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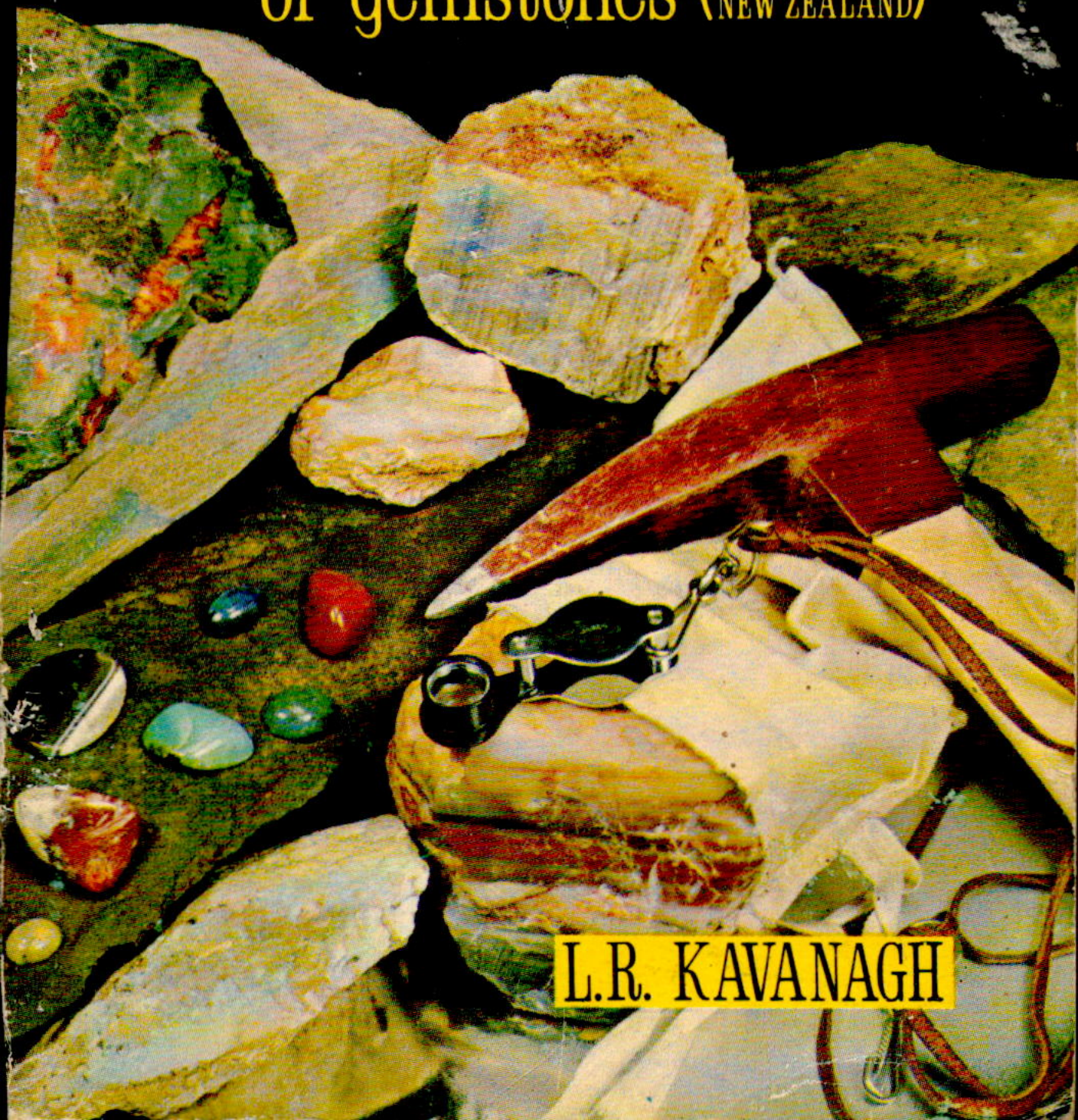
ROCKHOUNDS HANDBOOK

of gemstones (AUSTRALIA & NEW ZEALAND)



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HOW TO START

If you like adventure, outdoor life, and discovering things, rock hunting is for you. This fascinating hobby is already very popular. Each week rockhounds search for unusual gemstone material or minerals, ores, and gemstone crystal forms. They explore in river beds, quarries, rock slides, and along the seashores, collecting unusual specimens or bringing home material suitable for jewellery and other decorative works. Some rockhounds travel great distances in search of gem material; the opal fields in South Australia, New South Wales, and Queensland are within easy reach of most Australians. The agate deposits of Queensland and the Northern Territory and the colourful jaspers from all over Australia are also accessible. These are just a few of the many varieties available in Australia.

☐ To start collecting, just follow these tips:

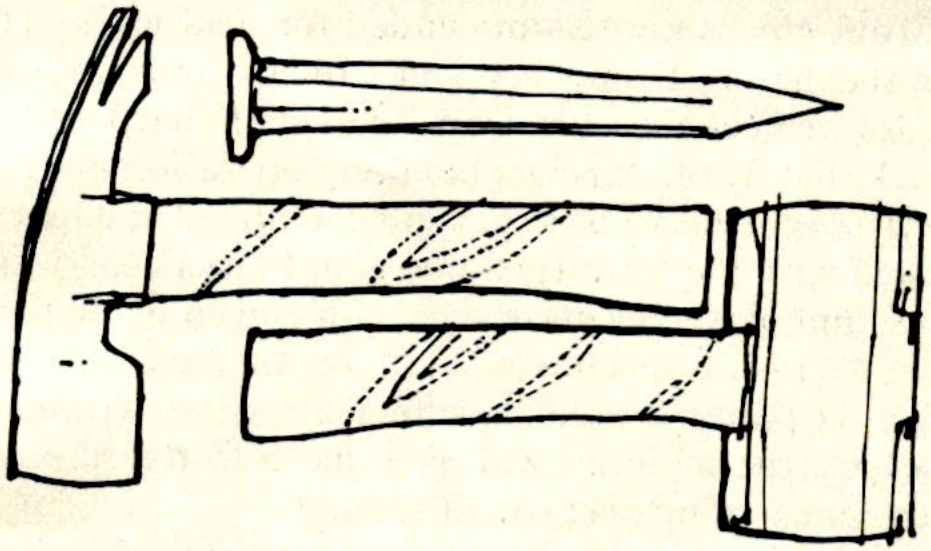
1. Join a gem club if there is one in your area.
2. Ask questions about gems and rocks at museums, rock shops, mining offices, from geologists and miners.
3. Buy at least one well-illustrated book on rocks and minerals.
4. Join your local library and read every book available on rocks and minerals, mineralogy, gem-collecting, and gemstones and ask them to obtain on loan any books they do not have.
5. Study the displays at museums, rock shops, and gem clubs.
6. Ask an experienced rockhound to take you on a field trip.
7. Meet other rockhounds and exchange material, visit other gem clubs and see their displays.

☐ Again, do not under-estimate the value of joining a gem club which will bring you into contact with hundreds of people with similar interests. Most clubs run periodical displays and competitions and these are a good source of information to increase your knowledge on all aspects of gem-collecting and cutting.

☐ Attending one of the field trips conducted by a well-organized club is very instructive. A field-day committee will make preliminary investigations of areas and select sites where amateurs can get their first taste of collecting. When it has decided on an area, this field team will send out an advance party to explore the site, seek the land-owner's permission, select suitable areas for parking, picnicking, or camping, and to collect specimens and material suitable for both collectors and cutters. This will

be displayed at the club meetings on the night before the field-day. The club supplies field officers for the day itself and these officers will assist you in the field as much as they can. Clubs often obtain permission to enter areas or arrange conducted tours over open-cut and working mines and treatment plants that are not normally open for inspection. Many clubs also obtain an excellent selection of speakers on various relevant subjects. If the club does not conduct trips, you have every right, as a financial member, to suggest that they do so.

☐ If there is no gem club in your area, you might call a meeting at your home or local hall to see if you have enough interested friends and neighbours to start a club. If you work together, you may be able to obtain premises and cutting equipment much sooner and with less financial strain.



TOOLS TO USE

The basic essentials for any gem-hunter should include a rock hammer (geologist's pick), gardening gloves, comfortable knapsack, wrapping paper for specimens, notebook, ball-point pen, and safety goggles.

☐ The rock hammer is shaped differently at each end; the square, blunt end is used for striking and breaking and the pointed end for gouging dirt and raking gravels. These hammers are available in various weights; for a man, a 22 oz hammer will suffice and an 18 oz will be suitable for a woman. Locally-made hammers with wooden handles can be bought for less than $3.00 whilst the all-steel imported models with vinyl- or leather-covered hand grips are between $6.00 and $7.00. They are essential when breaking rocks in order to remove surplus material and to expose the inside patterns.

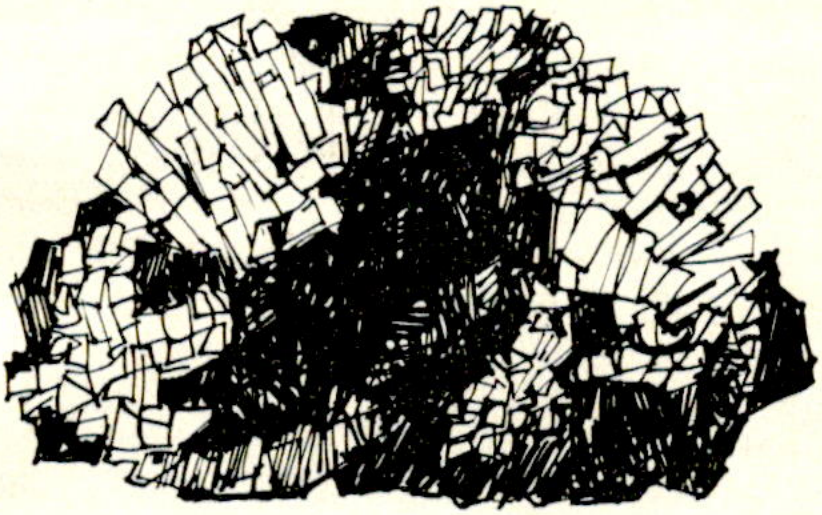
☐ Stout gloves are recommended for field work. These save the hands from cuts and knocks and the safety goggles protect the eyes from the small sharp splinters of rock that fly off during a breaking operation.

☐ All specimens to be kept can be wrapped in paper and labelled with the locality. Some gem-hunters carry small boxes, and plastic or glass vials with cotton wool, for the delicate crystal specimens but, for the first few trips, wrapping paper should be sufficient; when wrapped in packages, the material will pack flat into the haversack for easier carrying over rough ground.

☐ A notebook and ball-point pen are essential to record anything of note; such as locality or map reference, and the landowner's name so that, in the event of material being in good demand, the gem-hunter can re-locate the source of supply. It will not be necessary to know the names of the rocks when labelling them at this stage; numbers or letters can be used until the material can be identified.

☐ If working near cliff faces, a hard hat is essential and, in mine shafts and tunnels, a dependable light and stout rope can be added to your list.

☐ As the gem-hunter ranges further afield, more equipment can be added. A crack hammer of at least 2 lb, together with narrow (thin) and short (broad) chisels, will open many large rocks or cavities. In areas where the material is small, various-sized mesh sieves are required and with these a small shovel becomes necessary. For those who wish to pan for gold, small gold pans are an inexpensive addition to the list but, in the absence of these, hub-caps from most modern cars are an excellent substitute. This array of equipment need not be purchased until the need arises.



WHERE TO SEARCH

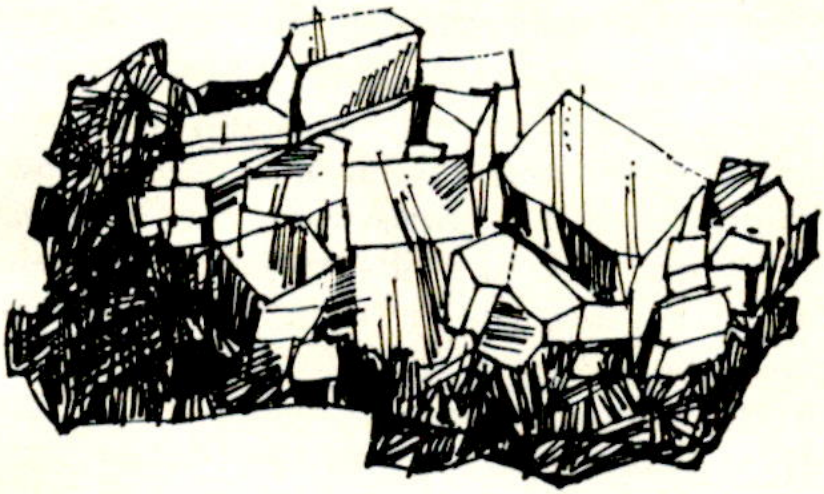
With the exception of Australites (small glass buttons from the moon), and some isolated gems, it is improbable that you will find good specimens of crystals and gem material lying on the surface of the ground. These are subjected to extremes of heat and cold and would be cracked and weathered beyond recognition.

☐ So the search should be carried out in places that have recently been exposed, where the layer of earth or vegetation has protected the rocks from these extremes for many years. Places to look are: recent rock slides, or falls; freshly-dug road and railway cuttings; culverts and floodwater run-offs; river beds where gravel banks are piled up after storms; at the base of cliff faces where fresh rocks have fallen from outcrops or where the river forms a natural sluice trap; where a large tree has been

uprooted by storm or bulldozer; and at the mouth of rivers, in sand bars and along the beaches nearby.

☐ Other good localities are quarries and old mine workings, especially the abandoned ones. For in the past, these quarries and mines were worked only for tin, gold, copper, lead, and so on, and no thought or time was devoted to collecting or marketing crystal or mineral deposit, unless it was of very fine quality.

☐ In all these areas there is a danger of rock falls. In mine shafts, rotten timber, water, and snakes are other hazards, so extreme caution must be maintained at all times. If searching alone, always tell someone the approximate area you intend to visit and work and, if you *do* enter old mine shafts or workings, always leave a "marker" (such as a coat or pullover) outside, in a conspicuous place. If you experience difficulties, these precautions will ensure that help reaches you quickly.



THE NATURE OF GEMSTONES

If you only want to display specimen materials, every type of mineral and its variations will be of interest to you. If you are collecting gemstones for cutting and polishing for display or jewellery making, then a more stringent examination of material must be applied. These stones must have a hardness rating of at least 7 to be classed as durable (hardness list detailed in later section); they must also be non-porous, smooth or greasy to the touch, and attractive enough in colour, markings, or inclusions to warrant the time and skill that will be spent in shaping and polishing them.

The qualities of gemstones: With the exception of such organic products as pearl, amber, ivory, and coral, they are all minerals and, of these, only the natural glasses and some opals are non-crystalline. Not all minerals are

suitable for fashioning into gemstones. Only those possessing the three cardinal virtues of *beauty*, *rarity*, and *durability* are acceptable. Of the many thousands of minerals known to man, only about one hundred meet these requirements in some way. Some gemstones possess only one of these virtues and rely on beauty or rarity. Such gems as opal, turquoise, and malachite fall into this category. Other gems abound in relatively large amounts, and rely on their colouring or beauty and their durability. Agate, amethyst, rose quartz, jade, chrysoprase, jasper, bloodstone, and fossil wood are included in this group.

GEMSTONES MAY BE DIVIDED INTO THREE GROUPS

TRANSPARENT (will admit light and can be seen through).
TRANSLUCENT (will admit light but cannot be seen through).
OPAQUE (will not admit light and cannot be seen through).

☐ The largest and most important group, the transparent gems, can easily be divided again, into those that are colourless and those that are tinted.

☐ The colourless gems depend for their beauty on lustre, refraction and colour dispersion, which gives them their brilliance and fire. Of these, the diamond stands supreme.

☐ The coloured gems, however, depend for their attractiveness more upon an intrinsic hue and depth of colour.

In either case, the final exploitation of their inner beauty depends on the skill of the lapidary and, when material is not of top quality, the most attractive compromise must be reached and then lustre and dispersion play their parts. On the other hand, the translucent and opaque gemstones rely almost entirely on their colour and colour distribution for their beauty.

☐ Lustre plays an important part, more particularly in the translucent gems (the phenomenon known as asterism, which gives us the star gems, is an example of this). Lustre is dependent on the degree of polish and, although this also plays its part in opaque gems, it is the pigmentation on which this type relies.

☐ Whereas the transparent gems are invariably facet-cut, the translucent and opaque are cut and polished *en cabochon*. The lower-grade material is often tumble-polished and made into baroque jewellery. The cabochon and tumble-polishing methods are those that have been adopted by a large proportion of amateur gem-hunters, as most attractive gemstones can be produced without technical knowledge or a large outlay on machines. Indeed, just as in other hobbies, exceptional work can be produced on simple, home-made equipment. Full details of these cutting methods are given in later chapters.

☐ Some of the translucent and opaque gem materials (e.g. jade) lend themselves admirably to carving. Should the gem-hunter decide to pursue this avenue of gem-cutting, it is advisable that a comprehensive book on this subject be purchased (there are some excellent ones available from rock shops and book stores).

☐ When searching, do not expect to stumble over

diamonds and sapphires, because they occur only rarely in Australia; concentrate on the more common varieties instead. Other minerals are found and used chiefly as metals. Some are valuable (e.g. gold) and are found chiefly in their native state; these are called precious metals. Others (e.g. silver, copper, and quicksilver) are less valuable, and are also found in their native state but more in combinations, as ores. Some useful metals, iron, lead, zinc, and tin, are rarely found in a native state but are abundantly mixed with earthy or other elements. These are ores.

☐ Some earthy minerals not included amongst precious gems, but consisting of similar elements (i.e. having the same chemical composition) are called silicates (silica being the prevailing ingredient) and oxides, and these are extremely important to the gem-hunter.

☐ Other types of minerals which the gem-hunter may encounter are composed of a great variety of minerals of which lime and magnesia are the most familiar bases and are called carbonates and sulphates.

☐ But it is to the silicates and oxides that the amateur gem-hunter must turn, to obtain (at reasonable cost) large quantities of suitable, coloured gem material for his hobby. The high-quality material still commands a good price in the world gem markets but the lower-grade and lower-priced material is the one attractive to the amateur.

The quartz group produces a wide range of gemstones in the oxide group, both in the crystalline and crypto-crystalline varieties. This does not mean that the gem-hunter or rockhound should confine his search and collecting to the quartz oxides, but it will give him a vast range of stone of the same hardness which will be

essential if he starts tumble polishing later.

☐ There are many other gem materials available throughout Australia and New Zealand that are sought after eagerly by gem-hunters everywhere. If you should find a new deposit of an unusual material, a ready market is waiting.

☐ The following table will act as a guide to the material that is available in Australia and New Zealand and is grouped together with similar minerals for reference.

ELEMENTS:

Diamond, gold, silver.

OXIDES:

Corundum—sapphire and ruby.

Opal.

Quartz—Crystalline varieties:

Rock crystal—colourless

Amethyst—violet

Citrine—yellow

Smoky quartz—brown

Rose quartz—pink.

Quartz—Micro or crypto-crystalline varieties:

Prase—leek green

Chrysoprase—apple green

Tiger's eye—yellow-brown, red, blue, multi

Siderite—blue

Aventurine—brown-yellow, red, blue, green with scales of mica

Rutilated quartz—clear with golden needles of rutile

Tourmaline quartz—as above with needles of tourmaline

Chalcedony—translucent white or bluish colour

Cornelian—translucent flush red
Sard—brownish red
Plasma—dark green with white or yellow spots
Bloodstone—light green with intrusions of yellow-red or brown jasper
Agates—in all variations—banded, moss, ribbon, eye
Agatized wood—light to dark brown, some red. Called by the common name of fossil wood.
Onyx—similar to banded-agate except the lines are straight
Sardonyx — similar banded but colours are brownish-red and white
Jaspers—impure variety of quartz, mainly reds and browns.

ALUMINATES:

(Those oxides containing aluminium traces)
Chrysoberyl
Spinel

CARBONATES:

Azurite
Malachite
Rhodochrosite

SILICATES:

Andalusite
Beryl
Chrysocolla
Epidote
Garnets
Jade (nephrite)
Prehnite
Rhodonite

Serpentine
Topaz
Tourmaline
Zircon

PHOSPHATES: BORATES: SULPHATES:

Lazulite
Turquoise

☐ There are many variations that could be added to this list, but some are merely a descriptive name applied to a particular variation, or a name given locally to rock found in that area. Nature provides small, isolated deposits of gems in the most unusual places. These are awaiting discovery by the amateur who has plenty of time to fossick in isolated areas where it would not pay a commercial company to operate. You should, therefore, explore all cracks and fissures in a rock face and hit all rock faces with your rock hammer; a dull thud will tell you if there is a cavity behind the skin of the rock (this may contain a crystal of rare beauty). In addition, search where there has been a slip or fault in the formation or where two different rock faces have been forced together. These are the places most likely to be subjected to heat and pressure, for these two elements are necessary for the formation of crystal.

CRYSTALS

☐ A crystal forms into a definite geometrical shape, such as a cube, rectangle, hexagon, rhombus, or rhomboid. Some of the crystals have edges (or faces to give them their correct name) that are perfectly formed and clean, by the wonderful means of nature alone.

☐ Gemstones crystallize in only six basic crystal shapes, namely: cubic, tetragonal, hexagonal, orthorhombic, monoclinic, and triclinic.

☐ The gem-hunter will readily recognize the cubic and hexagonal crystals and slight variations of the cubic, such as the octahedra (two pyramids with the square bases joined together), but of the others there are so many variations that it is a study of its own. It is sufficient for the gem-hunter to know that if he finds a crystal shape (or part of one) that is unknown to him, he should wrap it well for protection from breakage until it can be identified. If you find a cavity or deposit containing crystals, use patience and care in extracting them. Speed and impatience may result in ruining a perfect specimen. Always try to remove as many crystals in a cluster as possible for these are prized by collectors. If you can only remove them individually, break them off cleanly, as close to the base as possible, in their natural state.

☐ Most of the gemstones that are polished by amateurs are of crypto-crystalline material, which means that they do not form definite crystal shapes. They are usually in massive form and occur in beds, or deposits, or in various-sized boulders that have been weathered out of the parent rock. Therefore, any rock that is different from, or heavier than its neighbours, anything that glitters or is bright, or has strange markings or patterns, or has inclusions of another material inside the parent rock, should be gathered for identification. This is where the rock hammer is useful, for these crypto-crystalline rocks usually have an exterior that is quite different from their interior. It is necessary to establish what is on the inside before troubling to carry them home.

☐ It is important, therefore, to progress slowly and patiently along each rock face, slide, or river bed, examining each rock carefully for any previously-mentioned quality. If you decide that a particular rock is unusual, place it on a solid rock and hit it with the hammer so that you break a piece off one end. If it shows attractive patterns, colours, or markings, search the area for another one of similar external design and repeat the procedure. If it shows similar characteristics, it is safe to assume that all other rocks in that area with the same external appearance have similar interiors. Collect as many of these as you can use and leave some for the next adventurer. Wrap all specimens in paper and record the find in your notebook to enable you to locate the area again.

☐ If the new rockhound experiences difficulty in locating gem material, or even suitable beach stones, the assistance of a more experienced person will teach more in one field trip than a lot of reading will accomplish. Read all you can and, after a field-day, re-read the relevant books, as these are valuable references to turn to and a small, well-illustrated pocket version is invaluable to carry in the field.

TUMBLE METHOD OF POLISHING

Of the several methods of polishing used today to convert rough stones to the polished state, there are three styles that have been widely adopted by amateur gem-hunters; these are *tumbling*, *cabochon*, and *facet cutting*.

TUMBLING

☐ To most gem-hunters, the tumbling of gemstones is an excellent "first step" into this hobby. It consists of placing broken rock in a drum with an abrasive powder and water. By rotating the drum at a relatively slow speed, the action of the stones and grit tumbling inside will grind away the rough edges and flaws.

☐ With the flaws removed, the rocks are left with an even, contoured surface. Repeating this operation with finer grits, and eventually a polishing powder, the end result will be a pleasing variety of polished stone of different sizes, colours, and shapes. These are called baroque stones and are used in the manufacture of gemstone jewellery.

☐ However, tumble polishing is by no means as easy as it may appear. By outlining in detail *one* successful method of tumbling, it is hoped that a satisfactory result will be achieved by all who try. The average gem-hunter will learn a lot with time and practice.

EQUIPMENT

☐ The equipment needed in this operation is:
a base to carry the revolving drum, a drum, electric motor, abrasives, and polishing powder.

The base: The tumbler base consists of two revolving shafts of $\frac{5}{8}$ inch or $\frac{1}{2}$ inch diameter, set some distance apart, on which the drum or container can revolve comfortably without rolling off. These shafts, supported at each end with suitable bearings, are connected at one end with a belt running over twin pulleys. At the other end, on one of the shafts, a large driving pulley is placed and a drive belt to the motor pulley is attached.

☐ This complete base unit and motor can be fixed to a bench top, but the wise gem-hunter will assemble it to a piece of thick plywood so that the whole unit is easily transportable. The latter method is desirable, as the

motor, running continuously for weeks, will create heat and, if easily transportable, can be placed in a draught or in the open air (weather permitting); both positions help to keep the motor at a cooler running temperature.

☐ If fastened to the bench top, the vibration is accentuated by the air-space under the bench, and the resultant drumming noise soon becomes irritating to the operator and his neighbours. Care should be taken when tightening all bolts to the board or bench that the shafts and pulleys "run free," with no tight spots on bearings, etc.

☐ Easily-accessible oil holes or grease nipples are desirable for, although there is little danger of overheating at such slow speeds, the oil or grease will ensure trouble-free running.

Electric motor: The power rating of the motor need only be small to drive a small tumbler with one or two barrels, each holding 6 lb of stone. However, the gem-hunter will find that a second-hand $\frac{1}{4}$ h.p. motor of the type used on washing machines will stand him in good stead and provide ample power if he should ever contemplate hooking up a tandem set of rollers to convert his tumbler to a tandem unit. The $\frac{1}{4}$ h.p. motor is also of sufficient power to drive other types of gem-cutting machinery such as the trim saws and grinding heads if his future plans include the cabochon cutting of gemstones. In addition, most $\frac{1}{4}$ h.p. motors contain a fan which is desirable in a motor running for long periods.

☐ Your base unit can be set out as shown on the opposite page.

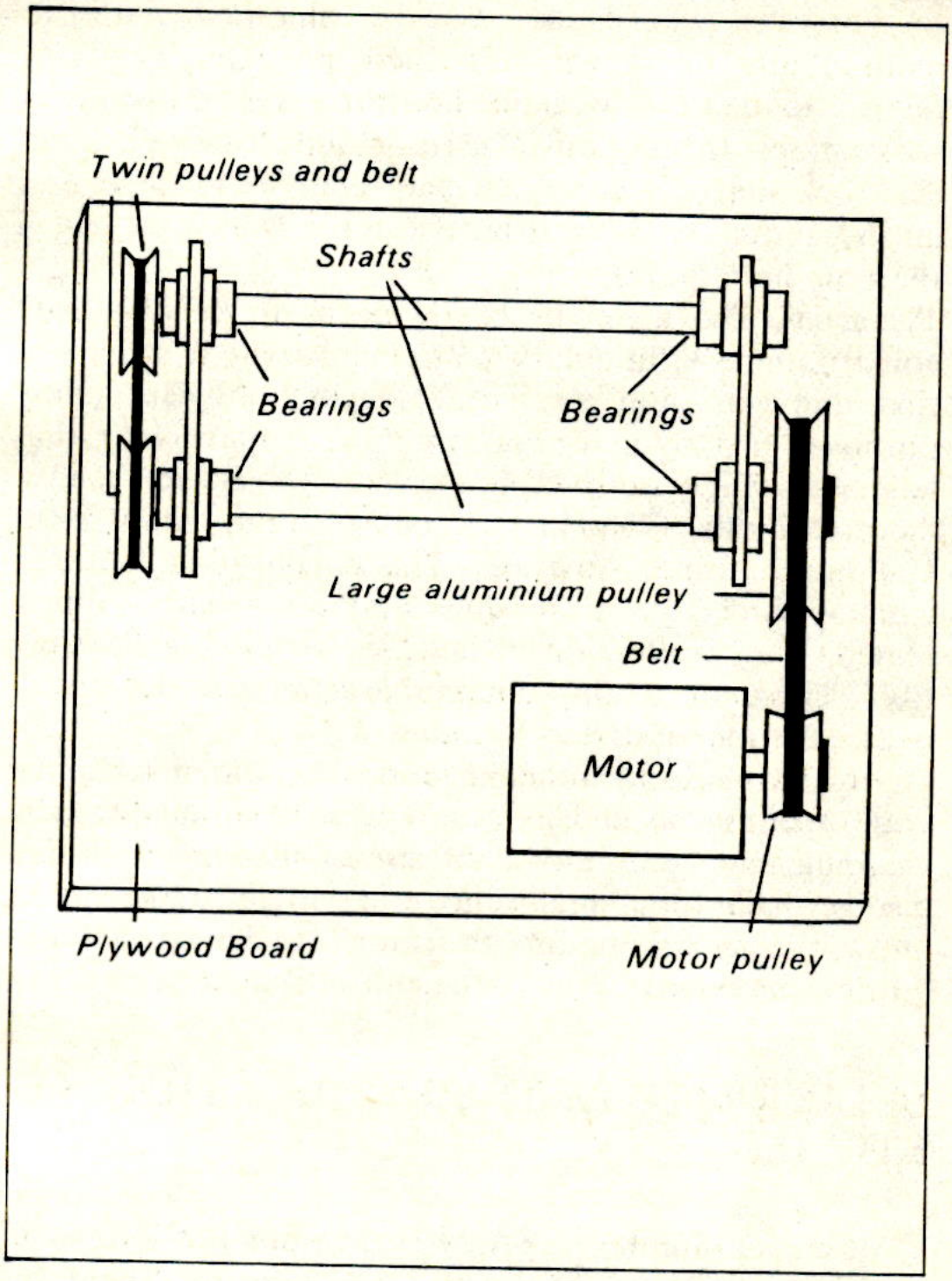


DIAGRAM OF A TUMBLING MACHINE.

☐ For those who do not have the time or facilities to manufacture their own unit, there are many types of factory-made units available and these are on display at rock shops throughout Australia and New Zealand. The rock shop dealer will be glad to advise on these and an inspection by the prospective buyer will soon reveal the type he requires.

The drum: The drum or barrel needs to be of sturdy construction. Although there are many who utilize paint tins, and glass and plastic jars, most hobbyists finally purchase factory-made barrels. One in particular that has been widely adopted is the Patented Barrel, manufactured by the Gemmasta Lapidary Equipment Co. of Richmond, South Australia. This barrel, manufactured from extruded plastic casings and fitted with rubber-sealed, aluminium-capped ends, is virtually indestructible. These are readily obtainable from gem dealers all over Australia and New Zealand.

☐ But if you decide to make your own, remember that a wide opening on at least one end is essential for easy cleaning and the removal of stones. Provision should also be made for a small screw to be fitted to one end to allow the de-gassing or "burping" to be carried out without having to remove the end of the barrel.

SELECTION AND PREPARATION OF STONES

☐ The gem-hunter can now bring out collections of rocks gathered on field-days and, selecting them for colour and pattern, can start operations.

☐ Stones that appear to be of the same hardness are first broken up with a crack hammer to sizes suitable for use as jewellery. As a relatively small amount will be ground from the stone, they can be broken down to almost the size required when finished. Large stones can be used as pendants and key-rings, smaller ones can be used as cuff-links and brooches, even smaller ones for bracelets and the very smallest pieces for ear-rings.

☐ These various-sized stones are placed in the barrel together with all chips. The tumbler operates most effectively if it is filled to 60%-70% capacity. The quantity of stones in the barrel is important. Too few stones will slide around the inside of the barrel and produce flat-sided stones. Too many will reduce the amount of "travel" they have and will not tumble properly. There must be sufficient room for the stones to move or tumble over each other.

☐ This tumbling action causes the stones to roll over each other continually and, with the abrasive grit and small chips in between, soon begin to wear down. Thus the noise a tumbler makes will soon tell the operator if the stones are rolling efficiently. A continuous and monotonous rolling sound is produced for the best results.

☐ The abrasive grit used is silicon carbide; mix approximately 1 lb of grit to each 6 lb of rough stone.

COARSE GRINDING

☐ Start with No. 80 or 90 grit grade, add to the stones in

the barrel, and cover with water. Add a small handful of washing soda and sugar. The soda helps to reduce the build-up of carbide gas and makes for easier cleaning of the machine. The sugar will make the grit "sticky" and will ensure that, each time two stones roll over each other, there is some grit between them.

☐ Seal the barrel and place on the machine. Now comes the time of waiting. The barrel should revolve between 30-50 r.p.m. After 24 hours of continuous running, remove the barrel from the machine and release the gas pressure. If this is your first batch, you will be anxious to look at the stones, so remove a handful, wash them under the tap, and notice if the sharp edges or corners are starting to show wear. It may be too early if hard stones are being tumbled, but the softer stones should give you some indication.

☐ It is hard to say how long the first grinding should last, because much will depend on the type of stones, how they tumble, the amount of fall, etc. Release the gas pressure every 24 hours for the first 3 days after placing any fresh grit in the barrel. After this it should be necessary to release gas only every 48 hours. Frequent inspections during the first two or three batches will soon give you an indication of how to plan your inspections. The coarse grind should continue until more than 50% of the stones are of good, even contour and all visible flaws are removed. This may be 2, 3, or 4 weeks of continuous tumbling. Add water occasionally to allow freedom for the stones to move about in the barrel. If the grits are allowed to become too thick the stones will not tumble and will remain suspended in a thick, glue-like "goop." An indication of this will be the virtual absence

of noise. Remember that you must hear a rumble all the time. This is the most important grind. Finer grits that are used in the later stages cannot hope to remove blemishes that the coarse grit has missed.

☐ When your inspections reveal that most of the stones are sufficiently ground, remove them from the barrel and wash them clean.

INSPECTION

☐ Now comes the first and most important inspection. Select only rocks that have had all external flaws ground away and that show good contours. Some will have chipped or split and will still have sharp edges. Soft coatings and dirt will have been removed and may have uncovered holes or cracks. All faulty stones must be placed aside to coarse grind again. Those badly flawed with deep holes or cracks should be discarded or broken in half so that the offending marks will be ground out in the next coarse grind. You may find that you eliminated up to 40% of your stones. Those that pass your inspection will therefore not be sufficient to fill the barrel to 75% capacity for the second grind. This means that another first grind is necessary to make up the amount, for the one-barrel tumbler.

☐ If your tumbler will accommodate two or three barrels of various sizes, you can continue the second grinding in a smaller barrel while the larger barrel carries out another coarse grind. When you are operating barrels with different grits and at different times, it becomes necessary

to keep a notebook record of all operations or a blackboard fastened to the workshop wall.

☐ At the end of this coarse grind the novice can learn a great deal about the relative hardness of stones. Some very hard stones will show only slight wear, other soft stones that were the size of a thumb-nail when placed in the tumbler may be almost ground away. All rocks of one type may have split, and will have to be discarded. All this information should be recorded for future grindings. The grit and residue from the first grind should be discarded.

☐ The stones should be washed thoroughly before the second grind and, if the same barrel is to be used, it should be scrupulously cleaned. It is at this point that the usefulness of a barrel from which both ends can be removed quickly becomes clear.

THE SECOND GRIND

☐ Use grit size No. 220 silicon carbide and repeat the procedure of the first grind. Fill barrels to 75% capacity, add water and sugar. Record the time of starting, oil the machine, and switch on. This operation should only take 7 to 10 days. Regular inspections will soon show how the stones are progressing. This operation is not designed to remove much material, merely to remove the grinding marks of the coarser grit. There should be little or no loss of stone. At the end of this operation a further inspection can be carried out. The stones must be washed and the barrel cleaned scrupulously. Now prepare for the third and final grind.

THE THIRD GRIND

☐ Using grit No. 500 silicon carbide, prepare as before and start. This grit is very fine and will have the effect of preparing the stones for the polish and will give a satin-textured finish to the stones.

☐ The third grind requires approximately the same time as the second, but here again regular inspections will decide if it needs a day or two more. No fixed time is adhered to in any of this grinding and the gem-tumbler will soon start to form his own opinion about treating various stones. When you are satisfied that the stones are ready for the polish, the same cleaning procedure must be observed.

THE POLISH OPERATION

☐ Remove all traces of grit from stones, hands, and barrels with frequent washings. When satisfied that 100% cleanliness has been effected, *place* the stones in the barrel. If you pour them in you will chip some and this will prevent a good finish being obtained.

☐ For polishing, use tin oxide (putty powder) at the rate of ¼ lb to 8 lb of stone. This is an expensive polish but it is most effective for the majority of stones; add sugar to the polish and 1 or 2 drops of detergent but no washing soda this time. Always insist on *pure* tin oxide, as some brands have fillers in them to create more bulk. *Be wary of bargain buys in polish powders.*

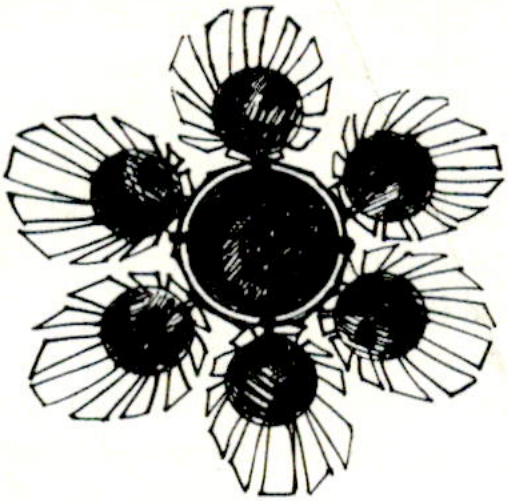
☐ The gem-hunter has spent some time in bringing the stones to this final stage and care needs to be exercised in this final operation to prevent chipping. It is advisable, therefore, to reduce the speed of the barrel to 25-30 r.p.m. This can easily be accomplished by placing a smaller pulley on the motor and adjusting the belt. Also, the addition of plastic granules (1 cup to 8 lb stone) acts as a buffer between stones and "carries" the polish to the stones. A few drops of detergent help to break the surface tension of the water over the stone and should allow them to polish more quickly.

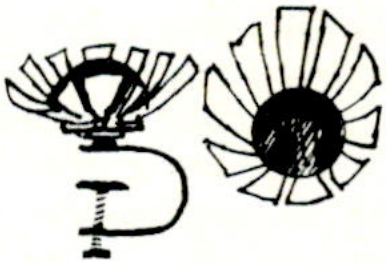
☐ In 2 or 3 days your stones should start to show a polish. Remove a few from the barrel and wash them under a tap until clean. While still wet, place on a clean piece of cloth and wait until dry. If it has had sufficient polish you will be unable to tell when it is wet or dry. The stone will dry out dull if it has insufficient polish. If the latter is the case, it may be returned to the tumbler. Do not add further tin oxide; time is all that is necessary. Repeat inspections until you are satisfied with the polish.

☐ If, at any time, you are in doubt as to whether the stones will ever polish, remove one from the tumbler and ask a friend or dealer who has a polishing machine to try it on the buff; if it polishes, it only needs more time in the tumbler.

☐ To clean the finished stone thoroughly, clean out the tin oxide, wash the stones, add fresh water to the barrel with a few drops of detergent, and rotate on the machine for about 1 hour.

☐ This will really clean the stones and save a few washings. Spread the polished stones on a clean piece of towelling and sort out your gemstones.





MAKING JEWELLERY

To utilize the gemstones and turn them into jewellery, the amateur lapidary will need *findings*.

☐ These are bracelet and necklet chains, bell caps, key chains, and similar parts in either gold or silver-plated finish.

☐ This is the economy class of jewellery and is sufficient for most stones that you tumble, intending to offer as gifts or for sale amongst friends.

☐ Occasionally, there will be a stone of quality or with peculiar markings that makes it a rare stone and this will demand a better-quality setting; findings in solid sterling silver and 9ct gold are available from most rock shops.

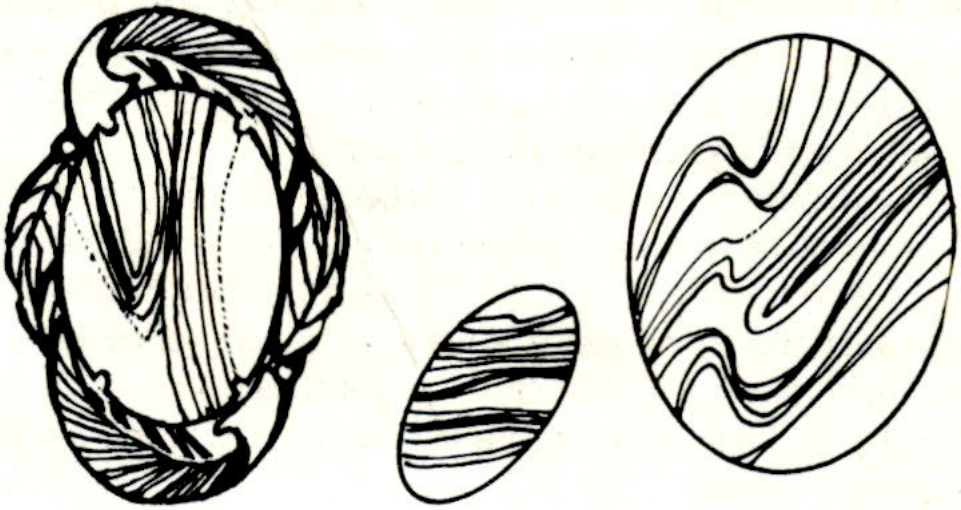
☐ When sorting the finished stones, the gem-hunter will find an appalling lack of stones that can truly be classed

as pairs. Pairs of gemstones are necessary for ear-rings and cuff-links. The problem of obtaining pairs is solved for those gem-hunters who have access to a diamond saw and grinding wheels.

☐ Instead of breaking the rocks with a hammer before placing them in his tumbler, this gem-hunter will saw his rocks into slabs of uniform thickness and trim them into selected shapes—e.g. rectangles, triangles, and squares, etc.—grinding away the rough edges with a 100 or 120 grit wheel of silicon carbon. This ensures that all rocks that go into the tumbler are nearly perfect; as with the use of the diamond saw and grinding wheel, only the best material is selected and all blemishes are removed. This will replace the first grind in the tumbler and the stones can be placed in at the second grind stage with the 220 grit.

☐ It will take a long time to cut and shape sufficient stones to fill a barrel to 75% capacity, but the end result is well worthwhile: you will find yourself with no loss, a shorter grinding schedule, and much better-quality stone to use in jewellery.

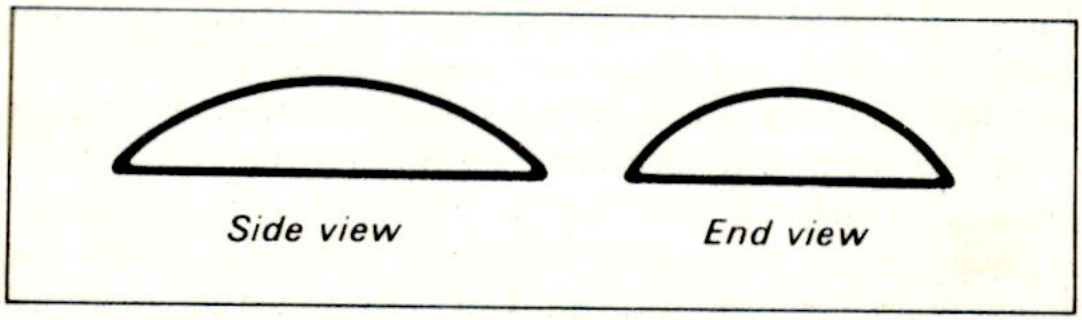
☐ This method is called pre-shaping of tumbled stones. From this stage, it is a simple matter to advance to the next cutting stage.



CABOCHON METHOD OF CUTTING

This opens up to the gem-cutter the widest and most satisfying section of all cutting. A cabochon stone can be best described as one with a smooth-polished, rounded, dome-shaped form on one side and a flat back on the other, usually oval in shape.

☐ This method of polishing is used extensively with opaque gem material.



OVAL CABOCHONS.

☐ Whilst facet cutting and engraving will be perhaps more satisfactory, it is a more expensive hobby and the range of material to facet or carve is becoming more limited and expensive all the time.

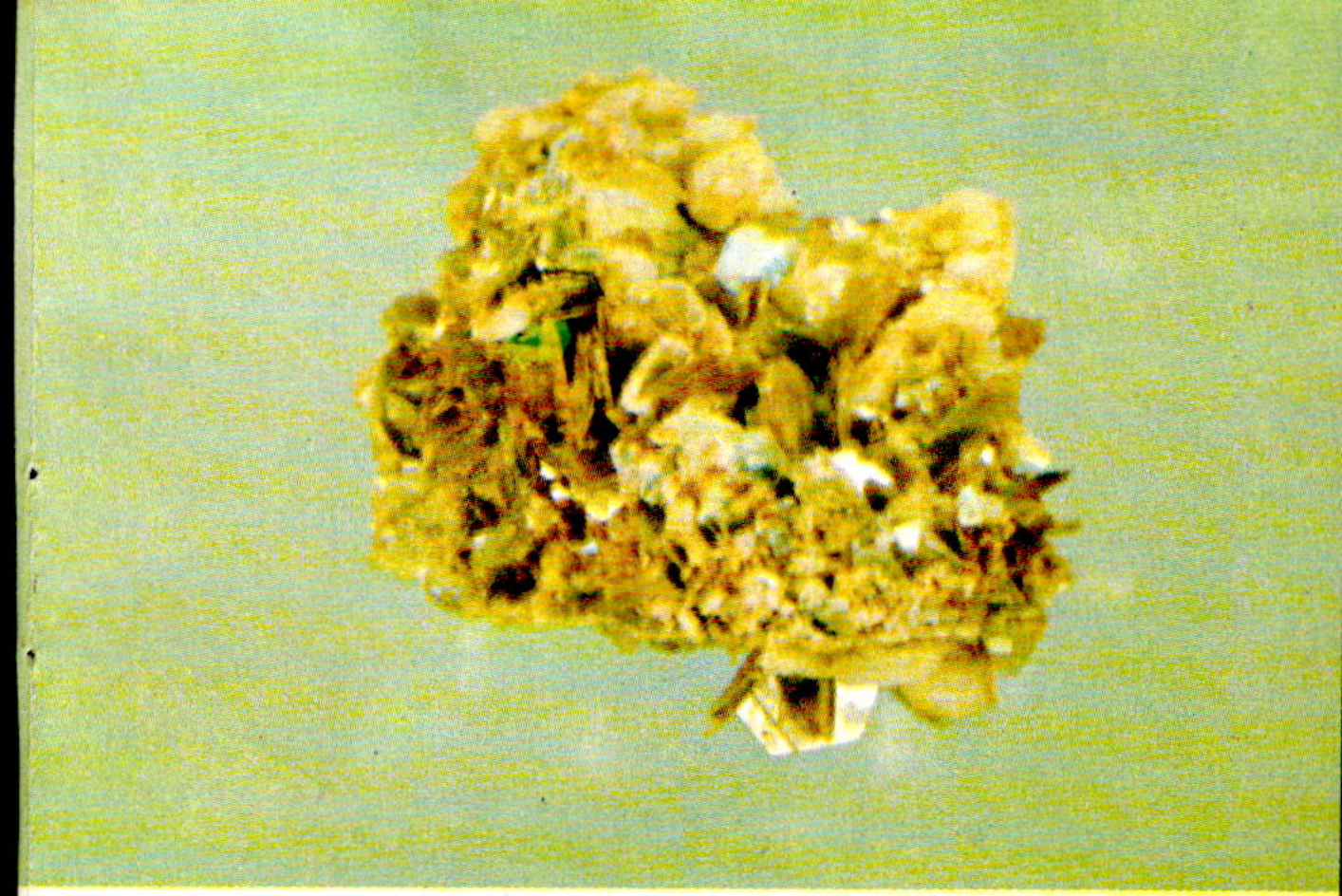
☐ Tumbling gemstones, although a fascinating and fruitful hobby, does not provide much hand-work until the gems are finished. Cabochon cutting therefore satisfies the hobbyist who wants to do something with material soon after he finds or purchases it.

☐ To make a stone into a cabochon, there are six simple steps to follow:

1 Slabbing and shaping
2 Coarse grinding
3 Fine grinding
4 Dopping
5 Sanding
6 Polishing.

SLABBING

☐ This is carried out with the use of a *diamond saw*. The saw consists of a steel or bronze disc with the edge impregnated with diamond dust; both natural and synthetically-made diamonds are used. This diamond edge accelerates the grinding action and, as it is thin and makes a relatively fine cut through the rock, it gives the impression of sawing the rock away. Although this saw-blade will cut (grind) through the toughest of rocks, it does not have teeth like the well-known wood-cutting saws to slice through fingers. Momentary contact with the saw

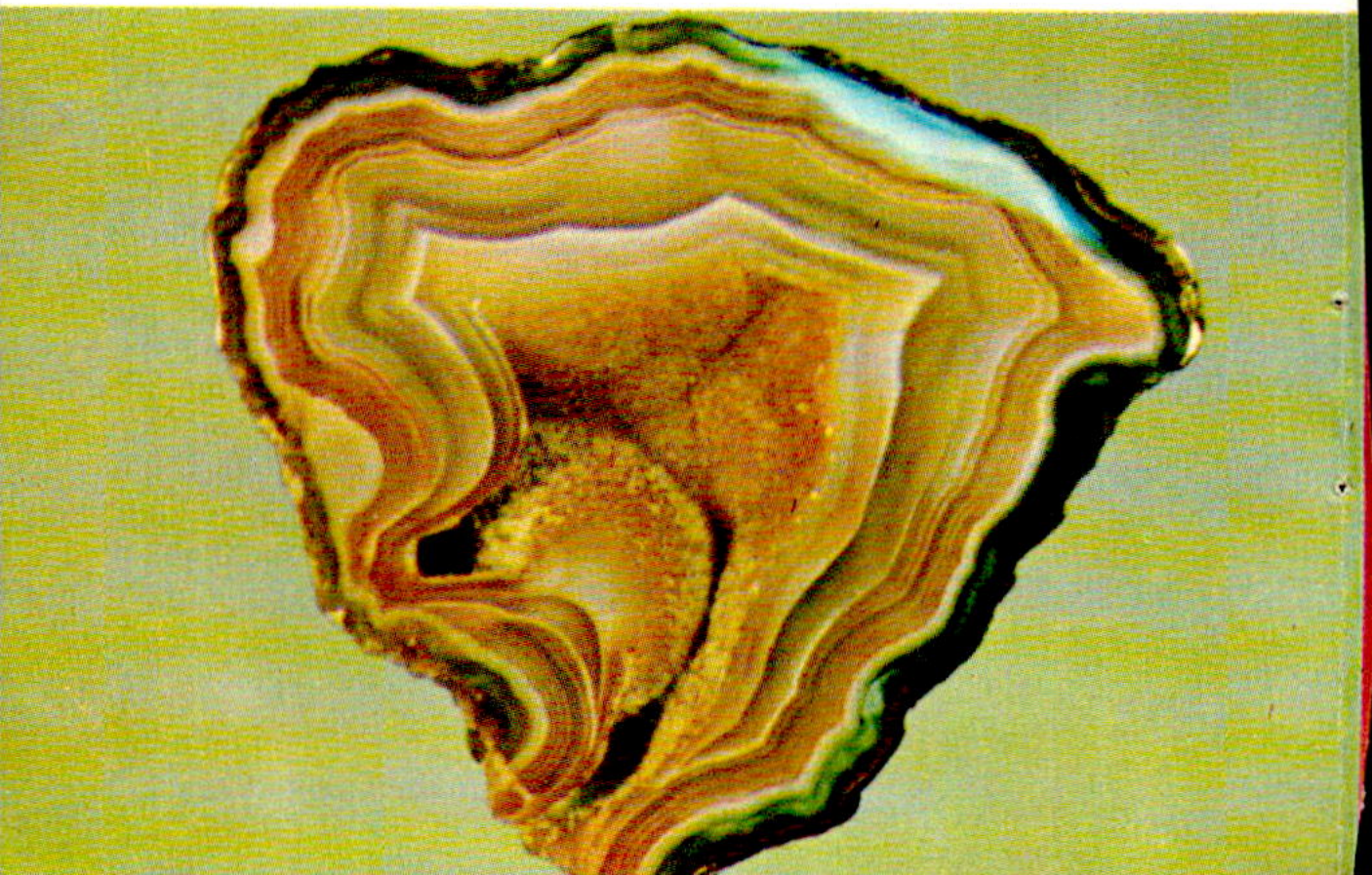


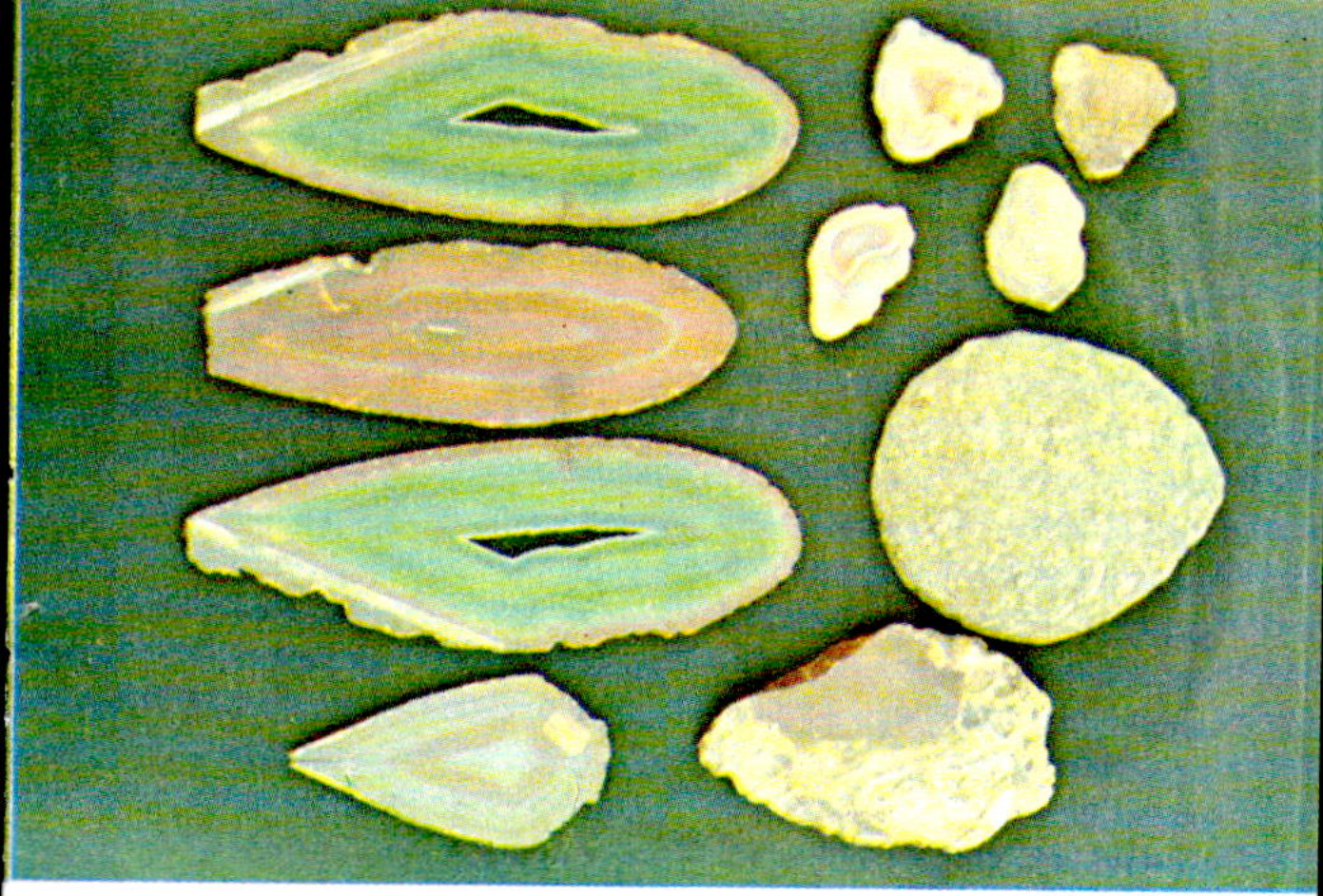
Mica and feldspar from the Harts Ranges, Central Australia

South Australian malachite

Rock crystal (clear quartz)—crystal group

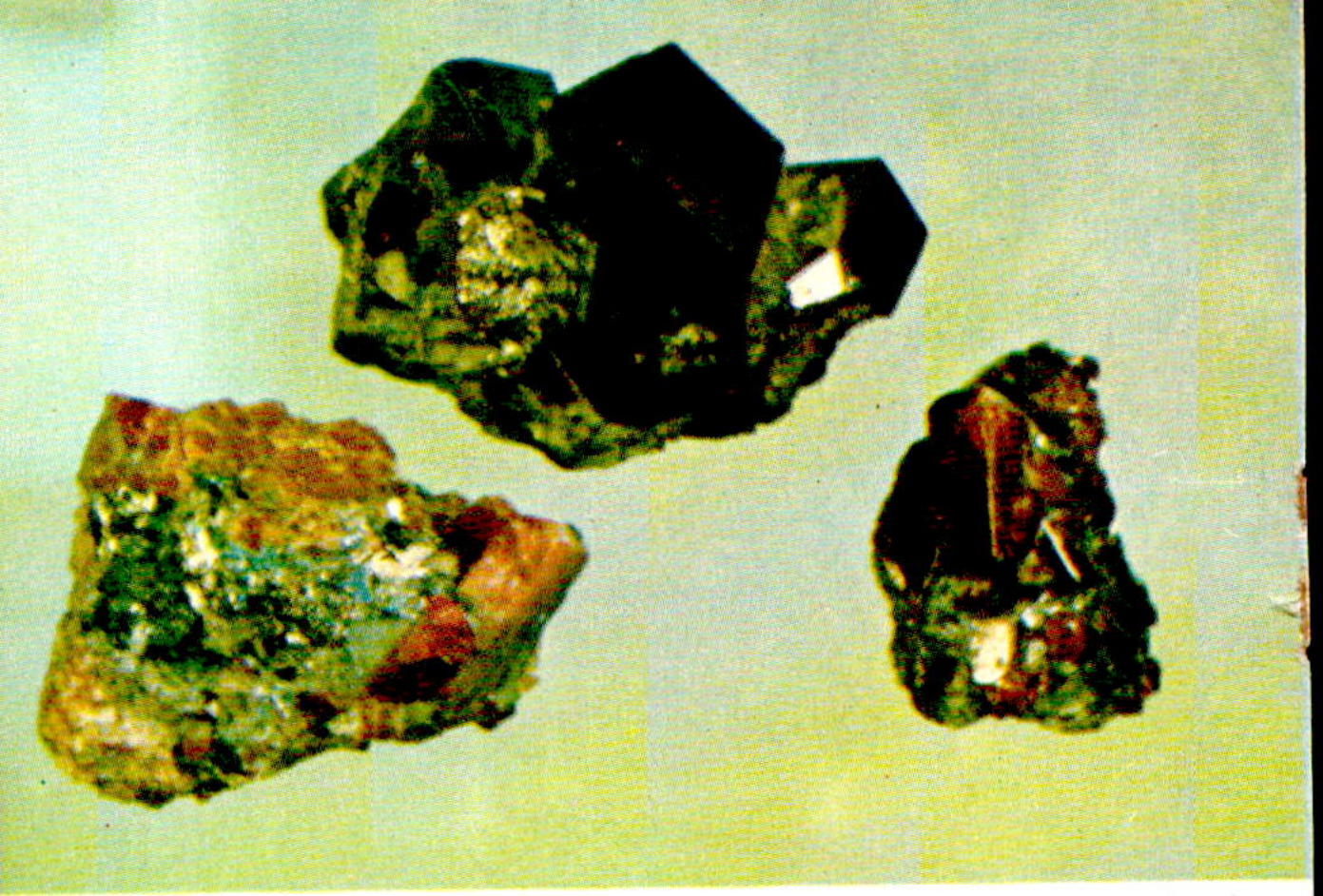
Agate geode





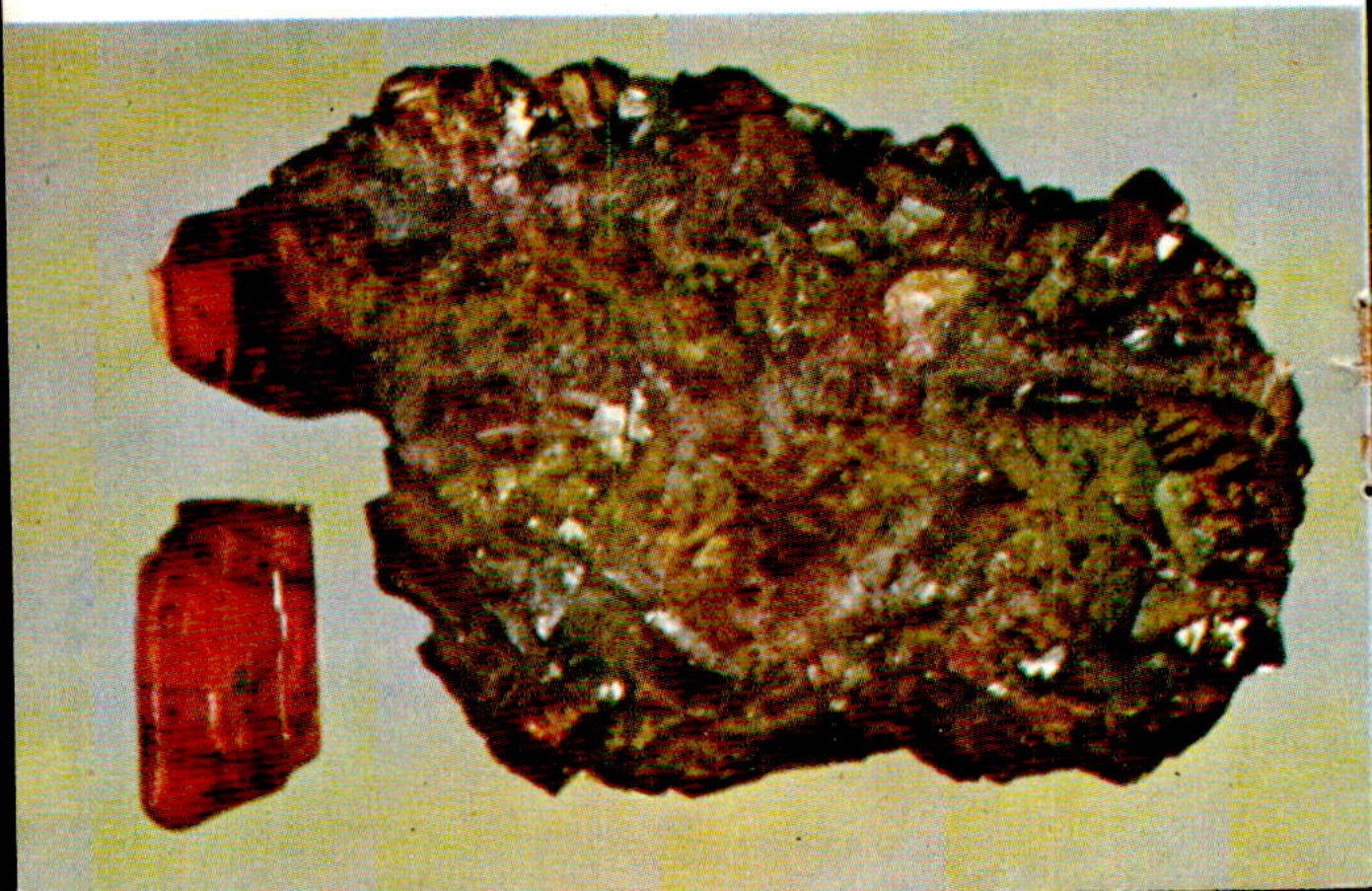
Agates—polished slabs

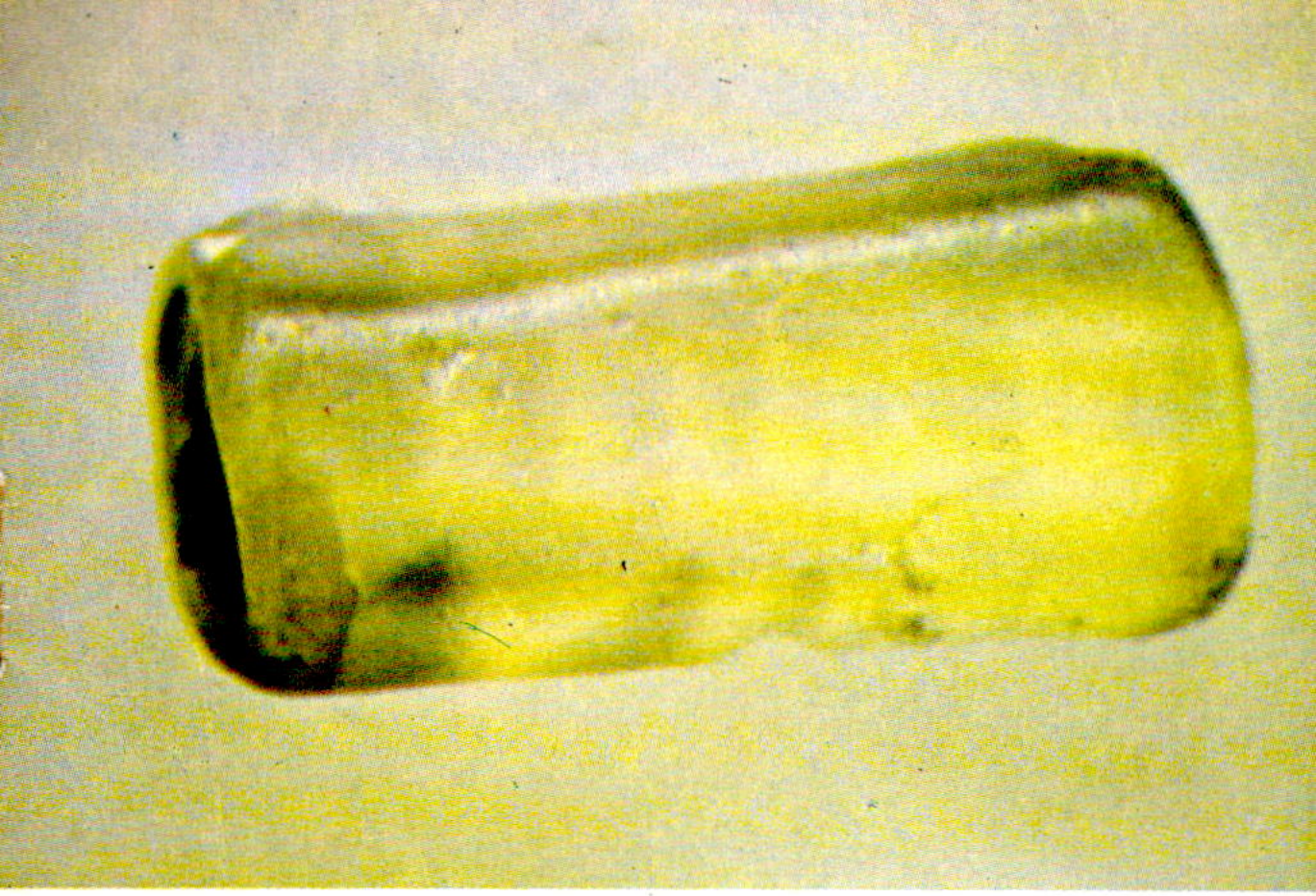
Chiastolite (Australian lucky stone)



Garnet (top) and rhodonite (pink) Broken Hill, N.S.W.

Rhodonite crystals



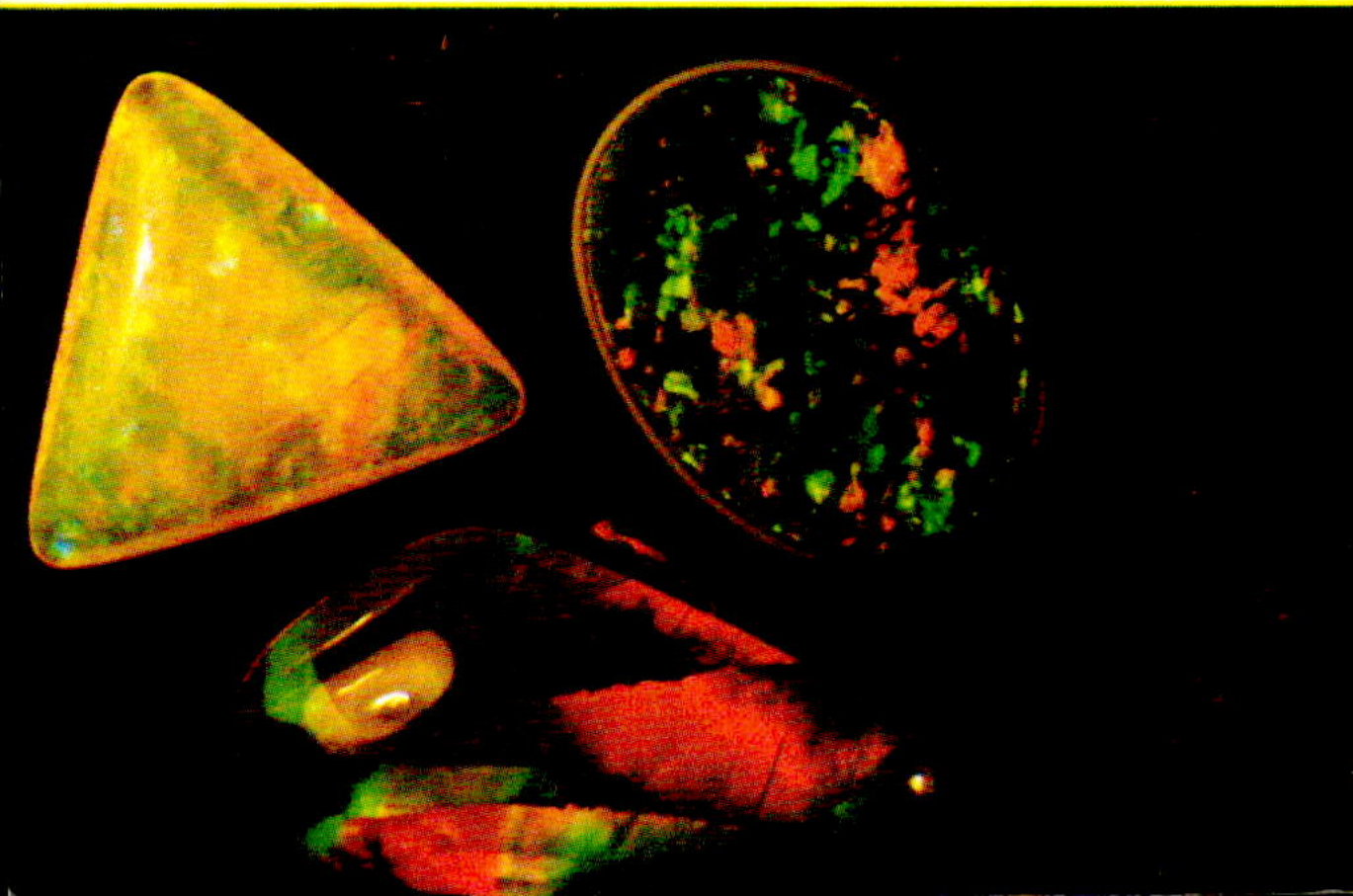


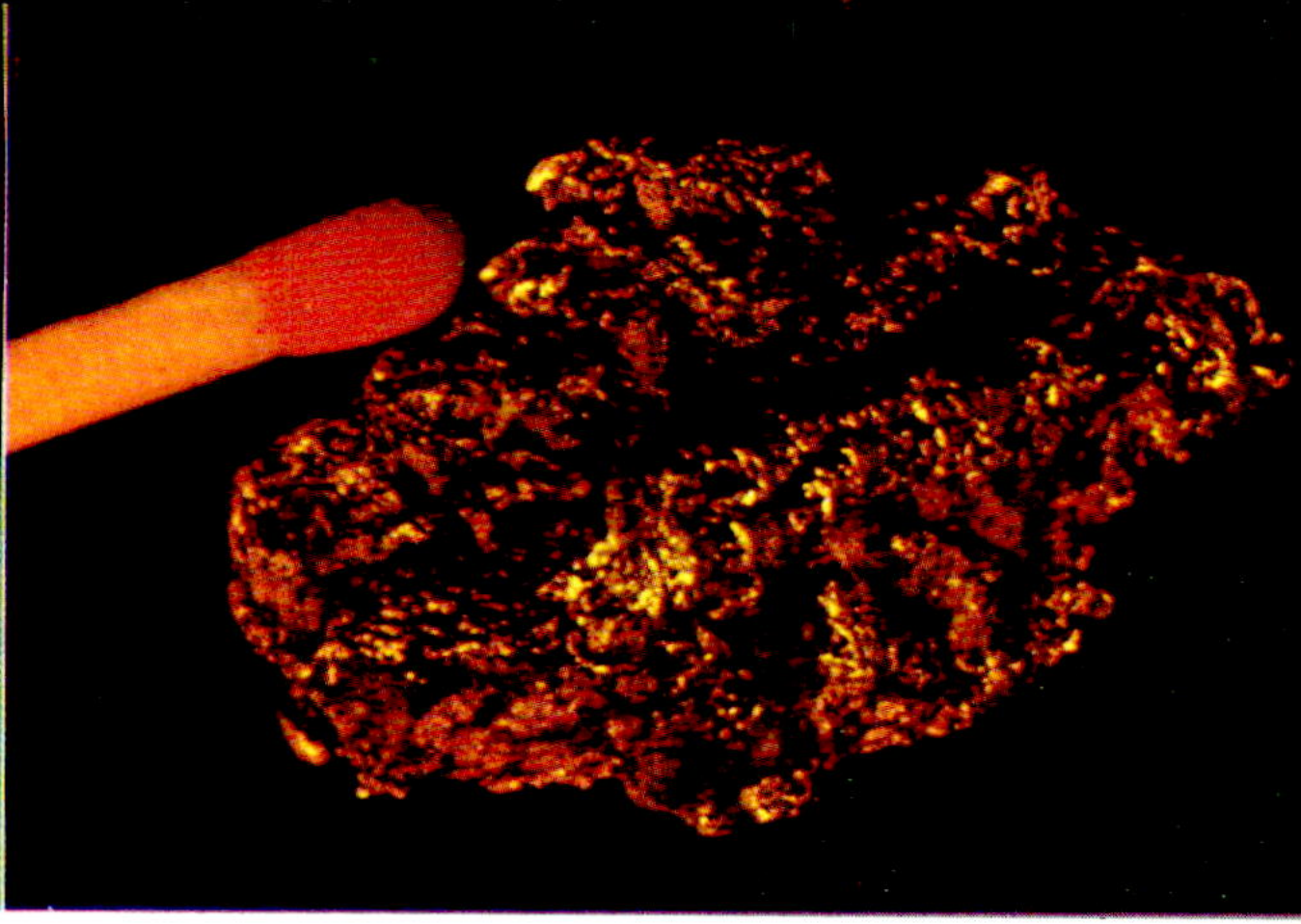
Golden sapphire — Queensland

Fossil wood — Tibooburra, Northern N.S.W.

Sapphire—(in ring)

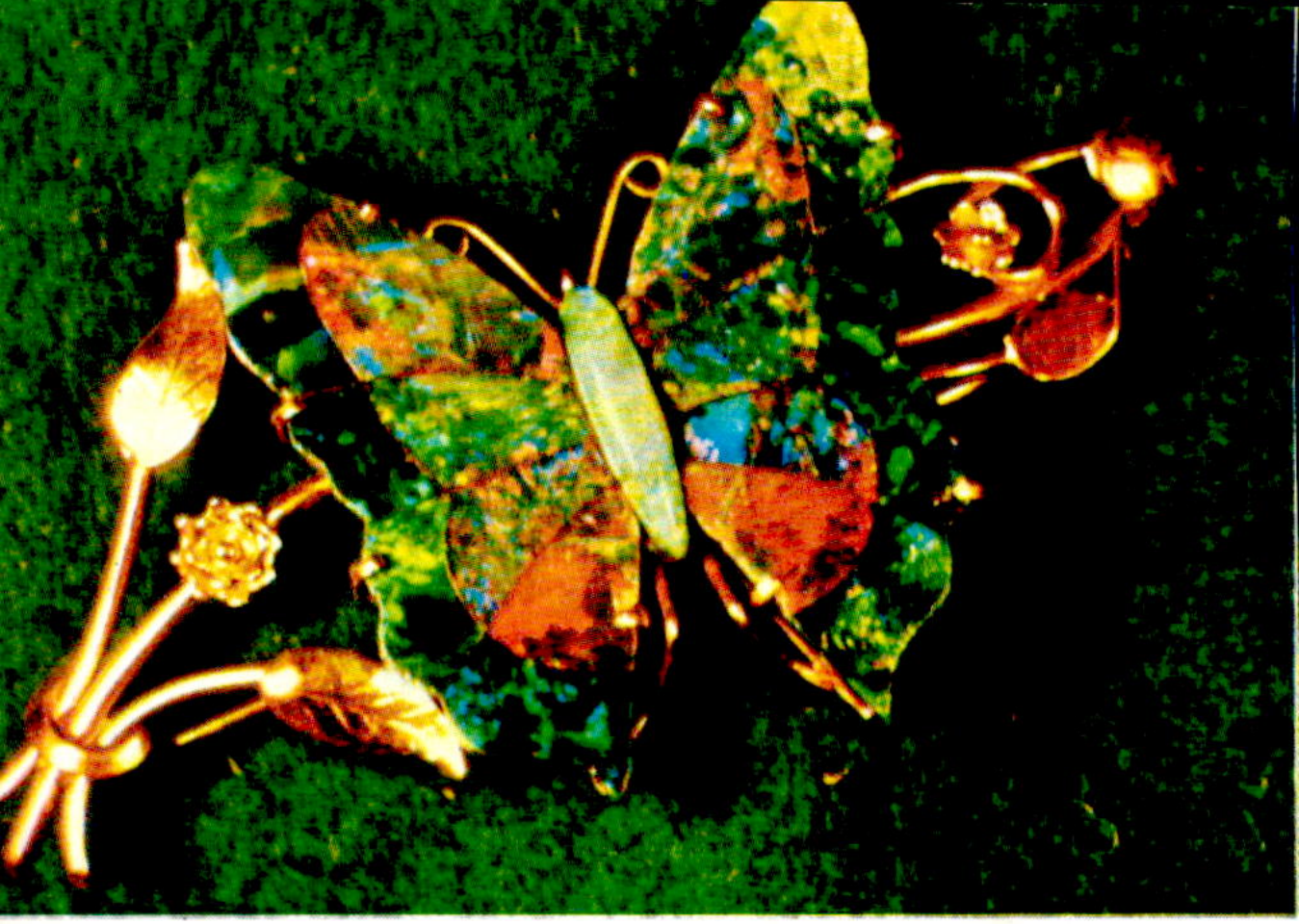
Solid, triplet, and doublet opal stones





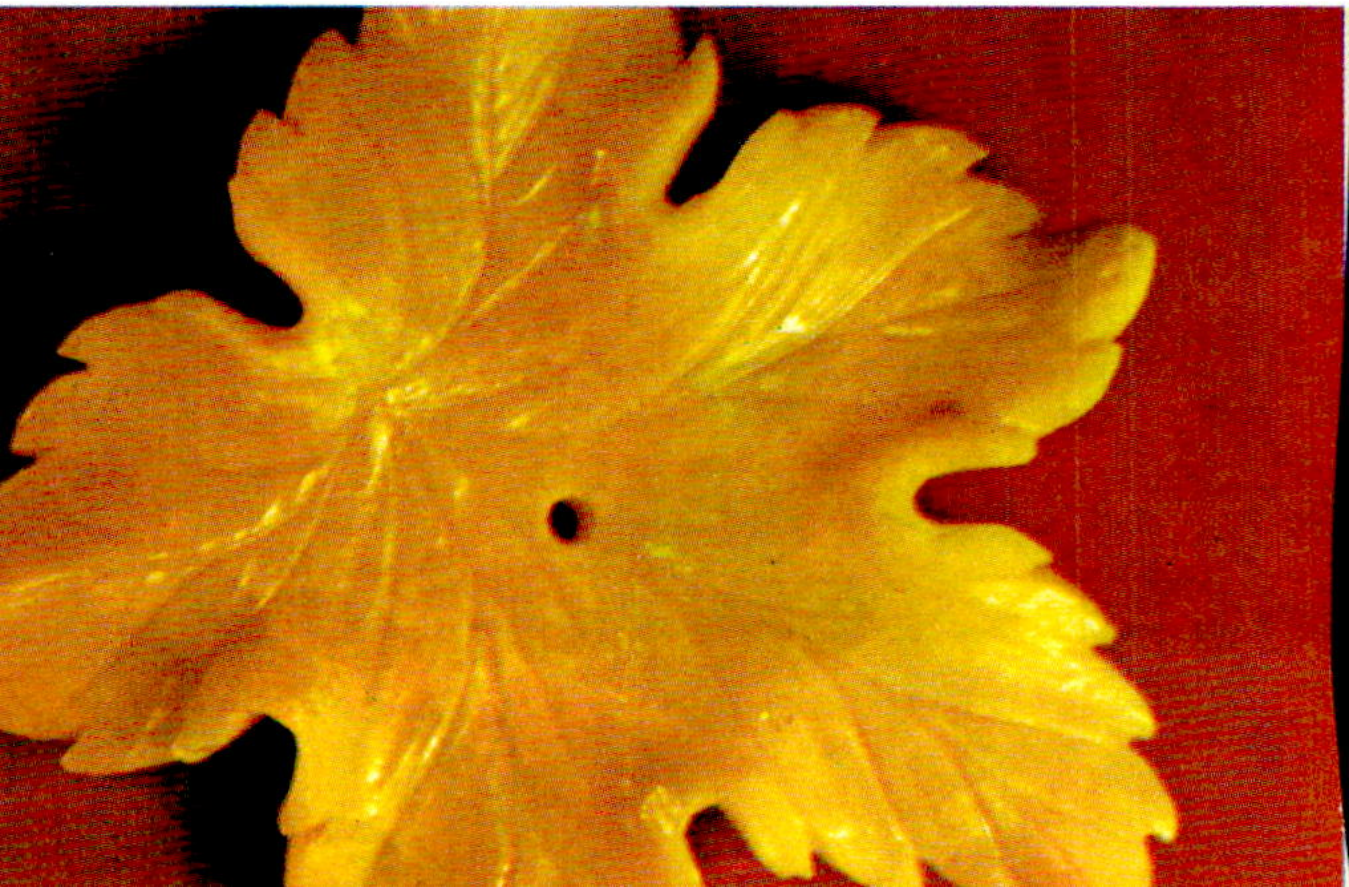
Gold nugget (match head comparison)

Rhodolite garnet (faceted) set with diamonds



Parti-cut doublet (butterfly pattern)

Opal matrix, carved leaf ready for dye



produces a burning sensation rather than a cutting one.

☐ Some very fine saws manufactured especially to slice precious opal, ·005 of an inch in thickness, need extra precaution when working, as these saws travelling at high speeds will sometimes split the skin. As an operator needs to be well-experienced before he uses a saw so thin, there is little danger of amateurs striking this problem. An all-purpose saw suitable to cut all rocks is generally ·025 inch — ·030 inch thick, and presents no problems. These saw-blades are mounted on a spindle (which must run true) and project through a fine slit in the table top or bench plate. A $\frac{1}{4}$ h.p. or $\frac{1}{3}$ h.p. motor to drive the saw bench spindle is essential; far better to have too much power than too little; check the drive belt regularly to take up any slack or stretch that develops. To overcome friction, a *coolant* must be used with these saws. This can be a mixture of kerosene and oil at the ratio of 2 to 1, or, water used with a suitable lubricant, preferably one that is a rust-inhibitor as well. This additive comes in powder form and is mixed with water at the rate of 2 oz to 1 gallon of water. Many saw benches have a small tank underneath the table to hold this coolant and the blade is kept moist as it passes through the fluid. To ensure maximum life from saw-blades, some manufacturers insist that the fluid should be carried, by plastic tube, to a point above the area of contact between the saw-blade and the stone and delivered in regular quantity so as to saturate to the full the part of the blade engaged in cutting the stone. In the latter case extra precautions have to be taken to prevent splashing the operator.

☐ When you are sure that the saw is running true and there is sufficient coolant in the tank, take a piece of rock

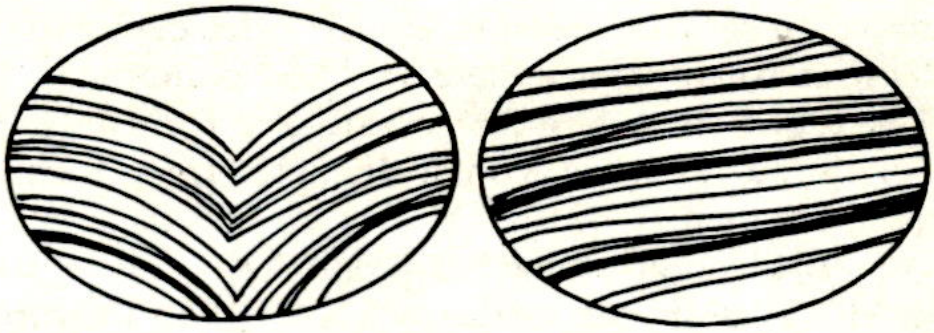
and make a cut along one edge. Then cut across the end to expose the rock in both directions to enable you to select the best-patterned area. To do this, place the feet in a comfortably balanced position, grip the rock with both hands and place firmly down on the table top and feed onto the saw-blade.

☐ The speed with which each rock can be cut will vary according to its bonding or hardness, so do not expect to cut every rock in the same time. The various noises of the saw-blade when it comes into contact with the rocks will soon be your guide as to the hardness of individual rocks. A firm, steady pressure allows the saw-blade to cut at its own rate and also gives sufficient time for the sludge or wastage from the cut to clear itself and allows the saw to run free without the risk of binding. Once you have started the cut, go right through the stone and complete it. Do not withdraw the stone half-way through the cut and do not try to adjust the direction if you find that you are askew when half-way through. The saw-blade has not been made that will cut around corners.

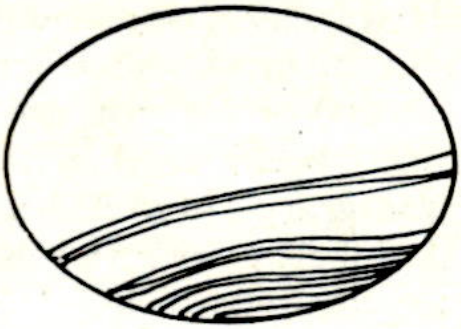
☐ When the best side of the stone has been selected, slice off a slab ¼ inch thick, feeding the stone very slowly onto the saw-blade, keeping it as straight as possible so the cut will be parallel to the edge you have previously cut. When this slab is cut, put it on your bench and, with the aid of a stencil, mark out the size of the cabochon you wish to cut, using an aluminium pencil.

☐ Stencils are readily available from gem shops and one marked in millimetre sizes is recommended. The jewellery trade throughout the world manufactures fittings in this measurement and it is accepted as an international standard. The aluminium pencil used in marking is far

superior to ball-point or pencil which are easily erased. The aluminium should continually be filed to a fine point as it is the point that wears away and leaves an aluminium line on the stone and, if allowed to become blunt, will register a false measurement. Bronze pencils are used on some rocks, as this seems to give a better contrast than aluminium against different backgrounds. When marking out the shape on the stone, always try and work around the best-patterned area, trying to make the pattern balance the stone shape.



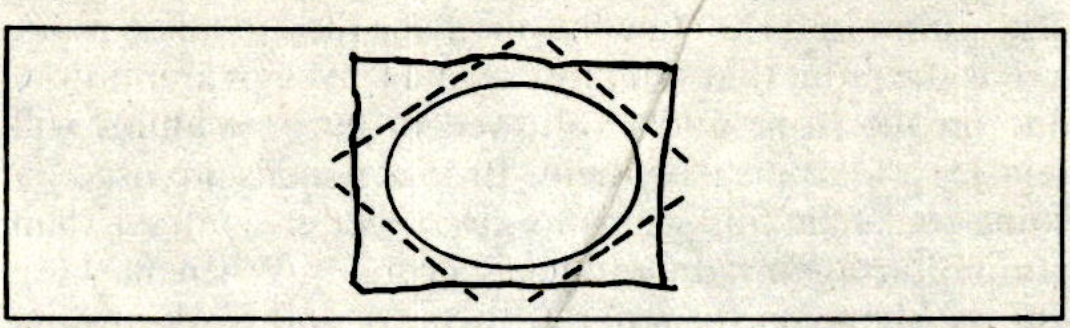
Correct balance



Incorrect

The stone can now be taken back to the saw and all

superfluous edges can be sawn off, close to the lines.



Where to cut after marking.

☐ The stone is now ready for shaping and this is carried out on the *grinding* wheels. Many grinding heads are available from your nearest lapidary dealer but if you prefer to make your own, here are a few points:

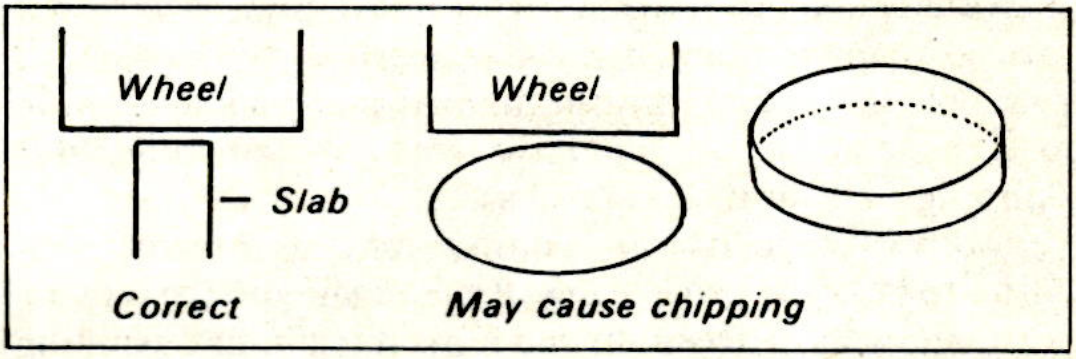
☐ Use 6 or 8 inch diameter wheels and, for safety, have the shafts no less than $\frac{1}{2}$ inch diameter for 6 inch and $\frac{5}{8}$ inch for 8 inch.

☐ An arbor or grinding head that will carry a wheel either side is desirable as this will allow you to transfer from coarse grinding to fine without the delay of changing wheels. Your supplier will guide you in buying wheels, as to bonding and hardness. It is sufficient that you should know the wheels are made of silicon carbide, the coarse grit being of either 100 or 120 grit size, and the fine of 220 grit. If only one wheel is used, grit size No. 180 is a general, all-purpose grade. Manufacturers recommend wheel speeds on the label as a rule and, as the wheel wears down in diameter, the wheel speed will need to be increased to maintain the correct surface feet-per-minute rate, so a 2 or 3 step pulley on your motor and arbor is desirable when assembling your equipment.

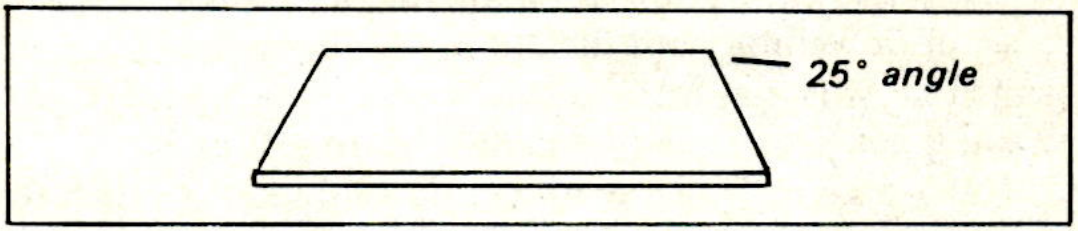
☐ It is essential to run a trickle of water onto the wheels

when grinding, so provision must be made for a water supply, drain-tray, and splash guards.

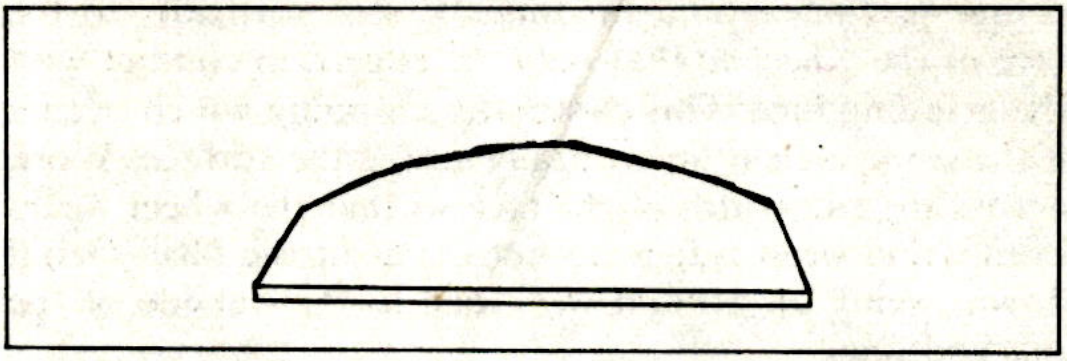
☐ Now take the slab that has been cut to near shape and start to grind away down to the aluminium line, using the coarse grit wheel and holding the slab vertically to the face of the wheel so that only the edge is in contact with the grinding face. This eliminates chipping which occurs if the stone is held horizontally across the surface. Work across the full width of the face so that the wheel wears evenly and deep ridges do not occur in the face. Grind down evenly all around the stone to the outside of the marked line.



☐ This is now called a "blank," and the next step is to start to grind a domed surface on one side, leaving the other side flat. If this back surface is rough it can easily be ground flat, using the side of the wheel. Select the best side to be the top of the stone and grind the first bezel at an angle of approximately 25°, leaving a small, flat ridge around the base.



☐ Shaping the domed top is continued by grinding two more bezels across the top of the stone until a domed effect is created, grinding right to the centre of the stone and ensuring that there is no flat disc left in the centre.



It will be easier to finish a high domed stone than a flat one, so keep the point as thick as possible. With practice, you will be able to finish thinner material and more material can be cut from the rock by reducing your slabbing to 3/16 inch thickness.

☐ At this stage, it will become difficult for the gem-cutter to hold the stone firmly at the edges with the fingers, so, to allow more freedom and movement in fine grinding and sanding, the stone is now mounted on a stick. This is called *dopping*.

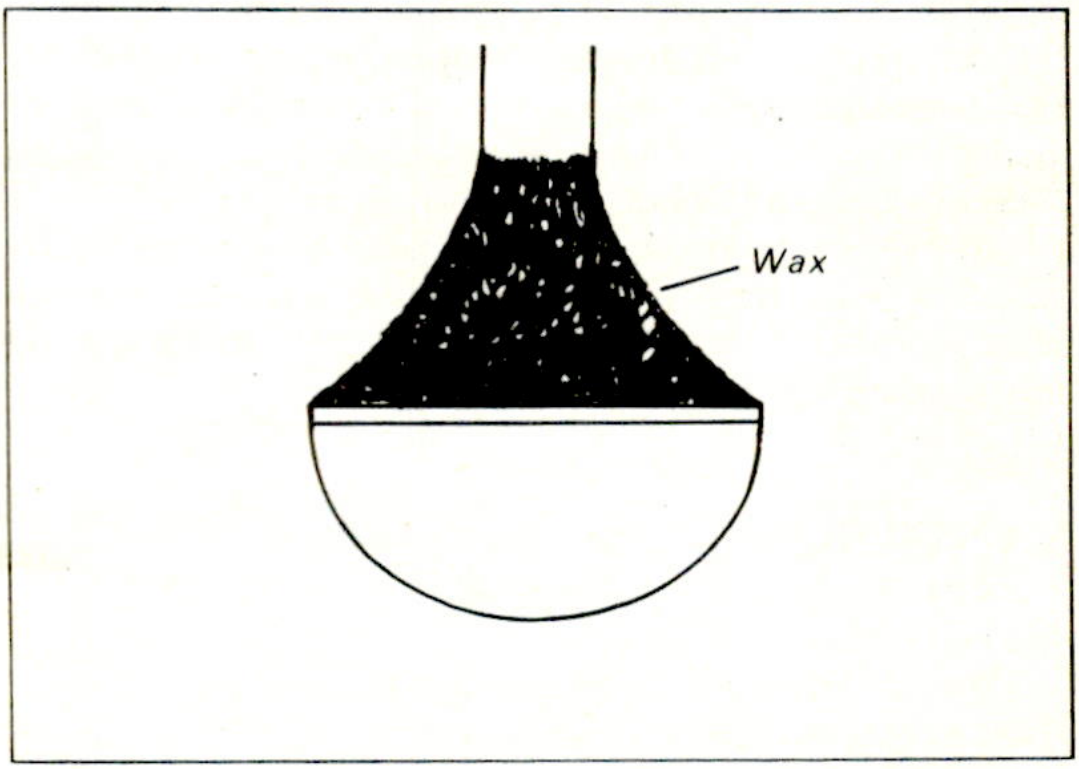
DOPPING

☐ This operation consists of affixing the blank to a short piece of dowelling with the aid of sealing-wax. As a cold gemstone will not stick to this wax, it will be necessary to use a gas-jet or spirit-lamp as a heating source.

☐ Cut $\frac{3}{8}$-5/16 or $\frac{1}{4}$ inch diameter dowelling into 3 inch to

5 inch lengths to act as dop sticks, take a piece of wax and melt in the flame and drop onto the end of the stick. Alternatively, the wax can be melted in a small tin and the end of the stick dipped in while the wax is molten. Holding the stone in your fingers, warm it in the air above the flame; this will prevent the stone from becoming too hot and fracturing.

☐ With the stone quite warm, take the dowelling from the tin of wax and place it centrally on the back of the stone. The wax will soon cool and you will have a few minutes before it sets in which to push the surplus wax down the stick, using moist fingers, until it is built up to an even contour from the shaft of the stick *to the edge of the stone*. Keep the base of the stone at right angles to the dopping stick, sighting by eye from the side and the end.



The first few attempts will be tricky, and you will get wax everywhere but, with practice, good results will soon be achieved. Scrape off excess wax, which would clog your wheels and discs, and allow the wax to harden thoroughly. The dopped stone will now allow easier handling and greater manoeuvrability on the wheels.

☐ On the coarse wheel, true up the small setting edge left at the base of the stone and fit to the stencil hole. If you already have your fitting for this stone, grind it to fit the setting, as some fittings vary slightly and this may save you the trouble of regrinding a finished stone to fit a setting. Grind away any other surplus material from the top until an evenly-contoured shape is obtained.

☐ Transfer to the fine-grind wheel and grind lightly, removing all deep scratches left by the coarse wheel. Keep moving the stone around so that no flat surfaces are allowed to develop. These will be difficult to see when the stone is wet, but an absorbent cloth or paper will dry the stone quickly for inspections. Do not press too hard against the wheel, try to develop a light touch so that an even cut is maintained.

☐ At every operation, persevere until you are perfectly satisfied with the result. If all coarse scratches are not removed at this stage, it will be harder to obtain a good finish later.

SANDING

☐ When the stone is perfectly smooth and of even symmetry, it is ready for sanding.

☐ Sanding discs run slower than grinding wheels. They consist of a backing plate, made from aluminium or marine plywood, and fitted onto the grinding machine in place of one of the wheels. The disc is covered with a sheet of rubber (not too soft) to which the wet and dry silicon carbide paper or cloth sheets are adhered with disc cement. The disc cement, while sufficiently strong to hold the disc firmly in place, and not affected by water, will not set hard. This allows the disc to be peeled off and a finer or coarser one set in its place whenever necessary.

☐ A trickle of water can be run on the cloth when in operation, cutting down any harmful dust menace, keeping the paper free from clogging, and cooling the stone.

☐ Sanding, if carried out dry, will generate heat, and care should be taken not to allow the wax to soften so much that the stone flies off the dop. Start sanding with 220 grit paper, then 320 or 400 grit, and finish with 500 or 600 grit. Do not use pressure during sanding; remember that the light touch is best. When you have sanded on all three grades of paper, the surface should have a good, satin finish and it will then be ready for the polishing operation.

☐ Not all stones will require the use of every paper mentioned above. There is no fixed rule, and experience will be your best guide.

POLISHING

☐ Before starting the polishing, put away all sanding discs, wash down the machine, your hands, and the dopped stones, to prevent grit contaminating the polishing buffs. Buffs are made from non-greasy leather (split kangaroo skin) and/or felt (medium hardness) attached permanently to a plywood backing disc and stored in plastic bags for cleanliness.

☐ The polishing agent recommended for all hard stones such as fossil wood, tiger's eye, agate, etc., is tin oxide (putty powder) and for softer stones such as opal, opalite, obsidian, and glass, is cerium oxide. The other polishes, tripoli, pumice, chrome oxide, and others, have their uses on various stones.

☐ Both cerium and tin oxide mix easily with water (mix about 1 tablespoon to 1 pint of water and store in a screw-top jar). Pour some into a smaller pot for use at the buff; if this becomes contaminated, the larger amount is still saved. Apply the polish to the buff with a small brush kept for that purpose alone. Apply the stone to the buff for short periods with gentle, but steady pressure. If your buff is too wet, the stone will slip but, when at the right moisture, you will feel the stone tugging and you will be polishing. It may take some time for a new buff to work up; if it is not polishing, do not keep adding more tin oxide as this may create a glazed surface on the buff which will have to be scrubbed off before you can polish again.

☐ Keep polishing until all scratches are removed, using

a jeweller's eye-piece or a binoscope that fits on the head and leaves the hands free to examine the stone.

☐ Rinse off all the polish and turn the stone slowly under a bright light. If the surface shows a blurred or satin effect, more polishing is needed. If a high gloss covers all the stone, your job is finished and only needs to be removed from the dop stick and placed in your finding.

☐ Polishing is the easiest part of this type of cutting for, if each previous step has been correct, a shine will start to appear in a few moments.

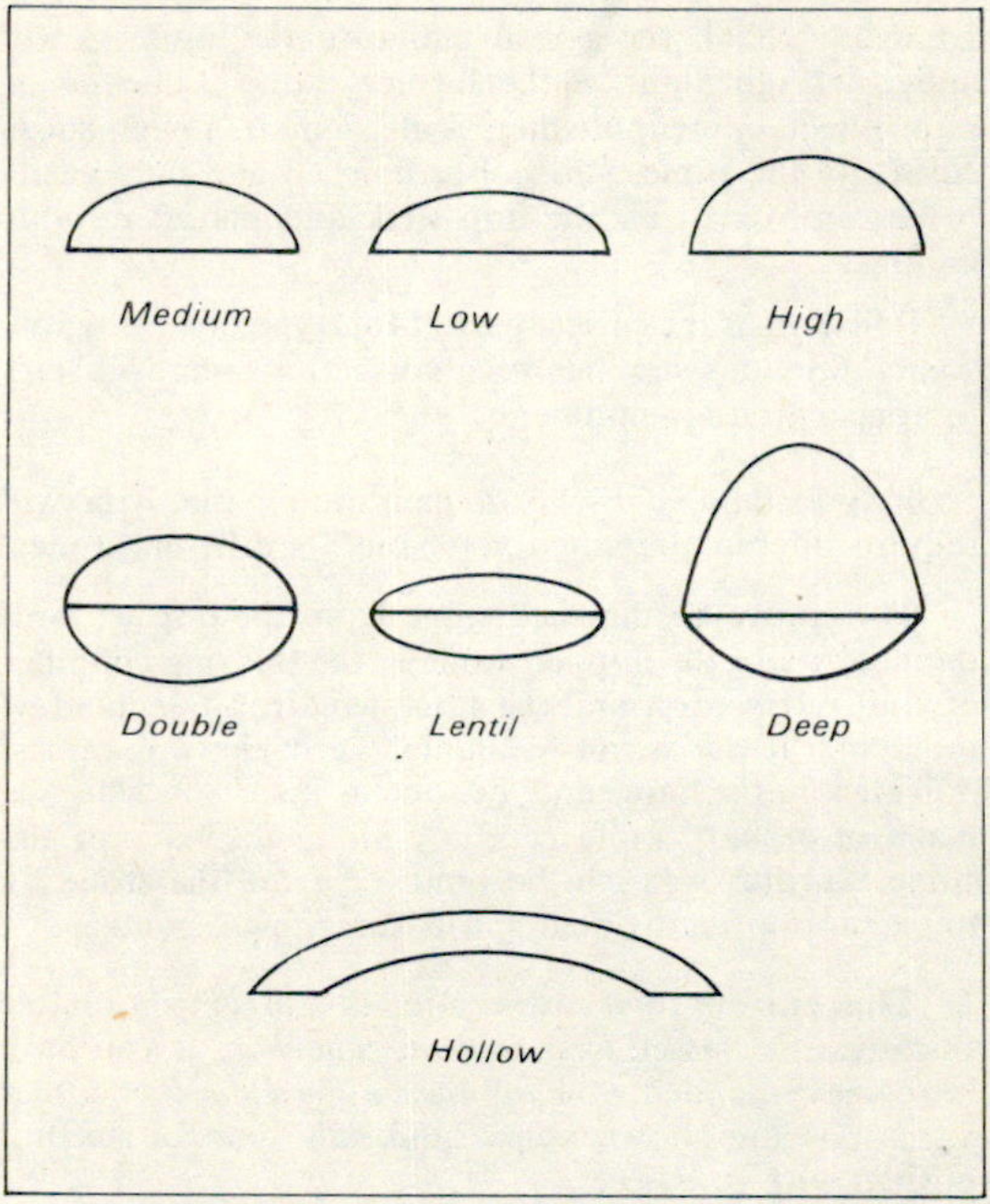
☐ In polishing, it is worth mentioning that you will require different pressures on the buff for different stones.

☐ To remove the finished stone from the dop without damage, place the dopped stone in the freezing chamber of your refrigerator and the stone will drop free in a few moments. If this is not available, warm the wax on the dop stick in the flame and, as soon as it softens, slide the blade of a sharp knife carefully along the back of the stone. Surplus wax can be removed from the stone by immersion in methylated spirits for a few seconds.

☐ This is your first stone and, if still of reasonable thickness, is classed as a *medium cabochon*. If you have been heavy-handed, you will have a *low cabochon*. Other variations are shown below and can soon be accomplished with practice.

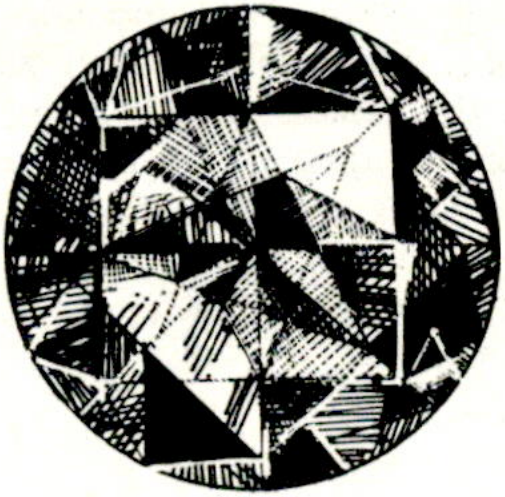
☐ Some semi-transparent gem material and dark stones show a lighter, more attractive colour if hollowed from

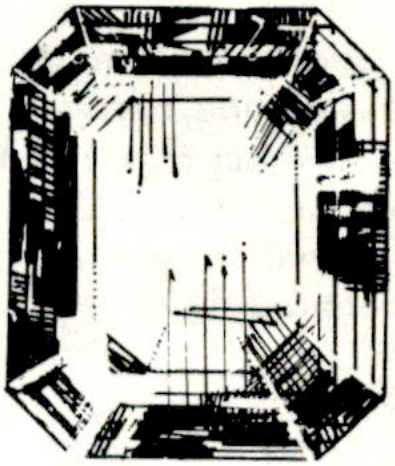
the back. This allows more light to pass through the stone. This is called a *hollow cabochon.*



Practice will soon allow you to cut matching pairs and sets as well as various shapes other than oval in outline.

☐ This is only one method of cutting the cabochon. There is no hard and fast rule. Material will alter in texture and hardness even in the same family of gemstones. Let experiment be your aim and, when you have over a hundred different cabochons in your collection, you will know the thrill of mastering many different techniques.





FACET METHOD OF CUTTING

Of all cutting procedures used on gemstones, facet-cutting is the most exacting. It can briefly be described as cutting small faces (facets) in a regular pattern to set angles, to take advantage of the varying optical properties contained in different gem material. This method is reserved exclusively for the transparent gemstones, either colourless or coloured (tinted); diamond, sapphire, ruby, emerald, and aquamarine are a few of the better known gemstones in this category.

☐ The machine used to polish gemstones of this nature contains two important sections—the faceting head and the circular lap.

☐ The manufacture of a faceting head is considered beyond the scope of the average handyman. Whilst it is possible to purchase separate faceting heads and to

combine these with your own manufactured laps, it is advisable to purchase a factory-made faceting machine complete before embarking on this part of the hobby.

☐ The faceting machine should be supplied to you on a solid plywood board to which the base is securely attached. On one end of the base will be the stand rod and affixed to this will be the dop arm, protractor, and stop screws,together with the fine adjustment screws for alignment.

☐ On the other end, a ball-bearing mounted pulley contains the shaft attached to the horizontal revolving disc, called a master lap, which is in such a position that a stone fitted into the chuck on the dop arm will come in contact with a disc placed on the master lap when the dop arm is lowered.

☐ When setting up your machine, mount the motor in such a position that the belt which is coming towards the variable speed motor pulley is at right angles to the motor shaft.

☐ Variation in the speed of the lap is obtained with the use of a variable speed vee pulley. Unlocking the grub screw and closing the vee pulley causes the belt to run at a larger pitch circle giving higher speed. To decrease the speed, the vee pulley should be widened to allow the belt to ride on the bottom of the pulley. The master lap must run in a clockwise direction.

☐ Although not absolutely essential, it is desirable to place a switch to control the motor on the board, within easy reach of the operator.

☐ The stand rod or vertical post is clamped to the bed with a knurled nut. By loosening this nut, the stand can be moved towards the lap or away, then re-locked in the

position required. On the vertical post is the unit attaching the dop arm. This carries a protractor (from which direct angles can be read) and an index plate with either 32 or 64 teeth. This controls the easy division of facets on rectangle (4), octagonal (8), round brilliant (4-8-16), and square. Also attached to this section are fine micrometer adjustments to make minute adjustments where necessary.

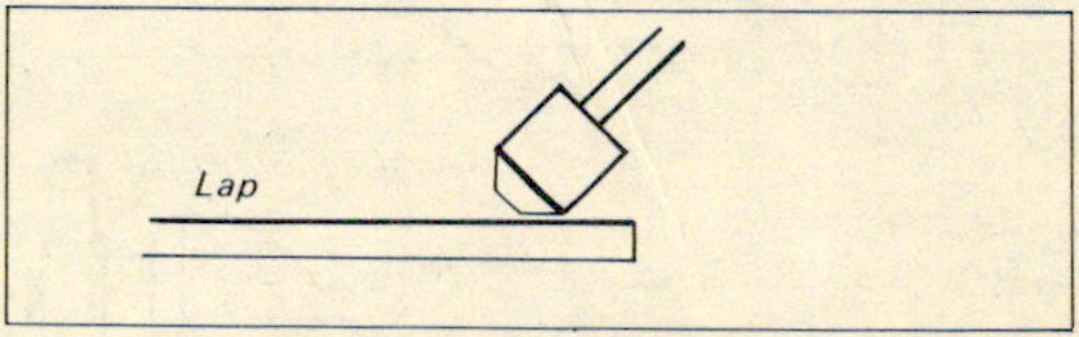
☐ On the end of the dop arm is the chuck; best types are removable from the sleeve, allowing better examination while cutting and also facilitating cleaning when changing grits. The dop stick clamps into the chuck and generally has two locking screws, the other screw acting as a pilot screw to centralize in the slot in the dop stick to prevent radial movement. Two copper laps will be needed, one impregnated with 240-300 diamond dust, and the other with 8·25 micron size diamond dust. A lucite lap will also be needed to use with cerium oxide polish.

☐ So now to faceting your first brilliant cut. ☐ For those of you who have transferred from cabochon cutting, it is merely another, more detailed, form of cutting. You will already have a balance of shape and contouring and you should also be accomplished at dopping.

☐ The quartz group of gemstones is often the best range of material for beginners. It cuts well, stands rough treatment, takes an excellent polish using cerium oxide, is inexpensive, and offers a variety of good colours. The main axis of a quartz crystal is easily determined. If you saw across the long crystal (much like slicing a loaf of bread) you will have a face suitable for the table of the gem.

☐ Start working on large gemstones (10-12 millimetre = ½ inch) and gravitate to smaller ones as experience allows.

☐ Saw the material to be faceted into a cube about 1 or 2 millimetres larger than the required gem. Using a 100 grit coarse wheel, grind the edges down until you have a cylindrical shape. Mount this cylinder on a wooden dop stick with ordinary dopping wax and insert into dop holder. Lower onto the revolving copper lap, impregnated with coarse diamonds, and rotate dop and grind off



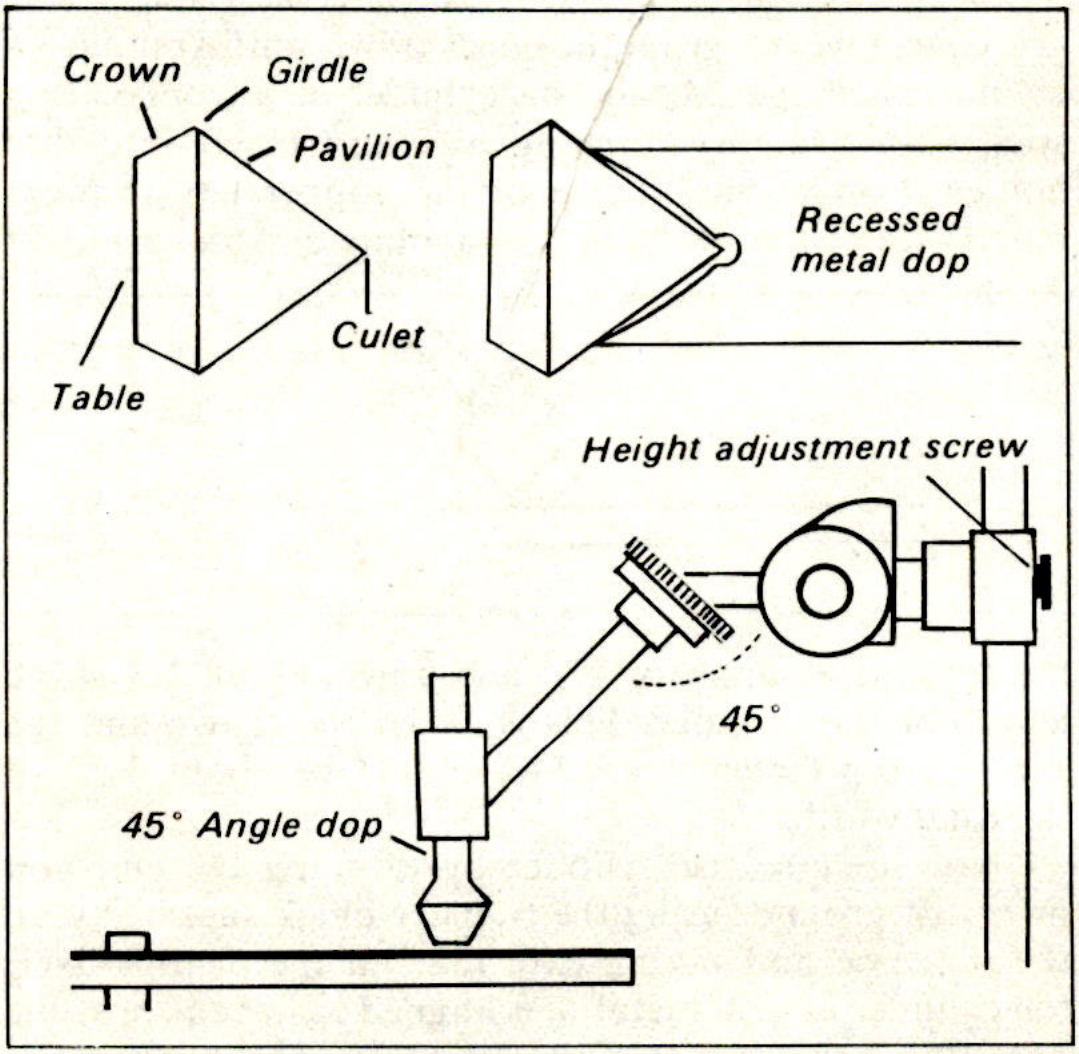
the edge (at an angle of 45°) and down, about 1/3 of the length of the cylinder. This is called the crown and the exposed top (called the table) should be about 40% of the total width.

☐ Now reverse the cylinder by dopping the end you have just ground, using the transfer block supplied with the machine and taking care that, in the change-over, the cylinder of gem material is aligned as near as possible onto the new dop. Grind the lower part, called the pavilion (the remaining 2/3 of the stone), to a cone, the point of which is called the culet. The point at which the two tapered parts meet (1/3 down the length of the crystal) is called the girdle.

☐ If the work has been carried out correctly, you should now have a preform resembling two cones joined

together at their bases, one of which has been truncated about half-way down.

☐ Use a slide millimetre gauge for measuring.



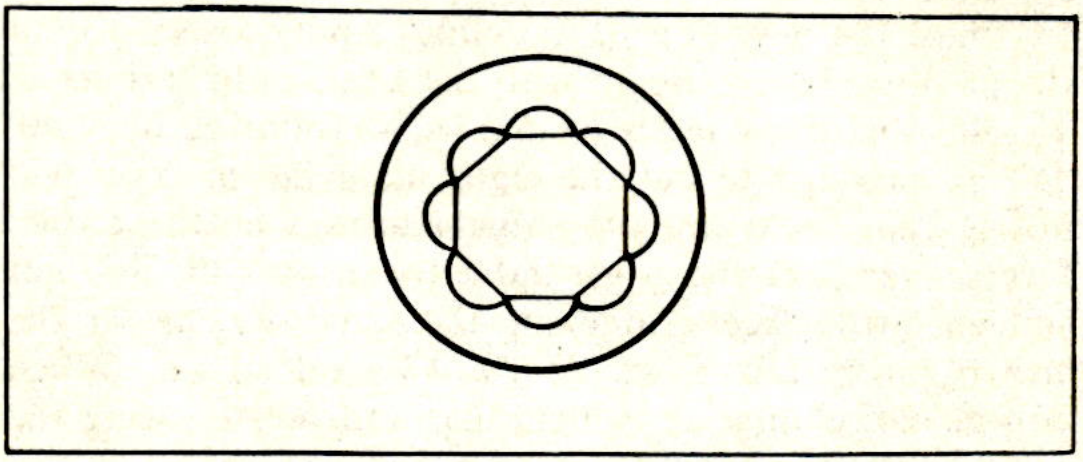
☐ Select a conical metal dop supplied with the machine, slightly smaller than the preform, warm it over the lamp, and apply the wax. Insert the culet of the preform into the wax and build up wax around the stone.

☐ Attach the 45° adaptor in the chuck, place the dop in this adaptor, and lock into position. Set the angle

indicator at 45°. This combination allows the table of the preform to rest squarely at 90° on the copper lap. Raise or lower the dop arm until it rests evenly.

☐ Using the diamond lap, grind the table until it is smooth and covers about 50% of the width. Change to a lucite lap and polish with cerium oxide. Then remove the 45° angle adaptor and place the dopped stone directly into the chuck, ensuring that the vee groove in the dop is aligned with No. 64 or No. 32 (the highest number), on whichever type of machine you are using. All figures quoted from now on are for a machine fitted with 64 tooth index plate. Halve the index figure for the 32 tooth machine. Set angle protractor at 90° and lower dop arm until the stone is touching lap. Disengage the index trigger and round your stone by rotating chuck in the fingers. Use the coarse side of the diamond lap, then the fine side.

☐ Now set the angle indicator at 45°, and the index at 64. Lower the arm to the lap and grind four main facets, using index No. 64, 32, 16, and 48, in that order. Finish this grind using index No. 8, 40, 24, and 56, checking to see if these eight main facets are of equal width.



☐ Now set the angle indicator at 27° to 30° and cut eight star facets using the index figures 4, 12, 20, 28, 36, 44, 52, and 60.

☐ Now set the angle indicator at 47° and cut sixteen girdle facets indexing at 2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 50, 54, 58, and 62.

☐ These star and girdle facets are very small and require only a touch on the lap.

☐ This completes the grinding of the crown of the gem; to polish these facets, change to a lucite lap and polish with cerium oxide, using the same angle setting and indexing as you have for grinding (starting with the star facets, then the main facets and the girdle facets).

☐ You are now ready for the transfer to cut the pavilion facets. Place your dop in the transfer block, then take another dop stick (warmed) and apply the wax as before and place this in the other end of the transfer block, adjusting the slide locks on the block so that the dops are free to slide.

☐ Warm the wax on the new dop and press onto the newly faceted end of your stone and allow the wax to cool and harden to create perfect alignment. After cooling, remove the old dop by gently heating it.

☐ Place the new dop in the chuck and proceed to cut the pavilion facets. Begin with the angle indicator set at 41°-45° and using index 64, 32, 16, 48 followed by 8, 40, 24, 56, proceed to cut the eight main facets. You will notice that these are the same readings as the crown facets. Next, set the angle indicator at 46°-48° and cut sixteen girdle facets, indexing the same way as for the crown girdle facets—2, 6, 10, 14, and so on. When completed, change to a lucite lap and polish, using the same angle stops and indexing as for grinding.

☐ This will complete the stone, which can easily be removed from the dop by immersing in cold water, or placing in the refrigerator for a few minutes. A very light tap is usually all that is necessary to release it.

Some general hints on lap care: Laps need only revolve at 300-500 r.p.m. Laps are generally 8 inches in diameter and charged on the coarse side with diamond dust 240-300 grit gauge and, on the fine side, 8·25 microns. If you take good care of your laps they will last for years. The most frequent cause of trouble is contamination of one lap with grit from a coarser lap. Absolute cleanliness is therefore essential in faceting. The chuck, stone, and the operator's hands should be thoroughly washed whenever you change laps. When using laps which are charged on both sides, it is wise to place a fresh piece of paper between the master lap and the cutting and polishing lap every time you change laps. Do not allow sludge to build up in the bottom of the splash pan.

☐ The copper laps used to impregnate diamond dust are soft and easily grooved if you point the dop arm towards the oncoming surface, so always place the dopped stone on the lap so that it trails. It is advisable to wash the lucite lap each time before using. Kerosene is used on the copper laps to improve cutting.

☐ This is merely a brief description of faceting on one type of material; there are dozens of various materials from which to facet stones and all possess a varying amount of optical density and require different cutting angles.

☐ A wise gem-hunter will therefore find it essential to purchase a good book devoted entirely to facet-cutting which will give more elaborate, detailed instructions and

lists of angles required for all individual gem material.

☐ For those gem-hunters who want to extend their knowledge of the optical and physical properties of gemstones, a two-year, part-time course is conducted each year in all capital cities by the Gemmological Association of Australia. Addresses of the various secretaries of each state branch are obtainable by inquiring at any jewellery shop in the Commonwealth.

CUTTING AND POLISHING THE AUSTRALIAN OPAL

Australia's national gemstone is beyond doubt the most interesting of all gems and, to many people, the most beautiful.

☐ The opal, which is almost exclusively found in Australia, requires extra precautions when cutting, to create attractive stones from the material available.

☐ A stone of the desert areas, it unfortunately occurs usually in thin seams and pockets with occasional larger, solid pieces varying from fist size to pieces as large as a football.

☐ When mined thick enough and having exceptional colour, it is invariably cut cabochon shape as a solid stone. Only rarely do you have to slab this material first, for, whenever possible, stones are cut to the "best advantage" — that is, the largest and heaviest single

stone is cut from each piece. Because material is so expensive, it would be foolish to grind away colourful material to reduce to a standard millimetre size, unless the rough piece is already close to a size.

☐ All opal, when rough, is sold by the troy ounce and, when polished, it is sold by the carat weight.

☐ The procedure is similar to that previously described in cutting a cabochon except for cutting off a slab $\frac{1}{4}$ inch thick. The material is first ground lightly all over with a coarse grinding wheel, to assess how far the opal colour is impregnated through the stone. This work is generally carried out by the miner before the stones are offered for sale. This will allow you to assess how the stones will cut out and also orientate the stone, to have the best show of colour on the top of the finished gem. When this has been established, grind flat the part to be the back of the stone and proceed to cut the cabochon, following the instructions given in the section devoted to cabochon cutting. Hints on cutting include the use of water as a coolant instead of the kerosene oil mixture, as the opal is porous at times and, if the oil is dirty from previous cutting, it will stain the stone.

☐ Most experienced cutters grind more than they cut when handling stones that are being cut as solids. Grinding, sanding, and polishing are all slower. Opal, with a hardness of only $5\frac{1}{2}$-$6\frac{1}{2}$, is susceptible to cracking if over-heated, so slower working is the rule and a constant trickle of water on the wheels and sanding discs at all times is desirable.

☐ Where the opal is too thin to cut as a solid stone, or the colour is weak or distributed in bars throughout the material, there are two attractive alternatives available

to the cutter: the doublet and the triplet. As the name suggests, the doublet is created from two pieces of material (double layer) and the triplet from three pieces (triple layer).

☐ To make a doublet, the precious opal is sliced in very thin sheets and cemented to a piece of *potch*, or poor-grade opal, generally of dark grey, greyish-white, or black-coloured material.

☐ A black colouring agent, such as lamp black or nigrosene (negro sand), is mixed with the cement and applied to the back of the opal after both faces of the opal and the potch have been ground perfectly flat. The bonding cement can be a mixture of shellac and nigrosene, or an epoxy resin glue and nigrosene, or an epoxy glue with the dye already impregnated in the glue.

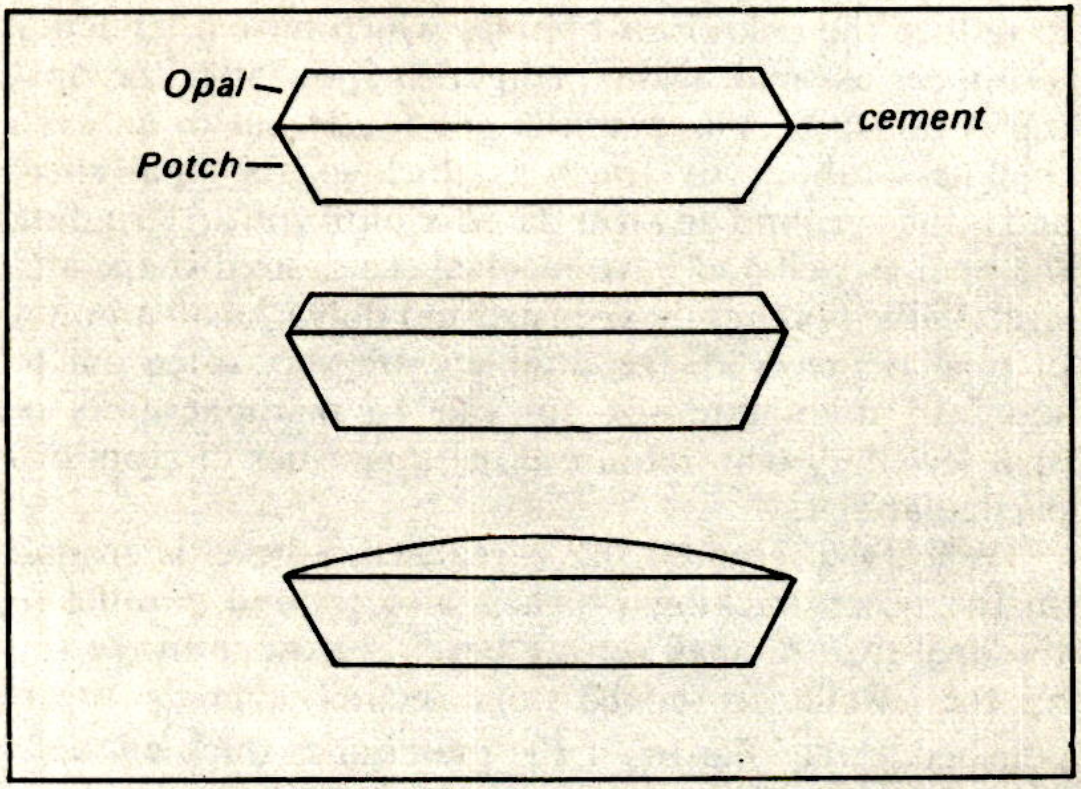
☐ Care must be taken to slide the opal onto the potch to reduce the risk of air bubbles which have a tendency to appear as small white or lightish spots after the opal top is polished. The potch is previously cut to an even thickness (about six times as thick as the opal slice) and is then ground down at the edge until you are grinding the opal as well and have reached the desired shape and size. As the potch is inexpensive and only a small amount of opal is involved, the doublets are very often cut to standard millimetre size for sale to manufacturers of opal jewellery who require large quantities of stones in particular sizes.

☐ When the required size is reached, a bevel is ground on the potch backing which is also ground parallel to the opal top. A small setting bevel is ground on the top for the jeweller to set the stone securely and the top is polished, either flat or, if the material is thick enough,

with a slightly domed effect. The amateur will find the domed effect easier to give a good finish and he can attempt the flat top when more experienced. Contrary to general belief, it is an extremely difficult task to polish a flat surface.

☐ A felt, leather, or cloth buff can be used, with tin oxide and/or cerium oxide as the polishing agent. Some cutters use pumice powder as the pre-polish in place of tin oxide with satisfactory results. Care must be taken at this stage not to over-heat the opal, especially if only a shellac base is used as the joining glue.

STYLES OF DOUBLETS



☐ To prevent the opal doublets from scratching and chipping at the edges, a method of applying a pre-polished, clear quartz top to make a third section was patented by a Sydney firm in the early post-war years. These pre-cut quartz tops are now being imported into Australia from Japan and are available in a great variety of shapes and sizes. With this method it is not necessary to polish the top of the opal doublet before applying the quartz top; just ensure that both are perfectly flat.

☐ A transparent epoxy glue is used to secure the top to the opal which, at room temperature of at least 70°, will require 24 hours to set and harden. Once again, care must be taken to eliminate bubbles from this contact.

☐ The clear quartz top has the effect of strengthening the gem, of enhancing the colour available in the stone, and of overcoming the flat appearance of most doublets.

☐ To ensure perfect flatness with the minimum of effort, most opal-cutters use diamond-impregnated copper laps (similar to those used in faceting) mounted vertically on grinding units, in place of one of the grinding wheels.

☐ Many fabricated doublets were manufactured at the opal fields in early post-war days, the most popular being the map of Australia using different coloured material for each state and mounted as a doublet on a common potch background. Birds, finches, parrots, swallows, and butterflies all made their appearance during this era. Unfortunately, with the rise in the price of opal and less leisure time as the mining towns modernize, this art appears to be dying.

DYED MATRIX OPAL

☐ From the Andamooka opal field in South Australia comes the unique opal material known locally as cooking matrix.

☐ A type of opal, often scorned, this material, a mixture of opal and porous sandstone, was found to accept a dye readily. For years it was cast aside or given away as specimens, until the curiosity of the local cutters brought to life the hidden colours of this fascinating gem.

☐ The sandstone mixed with opal presents an opaque white face to the gem-cutter and it is necessary to immerse in water and hold close to a strong light source to see any colour in the rough state. Dyeing the sandstone black allows the colours in this matrix to be seen by the naked eye. The gemmological name of this stone has been classified as *dyed matrix opal* for identification in the jewellery trade. Unfortunately, when the dyeing process was begun, there were many who did not have the knowledge to apply the dye correctly and who used unsuitable matrix. Not all matrix will dye evenly or well. Instead of the dark background, so essential for good contrast, the material was offered for sale on the open market with a grey or dirty brown background and could only be described as rubbish. This has created a buyer's resistance to all matrix and now only the top-grade material can be sold — and very cheaply compared with earlier sales. There were a few unscrupulous cutters who passed this opal off as rare and expensive black opal in their advertisements overseas and the damage to the opal trade in matrix exports was so extensive that there has been only a slow recovery.

THE DYEING PROCESS OF MATRIX OPAL

☐ This cooking matrix invariably occurs in large pieces and it is first necessary to take a small, experimental cut on one side and end to orientate the colour. The opal in some matrices will appear to be in pipes both small and large in regular patterns spread evenly through the stone. If you cut this material at right angles to the end of these pipes and use this as the top of your stone,a pin fire effect will be the result. If you cut the material parallel to the pipes, long bars of colour will occur. Cutting at a 45° angle will produce short bars.

☐ If you have trouble in orientating the stones, they can be cooked or dyed in the rough state. This is time-saving ultimately because the amateur can then use only the material that cooks well. Of course you will have to recook it later, but you will be secure in the knowledge that your stones will be excellent in colour.

☐ Once the direction of colour has been established, the material can be slabbed in $\frac{1}{4}$ inch slices and cabochons can be ground to shape. The previously-described method is used from the grinding wheels to the 600 sanding paper. No attempt should be made to polish the stone at this time.

☐ It will be more economical if a few dozen stones are done at the same time. You are now ready to dye. Make up a mixture of approximately 1 part sugar to 5 parts water, the sugar to consist of 20% glucose and 80% lactose. Place the solution in an oven-proof beaker together with the stones and add 2 drops of concentrated (98%) sulphuric acid (H_2SO_4). Place the beaker in the

oven set at 120° centigrade and leave for 24 hours. The water will evaporate and leave a black residue in the beaker. This is normally very hard to remove because sugar polymerizes, but the 2 drops of acid will make this mixture crumbly.

☐ Allow the beaker to cool, then tip the contents out and clean the stones roughly. The colour will "show" a little at this stage. Now place the stones in a clean beaker and cover with pure, concentrated sulphuric acid (98%) H_2SO_4. Place the beaker straight into the oven at 100° centigrade and leave for 4 hours. The acid will change the sugar that has entered the stone into carbon. This will impregnate into the sandstone and remain more or less permanently embedded.

☐ Take the beaker out of the oven when cool and wash the stones thoroughly in water, removing all traces of the acid. A weak alkali solution can be used if desired, but this is not really necessary. Now the stone can be dopped and the final polish applied using tin oxide, until a satisfactory finish is achieved.

Note: An ordinary domestic oven can be used for this process. No fumes are formed during the treatment and no corrosion will take place unless the acid is spilt. Honey should not be used as the sugar agent. Use chemical glass beakers; they are inexpensive and stand heating better. The higher the porosity, the more absorption will occur. Contrary to general belief, the dyeing process does not affect the colour in the stone. The dye merely provides a contrast so that the inner colour of the stone becomes visible.

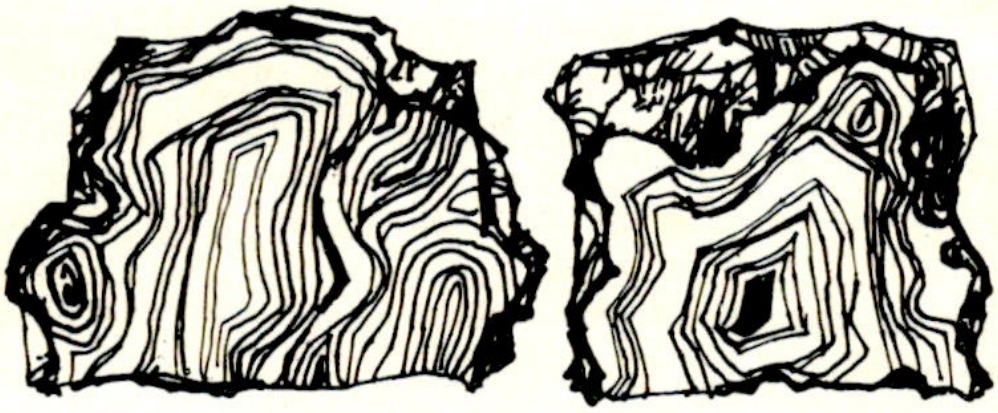


TABLE OF HARDNESS

The dust in the air is composed of silicon, with a hardness of 7, and it is essential that all gemstones of quality should have at least that hardness. There are exceptions, of course, such as opal and malachite, that rely on beauty and rarity, but the gem-hunter will be wise to concentrate his first efforts on gemstones with a hardness of at least the silicates (7). The hardest gemstone known to man is diamond, others are then listed in order:

Hardness rating	Gemstone
10	Diamond
9	Ruby, sapphire (corundum)
8	Spinel, chrysoberyl, aquamarine, beryl, topaz, emerald
7	Zircon, garnet, chiastolite, tourma-

line, agate, chalcedony, ribbonstone, jasper, amethyst, fossil wood, citrine, cornelian, chrysoprase, prase, bloodstone, rose quartz, blue agate, tiger's eye, smoky quartz, all banded and spotted agates, and jaspers

6 Prehnite moonstone, amazonite, nephrite jade, opal, rhodonite

5 Opalite

natural glasses, obsidian serpentine.

☐ Below this hardness, the stones are not durable to use as personal adornment but are listed for comparative purposes:

4 Fluorite

3 Calcite

2 Gypsum

1 Talc

☐ This is not a scale of comparison and the hardness ratios vary. For example, there is a greater difference in hardness between corundum and diamond than there is between ruby and talc.

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