 1954.

Kathan, M. L., *Working with Agate,* Portland, Oregon.

Eyles, W. C., 'The Diamond Saw and its Operation', *Lapidary Journal,* Del Mar, California.

M.D.R. Mfg. Co., *The Books of Gem Cuts* (2 vols.), Los Angeles, California.

Quick, L. and Leiper, H., *Gemcraft,* Chilton Co., Philadelphia, 1959.

O'Brien, D. and M., *How to Cut Gems,* O'Brien Lapidary Equipment Co., Los Angeles, California.

Sinkankas, J., *Gem Cutting—A Lapidary's Manual,* van Nostrand Co., Princeton, N. J., 1955 (2nd ed., 1962).

Soukup, E. J., *Facet Cutter's Handbook,* Gems and Minerals, Mentone, California.

Willems, J. D., *Gem Cutting,* Chas. A. Bennett Co., Peoria, Illinois.

BOOKS ON GEM TUMBLING

Victor, A. and L., *Gem Tumbling and Baroque Jewellery Making,* J. D. Simpson, Washington, 1958 (3rd ed.).

Daniel, G. L., *Tumbling Techniques,* Gordon's, Long Beach, California.

JEWELLERY MAKING

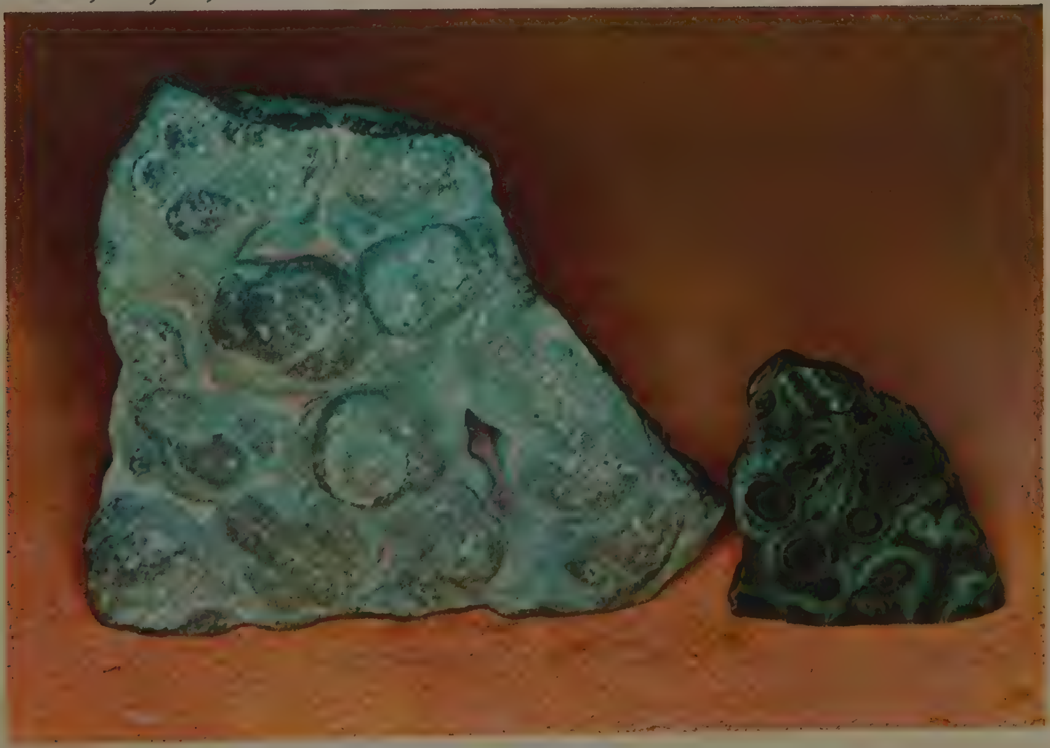
Baxter, W. T., *Jewellery, Gem Cutting and Metalcraft,* McGraw-Hill, New York.

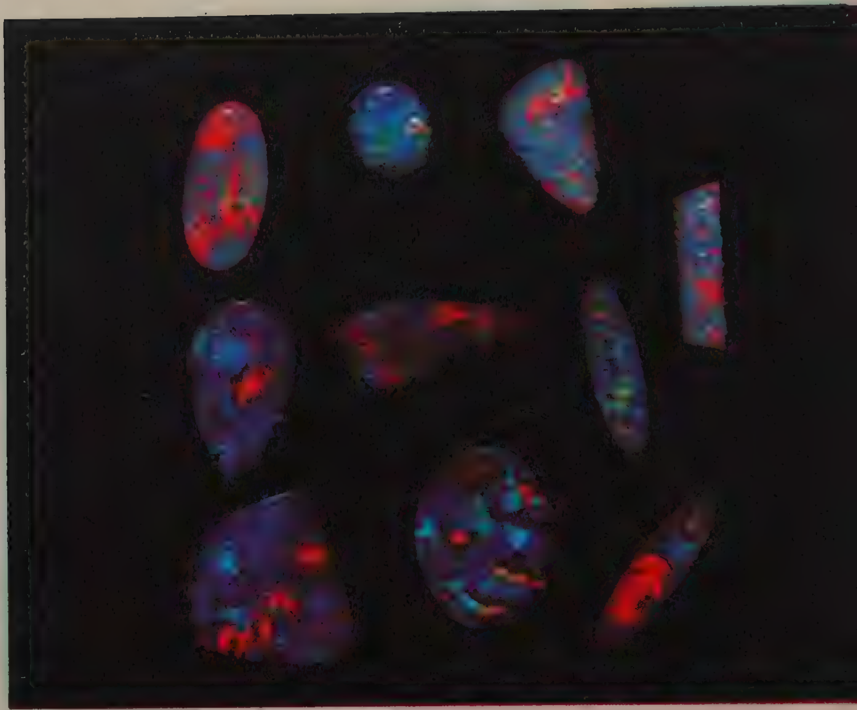
A lovely specimen of Azurite found at Cobar in NSW
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Mookaite, a multi-coloured chalcedony discovered at Mooka Station, Western Australia
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Boulder opal, precious opal which is found in cracks and cavities in boulders or nodules of ironstone in Queensland. This specimen the property of H. Makowski, East Malvern, Victoria
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Botryoidal (shaped like a bunch of grapes) malachite from Burra, South Australia
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz





Jewellery formed by the tumbling process, and hand cutting and polishing. Among the material used is Queensland agate, malachite and opal
Photograph courtesy Dawn L. Hibbert, Tony Lea, Fritz Kurz

Glossary

Many of the phrases and terms used in conjunction with gem collecting and the various phases of lapidary have been explained in the text. Others may have to be defined. The following glossary, therefore, will be of assistance to the reader for quick reference.

Amorphous	Material without any crystal structure (without form).
Arbor	Another name for the driven shaft of a spindle.
Asterism	The property of some gemstones to exhibit a star-like effect because of inclusions.
Atom	The smallest divisible part of an element which retains the characteristics of the element.
Atomic Weight	The ratio of the weight of an element atom to that of an atom of oxygen, given at 16.
Axis, Axes (plur.)	A hypothetical line (or lines) within a crystal to conform to its symmetry.
Basal	(of plane): Parallel to the base of a crystal.
Bevel	A narrow area ground on the back edge of a cabochon to prevent chipping and to facilitate mounting.

Beilby Layer	The surface layer of a polished stone, believed to be the result of fusion rather than of abrasion.
Bi-refringence	The difference between the high and low refractive index in a doubly-refractive gemstone.
Black Opal	Opal with a black or grey background.
Boule	The form which synthetic corundum (sapphire) and other stones assume during manufacture—shaped like a pear or small bottle.
Brilliant	A style of facet cut commonly found in diamonds, with 33 facets on the crown and 24 facets on the pavilion.
Cabochon	A rounded style of cut shaped like a dome. Not faceted. Sometimes shortened to 'cab'.
Carat	A standard unit of weight used in gemstones. Equal to 200 milligrams or 141·75 carats to the ounce.
Carborundum	A trade name for silicon carbide.
Cat's-Eye	*See* Chatoyancy.
Chatoyancy	A cat's-eye effect caused in a manner similar to asterism by inclusions within the stone.
Cleavage	The property of some minerals to be split along regular planes. Fluorspar, feldspar and calcite are examples of perfect cleavage.
Conchoidal	A term for the type of fracture found in many stones, shaped like the surface of a shell.
Coolant	A liquid used in lapidary grinding and sawing to prevent friction and heating.
Critical Angle	The angle at which a light ray within a stone neither escapes from it nor is reflected.
Crown	The section of a faceted gemstone above the girdle.

Crypto-crystalline	*See* Micro-crystalline.
Crystal	Gemstones or minerals containing a regular atomic pattern, symbolized by external symmetrical surfaces.
Crystal System	A classification alloted to one of the six main groups of crystals.
Cubic	The most symmetrical of the six crystal systems.
Culet	A small facet sometimes cut at the apex of the pavilion facets on a gemstone to prevent chipping.
Cultured	A term applied to pearls grown under supervision. Also a patented method of producing emeralds from natural material.
Density	The ratio of mass to volume of a material.
Dichroism	The bi-coloured effect seen in some gemstones when viewed from different directions (adj. Dichroic).
Dispersion	The breaking-up of white light into the colours of the spectrum, as in a rainbow.
Dop Stick	A wooden or metal holder on which a gem is fixed for easy manipulation during cutting and polishing.
Double Refraction	The effect in a gemstone when light is split into two rays each of a different refractive index.
Doublet	A spurious transparent gem consisting of two separate pieces cemented together, often one of gem material and the other of glass.
Doublet (Opal)	A two-piece opal made from a thin slice of precious opal cemented to a backing of common black opal (or glass).
Endomorph	An inclusion of one mineral in another, as rutile needles in rutilated quartz.

Facet	A flat face ground and polished on a gemstone, usually applied to transparent material.
Facet Head	A mechanical device for applying regularly placed facets upon a gemstone.
Feathers	Flat, bladed fractures within a gemstone.
Fire	The effect exhibited by Dispersion (q.v.) as in a diamond.
Fluorescence	The glowing of a mineral or gemstone caused by the excitation of ultra-violet light.
Girdle	The perimeter of a cut gem.
Granite	An igneous rock containing various proportions of quartz, feldspar, mica etc.
Grits	Silicon carbide, diamond or other abrasive material rendered into small graded particles.
Hackly	Referring to a splintery type of fracture, characteristic of some metals.
Hardness	The degree of resistance of a gemstone or mineral to scratching but not related to actual toughness.
Hexagonal	One of the six main crystal systems, usually characterized by six-sided crystals.
Igneous	Resulting from volcanic action.
Imperfection	A flaw, crack or foreign matter contained in a gemstone.
Inclusion	A foreign substance contained in a gemstone, as distinct from a crack or flaw.
Inorganic	A mineral not resulting from the action of living organisms.
Iridescence	The colour effect caused by thin layers dispersing light into several colours, as in an oil slick or in opal.

Isometric	One of the six main crystal systems. Another term for Cubic (q.v.).
Intarsia	The piecing together of separate flat slabs of stone to make up a complete picture.
Jamb Peg	An obsolete type of wooden facet head, employing various-angled holes.
Karat (carat)	Unit of fineness of gold, pure gold being 24 karats. Not to be confused with Carat (q.v.).
Lap	A flat circular metal plate revolving horizontally in the manner of a gramophone turntable.
Lustre	The appearance of a mineral resulting from the manner in which light is reflected from its surface.
Massive	A solid mass with no discernible crystal structure.
Matrix	The mother rock of a gemstone or mineral, often especially used in relation to opal.
Micro-crystalline	Material with the individual crystals invisible except under polarized light.
Millimetre	1/1000th of a meter, equivalent to about 1/25th inch.
Mineral	A naturally occurring substance, usually of inorganic origin but sometimes caused by organic agency as in coral, pearl etc.
Mineralogy	The science of the study of minerals.
Miner's Right	A state licence to prospect and take possession of a mining area.
Mohs' Scale	A table showing the relative hardness of ten minerals, ranging from the softest (talc) to the hardest (diamond).
Monochromatic	Applied to a gemstone showing one colour only.
Monoclinic	One of the six main crystal systems.

Mosaic	The embedding of fragments or small stones into cement or other media to form a pattern.
Nodule	A rounded form, sometimes irregularly shaped, enclosing gem or mineral material.
Nobbies	Opal-miner's term for rounded boulders or concretions of ironstone, often containing opal.
Norbide	A trade name for silicon carbide.
Octahedron	A form of the cubic (isometric) crystal system consisting of eight sides shaped like a double pyramid.
Opalized	Converted by replacement, in the manner of fossilization, to opal either precious or common.
Opalescence	A pearly, shimmering effect as in moonstone.
Opaque	Permitting the passage of no light through the stone.
Ore	The bulk of mineral-containing material.
Organic	Caused by the action of a living organism, as distinct from inorganic.
Orient	To align a gemstone in such a manner as to exhibit the most desirable effect.
Orthorhombic	One of the six main crystal systems.
Paste	A term used for imitation glass stones.
Pavilion	That portion of a faceted gem below the crown —the 'bottom' of the stone.
Petrified	Replaced by silica as in some fossils.
Preform	A gemstone, ground to a rough shape, prior to faceting or tumbling.
Potch	Common or worthless opal.

Pseudomorph	A false form, caused by replacement of one mineral by another.
Putty Powder	A term for tin oxide, a polishing compound.
Reconstruction	A method of building up (reconstructing) larger gemstones by fusing smaller particles of the same substance.
Reflection	The rebounding of light from a surface.
Refractive Index	The ratio of speed of light rays in air to their speed in a denser material such as a gemstone.
Refractometer	An optical instrument for measuring refractive index.
Rockhound	An American term for amateur rock and mineral collectors, occasionally used in Australia.
Rhyolite	A fine-grained volcanic rock, often coloured and banded. One variety is known as 'wonderstone'.
Rubbish	Inferior stones discarded by miners as worthless.
Rutilated	Containing inclusions of needle-like rutile crystals.
Silicon Carbide	A synthetic abrasive material marketed under several trade names.
Silk	A fibrous effect in some gemstones caused by slender microscopic inclusions.
Slab	A sawn section of stone or gem material, usually 3/16″ or ¼″ thick.
Silica	Silicon dioxide, or quartz.
Slurry	A pulverized mixture of grits and water.
Striations	Fine lines or ridges occurring on crystal faces, as in tourmaline, beryl and some quartz.
Specific Gravity	The ratio of weight of a gemstone to that of an equal volume of water.

Spectrum	The separate colours, together comprising white light.
Synthetic	A man-made gemstone with the same properties as the natural substance—not to be confused with 'imitation'.
Tektites	Small, regularly-shaped black 'buttons' of a substance similar to volcanic glass, found scattered over Australia and some other countries. Thought to be of cometary origin.
Tetragonal	One of the six main crystal systems.
Table	The large flat facet on the crown of a faceted gem.
Tin Oxide	A white polishing powder, often called 'putty powder'.
Translucent	Referring to diffused light—not as clear as transparent.
Transparent	Referring to the unimpeded transmission of light through a gemstone—perfectly clear.
Triclinic	One of the six main crystal systems.
Tripoli	A fine polishing powder made from diatomaceous earth.
Tumbler	A mechanical device, consisting of barrels resting upon rollers, used for grinding and polishing stones.
Twin (Crystals)	Two inter-penetrated crystals, grown upon a common axis.

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