BUREAU OF ECONOMIC GEOLOGY
The University of Texas
Austin 12, Texas
JOHN T. LONSDALE, *Director*

Report of Investigations—No. 42

Texas Gemstones

By

ELBERT A. KING, JR.

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INTRODUCTION

Throughout history man has sought stones and minerals for personal adornment and ornamentation. Stones and minerals that are sufficiently beautiful, durable, and rare are known as gemstones. A gemstone with only one of these qualities is less desirable than one with all three. For example, a stone with rich color but not sufficiently durable to withstand daily wear in rings finds little favor as a gemstone except in brooches or pins where the stone is relatively safe from abrasion. Likewise, a stone that is beautiful and durable may be of little interest as a gemstone because it is commonly found in great quantities. To be valued highly, gemstones must be beautiful to the eye, durable enough to withstand wear, and rare enough so that they are not easily obtained.

PROPERTIES OF GEMSTONES

The beauty of gemstones is mostly dependent on their color, diaphaneity, brilliancy, luster, and fire. Any one or a combination of these properties render stones desirable as gems.

Color is very important in many gemstones. The color of transparent varieties should be distinct enough to be pleasing to the eye, yet not so dark as to appear black or opaque. It is generally more desirable that the gemstone be of even color and not appear "patchy" or "streaked." However, some opaque or translucent stones such as agate owe their popularity chiefly to the variety of colors and designs within a single piece. Some transparent gemstones exhibit different colors when viewed in different directions. For example, some fine blood-red rubies appear brownish when viewed in a particular direction. The gemstone should be cut so that its finest color is most prominently displayed. This ability of some gemstones to exhibit different colors when viewed in different directions is called pleochroism.

Diaphaneity is the relative ability of stones to transmit light. Diaphaneity is described by terms such as transparent, translucent, and opaque. Transparency is highly desirable in stones such as diamond that are commonly facet-cut to reflect light. The gemstone should be water clear and free from inclusions and cracks so that it transmits light freely, but there are stones that do not exhibit this property that are prized as gemstones. For example, turquoise may appear to be completely opaque and not transmit any light, but it is sought for its fine blue color.

The brilliancy of gemstones is largely dependent on their index of refraction. The index of refraction is a measure of the ability of a cut gemstone to "bend" light rays and reflect them from the bottom facets back through the top of the stone. Of course, brilliancy is not noted in opaque or faintly translucent stones. The index of refraction of gemstones is expressed numerically. Air is the reference medium and is assigned an index of refraction of 1.00. Other substances are assigned values relative to that of air, for example, water, 1.33; topaz, 1.62; diamond, 2.42. The higher the index of refraction, the more brilliant will be the gemstone if it is properly cut and polished.

Luster is the appearance of the mineral on a fresh surface in reflected light; it is divided into two major categories, metallic and non-metallic. Most gemstones have non-metallic luster and are described by terms such as vitreous or glassy, resinous, waxy, greasy, and pearly.

The fire, or ability of gemstones to show flashes of different colors of light, is dependent upon a property called dispersion. The amount of dispersion is the extent to which the gemstone is able to separate ordinary white light into its component colors. The dispersion of gemstones can also be expressed numerically but for purposes of this publication will be referred to as low, moderate, or high. Diamond is a common gemstone that has high dispersion.

A gemstone's durability is primarily dependent upon its hardness. The Mohs scale of hardness, given below, is most commonly used for gemstones and other minerals.

Mohs Scale of Hardness

1. Talc
2. Gypsum
3. Calcite
4. Fluorite
5. Apatite
6. Orthoclase feldspar
7. Quartz
8. Topaz
9. Corundum
10. Diamond

On this scale, the higher numbers are the harder minerals. Mohs is a relative, not an absolute scale. Therefore, it should not be assumed that diamond is ten times harder than talc because actually diamond is very many tens of times harder than talc. However, a particular mineral is harder than any other mineral with a lesser number, and the scale is very convenient to use. Gemstones mounted in rings should have a hardness of at least seven on the Mohs scale, or the stones may become scuffed and scratched after a relatively short period of wear. Gemstones mounted in pins and brooches can be of softer material as they are not usually subjected to abrasion and rough treatment.

The tendency of some mineral to split with relative ease in particular directions along planes is called cleavage. Cleavage is also a factor determining the durability of gemstones. Some gemstones do not exhibit this tendency at all, whereas others cleave in several directions. The number of cleavages is always the same in any one mineral, and the direction of cleavages is constant in relation to the crystal structure of any one mineral or gemstone. It is apparent that of stones having the same hardness, the ones lacking cleavage or having the lesser number of good cleavage directions are the most durable.

Some stones, such as jade and agate, owe their durability to their compact fibrous structure, which makes them very tough and durable even though they are not especially hard.

Several other properties of gemstones, although not always contributing to the beauty or desirability of gemstones, are useful in identifying uncut specimens.

Streak is the color of the mineral when finely powdered or, for softer minerals, the color obtained by rubbing the mineral against a piece of unglazed porcelain or tile. The color of a mineral's streak is commonly different from the unpowdered specimen.

Fracture is the kind of surface obtained when the mineral is broken in a direction that is not a cleavage direction. Fracture surfaces are described by such terms as conchoidal (like the fracture of glass), subconchoidal, splintery, even, and uneven.

Tenacity is the resistance of a mineral to breakage. Brittle minerals break relatively easily on impact. Malleable minerals, such as gold, may be flattened under a hammer into very thin sheets without breaking. Sectile minerals may be cut with a knife without powdering. Most gemstones, even diamond, are brittle.

It is only natural to value most those gemstones that are not common or easy to obtain. Emerald owes its longstanding popularity to its fine green color, but tourmaline is sometimes found in colors that very closely approach that of emerald and yet sells for considerably less because it is so much more common.

Rarity is not the only factor affecting the value of gemstones. Freedom from internal imperfections, quality of cutting, color, and size must also be considered in cut and polished gemstones. Internal imperfections, such as inclusions and cracks, detract from the appearance of gemstones and interfere with the passage of light between the facets; consequently, gemstones containing these imperfections are not valued as highly as those without them. Poor cutting or polishing detract from the beauty and thus from the value of gemstones. Unpopular or poor color commonly causes gemstones to be less valuable. Rich green emeralds are exceedingly prized, whereas very pale green emeralds are relatively inexpensive. Diamonds that have the least hint of yellow are never valued as highly as pure colorless, pink, or blue stones. Few persons find the yellowish color attractive, unless it is a vivid canary yellow.

Size is important in determining the value of gemstones but not as important as perfection. A badly flawed gemstone of large size may be worth only a slight fraction of the value of a smaller perfect one. Gemstone size is usually measured in carats, a unit of weight, although millimeter size is sometimes used. Five carats is equal to 1 gram and approximately 28-1/3 grams is equal to 1 ounce avoirdupois. One one-hundredth (0.01) of a carat is called a point, and this term is often used, especially pertaining to very small gemstones.

The term used to compare the relative weights of minerals and gemstones is specific gravity, which is expressed numerically in relation to water. Water is assigned the value of 1.00. Therefore, at a given temperature a gemstone having a specific gravity of 2.00 is twice as heavy as an equal volume of water. A 1-carat sapphire (specific gravity about 4.00) will be smaller than a 1-carat amethyst (specific gravity about 2.65) because the heavier material will occupy less volume to have the same weight.

A summary of properties helpful in identification of common Texas gem minerals is given in Table I.

Comparatively recently in the history of gemstones, man has succeeded in the production of synthetic gems that have properties closely approaching those of many natural gemstones. To the untrained eye some synthetic gems may appear identical to natural stones, but synthetic gems can be detected with little difficulty by a properly equipped expert. Although most synthetic gems are inexpensive, their manufacture has not adversely affected the value of natural gemstones but instead has increased the demand for fine natural gems.

CRYSTALS

Gemstones that have an orderly internal molecular arrangement are referred to as crystalline. This internal order is commonly reflected in the external shape of "rough" or uncut gemstones. The resultant shape is a polyhedral solid bounded by planes and called a crystal. Well-formed crystals are formed in nature only under relatively ideal conditions of temperature, pressure, and space. The specific temperatures and pressures involved vary with different minerals, but most crystals need space in which to form so that their "growth" is not impaired by surrounding rocks and minerals. However, some minerals, such as garnet and tourmaline, can grow in metamorphic rocks by recrystallization of minerals in the metamorphic rocks. The size of crystals varies from microscopic to tens of feet. Any one mineral usually has one or two typical crystal forms or arrangements of plane surfaces that aid greatly in the identification of the mineral when it occurs in good crystals (fig. 1). Frequently gemstones are found as abraded stream-rolled pebbles, fragments, or masses that do not show crystal form. Crystals of the same mineral from different locations commonly show somewhat different crystal forms owing to slight differences in composition or conditions of formation. Mineralogists and crystallographers classify crystals by the symmetry that they exhibit. The crystal systems are (1) isometric or cubic, (2) tetragonal, (3) hexagonal, (4) orthorhombic, (5) monoclinic,

TABLE I. Properties of some common Texas gem minerals.

MINERAL	COMPOSITION	HARDNESS	SPECIFIC GRAVITY	INDEX OF REFRACTION	COMMON COLORS IN TEXAS
Amber	fossil resin	2.0-2.5	1.05-1.10	about 1.54	brown, yellow
Augite	$CaMgSi_2O_6$	5.0-6.0	3.2-3.6	1.60-1.71	greenish brown, black
Beryl	$Be_3Al_2(SiO)_6$	7.5-8.0	2.63-2.80	1.56-1.60	pale blue, colorless, greenish
Celestite	$SrSO_4$	3.0-3.5	3.95-3.98	1.62-1.63	colorless, blue
Epidote	$HCa_2(Al, Fe)_3Si_3O_{13}$	6.0-7.0	3.25-3.50	1.72-1.77	yellowish green, brownish green
Fluorite	CaF_2	4.0	3.0-3.25	1.434	colorless, violet, yellow, green
Garnet (Almandite)	$Fe_3Al_2(SiO_4)_3$	about 7.5	4.25	about 1.83	red, deep red, brownish red
Labradorite	$NaAlSi_3O_8$ 50% to 30% $CaAlSi_3O_8$ 50% to 70%	6.0-6.5	about 2.6	about 1.56	yellowish, grayish
Microcline	$KAlSi_3O_8$	6.0-6.5	2.54-2.57	1.52-1.53	pink, red, bluish, greenish, white
Obsidian	volcanic glass	5.0-5.5	2.3-2.5	1.45-1.53	dark gray, black, brownish
Opal	$SiO_2 \cdot nH_2O$	5.5-6.5	1.9-2.3	1.43	white, pink, bluish, brown, gray
Quartz (Crystalline)	SiO_2	7.0	2.65-2.66	1.544-1.553	colorless, violet, yellow, brown
Tektite (Bediasite)	natural glass	.5-6	2.33-2.44	1.48-1.52	dark brown, greenish brown
Topaz	$Al_2(F, OH)_2SiO_4$	8.0	3.4-3.6	1.60-1.63	colorless, bluish, sky blue
Tourmaline	$H_9Al_3(B \cdot OH)_2Si_4O_{19}$	7.0-7.5	2.98-3.20	1.62-1.64	black, dark brown

and (6) triclinic. A complete description of the classification of crystals can be found in almost any mineralogy text (*see* Selected References, p. 34).

Some gemstones, such as opal and obsidian, never occur as crystals owing to a lack of internal structural order. Such gemstones are termed amorphous, or without form. Amorphous gemstones mostly occur in nature as irregular lumps or masses, cavity fillings, or veins.

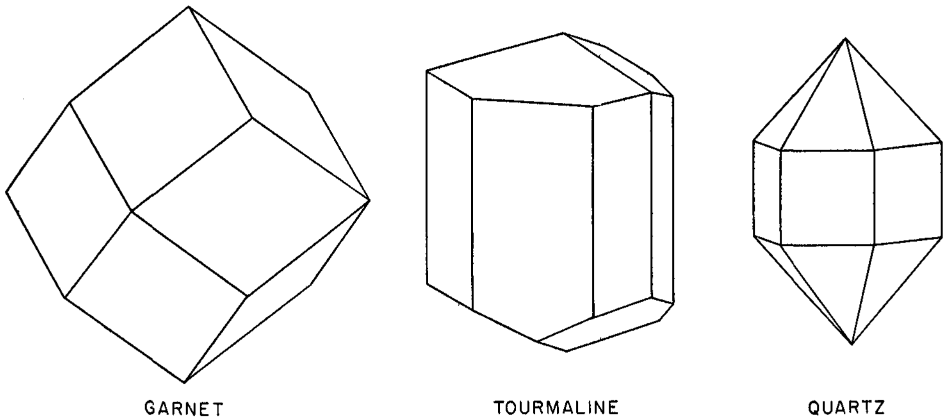

FIG. 1. Typical crystal form of three common Texas gemstones.

CUTTING AND POLISHING OF GEMSTONES

There are two types of widely used gemstone cuts. Opaque or figured gemstones are usually cut with a rounded upper surface and a flat or rounded back. A stone cut in this fashion is termed a cabochon or is said to be cabochon cut. There are several variations of this mode of cutting (fig. 2). Precious opal, agate, jade, star sapphire, and fossil wood are some of the stones that are cut mostly as cabochons. Transparent gemstones are usually cut with many plane polished surfaces. Such stones are called faceted, and the process of cutting and polishing these stones is called faceting. Emerald, diamond, topaz, and garnet are examples of gemstones that are commonly seen as faceted stones.

FIG. 2. Variations of the cabochon cut. Left to right: double cabochon; flat cabochon; simple cabochon; hollow cabochon.

The cutting of gemstones, although sometimes tedious and time consuming, is not especially difficult or complex. However, like most arts and crafts, technique and ability should improve with practice and experience. There are currently many amateur gem cutters in Texas. A complete set of equipment necessary to cut cabochon stones may be purchased for as little as $50.00 or $60.00. Most amateur cabochon cutters have equipment that cost less than $100.00 which enables them to do very fine work on many gem materials. Facet cutting requires more precise equipment, and a complete array of such usually costs more than $100.00, although less expensive equipment can be obtained. The beginning gem cutter or lapidary who is willing to assemble and make some of his own equipment can reduce his initial expenses considerably.

CABOCHON GEMS

The procedures listed herein for gem cutting do not apply to all gemstones. Stones that are especially brittle, soft, or difficult to polish require additional procedures or special techniques. Many lapidaries may deviate from these procedures. Some of the steps of cutting and polishing are merely matters of personal opinion and vary somewhat from cutter to cutter. There are several detailed texts on the art of gem cutting; the descriptions herein are designed to give the reader only a general idea of the procedures and techniques involved.

The cutting and polishing of cabochons require several steps. The initial step is sawing. Assuming that the rough gem material is large enough to be sawed (larger than about half an inch in diameter), it is clamped into the carriage of a diamond saw (fig. 3) and cut into slices about 3/8-inch thick. The blade of the saw is mild steel that has been impregnated with diamond dust around the edge, hence the name diamond saw. The blade is rotated rapidly, and the material to be cut is "fed" to the blade by a sliding carriage on which the gem material is clamped. The extreme hardness of the diamond dust in the edge of the blade enables the saw to cut through several inches of gem material in a few minutes. The lower portion of the saw blade is immersed in a mixture of kerosene and oil, and the rotating saw blade carries with it some of the kerosene-oil mixture; this acts as a coolant and lubricant for both the saw blade and the material being cut. Without this lubricant, the heat generated by sawing would shatter most gem materials and also damage the saw blade. As this "slicing" or sawing of the material usually takes several minutes, a weight

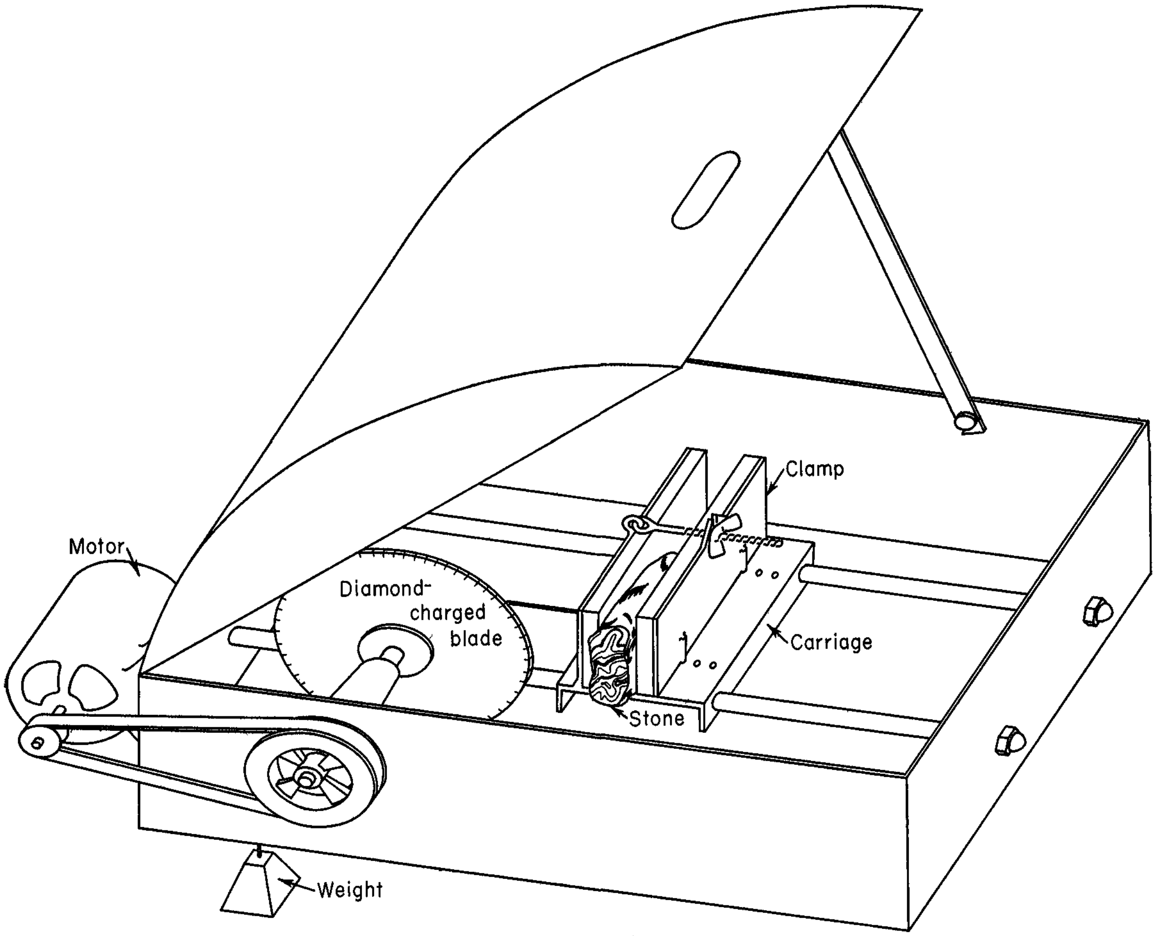

FIG. 3. Diamond saw.

and pulley are generally used to give the gem material the necessary pressure against the saw blade. When cut through, the "slab" of gem material falls into the kerosene-oil mixture at the bottom of the saw or onto a special platform that cushions its fall.

After being sawed, the slab of gem material is examined, and the location and size of the stones to be cut from the slab are determined. The desired outline of the shape of the gem to be cut is marked on the slab with a pointed piece of aluminum rod; ordinary pencil marks are not used because they wear away too quickly in the cutting process. Once the area from which the gem is to be cut has been selected and the outline of the gemstone has been marked on the slab, the excess material is trimmed away by a smaller diamond saw known as a trim-saw. In some slabs the excess material can be broken and "nibbled" away with a strong pair of pliers.

The remaining portion of the stone is usually held by hand and ground to the desired shape using the previously scribed mark as a guide. This is done using a relatively coarse-grained (about 150 grit) specially made carborundum grinding wheel.

Now that the desired outline has been obtained, the stone is firmly affixed to a slender wooden or hollow aluminum dop-stick (fig. 4). The process whereby the stone is attached to the dop-stick with a specially compounded jeweler's wax is called dopping. The dop-wax is heated over an alcohol lamp or candle flame until it is soft and pliable and is then spread around on the end of the dop-stick and formed into a mass about the right size and shape to fit the back of the gemstone. The stone is likewise heated, and the wax is applied to the back of the stone while both wax and stone are hot. Upon cooling, the wax firmly fixes the stone to the dop-stick. The dop-stick allows the lapidary to have firm control of the stone during all later stages of cutting and polishing.

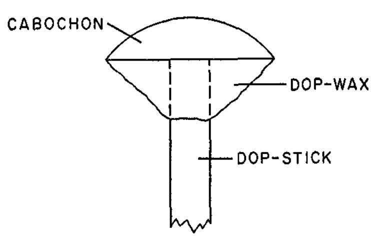

FIG. 4. Cabochon properly attached to dop-stick.

The top of the dopped gemstone is worked against the coarse carborundum grinding wheel until it is a rough approximation of the desired shape. The stone is then worked against a much finer-grained (about 220 grit) grinding wheel to remove the irregularities left by the coarse grinding and to further smooth and shape the surface of the gemstone. At all times while grinding, a small flow of water should be directed on the grinding wheel to keep the stone cool. Grinding on the stone for even a few minutes without cooling may result in the shattering of the gemstone because of heat created by friction of the stone against the grinding wheel. If the lapidary keeps the surface of the grinding wheel wet, there is little chance of damaging most gem materials.

The next phase of cabochon cutting and polishing is sanding. The gemstone is worked against two sanding drums of different grit size. This sanding can be done with the sandpaper surface either wet or dry, as needed or as preferred by the lapidary. However, great care should be exercised during sanding so that the stone is not overheated. Overheating can easily occur whether the sandpaper is used wet or dry. As in grinding, sanding is first done on coarser grit paper (about 300 grit) and last on finer paper (about 600 grit). It is in the sanding process that the first hint of polish is noted on the surface of the stone. After sanding, the gemstone should have perfect form with no surface irregularities, a very finely textured surface, and only very minor scratches left from sanding. The gemstone is now ready to be polished.

At this point the procedure depends on the nature of the gemstone being polished. Most gem materials are worked against a buffing wheel that is impregnated or saturated with a mixture of some polishing compound and water. A soft felt buffing wheel with cerium oxide as the polishing agent is used for many materials. The mixture of cerium oxide and water is usually applied to the buffing wheel with a small brush. The lapidary should once more be careful not to overheat the stone. If the stone becomes too hot to hold to the

FIG. 5. Cabochons at various stages of cutting and polishing. Left to right: trimmed from slab: ground to outline; after rough grinding; after sanding; polished.

underside of the cutter's wrist, it should be permitted to cool for a few seconds before continuing. After polishing on the buffing wheel, the gemstone should have a fine, high polish and be free of any scratches or surface irregularities. The finished gemstone is removed from the dop-stick by heating the dop-wax and pulling the stone loose. Any excess wax that hardens again before it can be removed from the stone by hand can be dissolved away by rubbing with an acetone-soaked cloth. Figure 5 illustrates the desired appearance of the gemstone at the end of each of the steps of cutting and polishing.

FACETED GEMS

The principles involved in faceting are about the same as those in the cutting of cabochons, but the equipment and technique are considerably different. The equipment required for the facet cutting of gemstones is built into or attached to a small specially constructed table (fig. 6), and the unit is commonly called a facet table. Most faceted gemstones are cut to obtain the largest flawless stone possible from the rough material. Therefore, one of the first and most important steps for the lapidary is to decide how the stone is to be cut from the rough crystal or pebble. The colors that can be obtained from the gemstone must also be considered, and the cutting of the stone oriented so that its best color is displayed. The lapidary also selects the orientation of the stone in relation to the cleavage or cleavages. It is difficult or impossible to polish facets of gemstones that are cut parallel to a good cleavage direction.

Once the orientation of the gemstone to be cut from the rough material has been determined, the stone is dopped onto a special metal dop-stick that fits into the chuck of the facet head. The chuck is tightened so that the position of the stone on the end of the arm of the facet head is firmly fixed, and the facet head is adjusted so that the first facet that is cut is the horizontal, top facet of the stone or table facet (fig. 7). The table facet is cut by grinding the gemstone on a flat cutting lap that is diamond impregnated (fig. 8). By minor adjustments of the facet head, the lapidary can precisely control the location of the table facet. As soon as the table facet has been ground to the proper size, the cutting lap is removed from the lap plate, and the polishing lap is secured

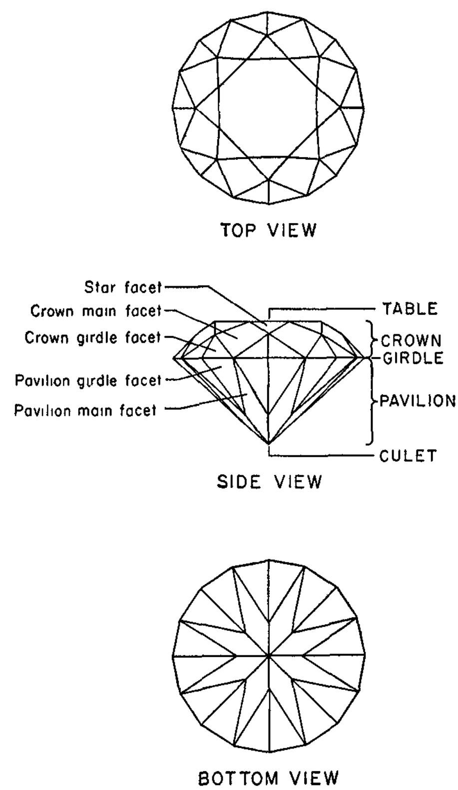

FIG. 7. Nomenclature of the standard American brilliant cut.

in place. Many different kinds of polishing laps and polishing compounds may be used depending on the properties of the material being polished. However, one lap and one polishing compound are usually sufficient for each gem variety. After the polishing lap is secured to the lap plate, the lapidary adjusts the facet head so that the stone is in exactly the same position relative to the lap that it was during the cutting of the table facet. The polishing

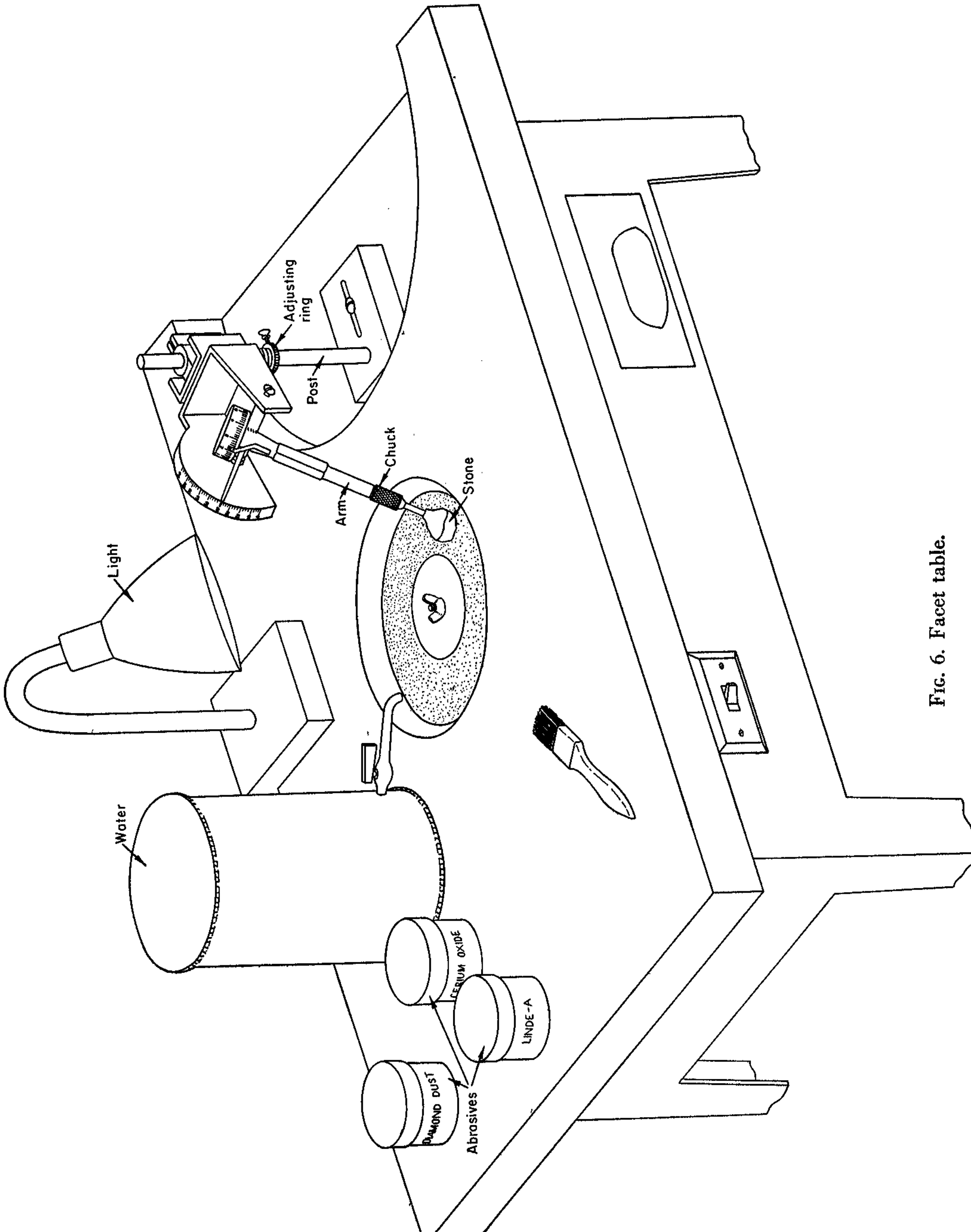

FIG. 6. Facet table.

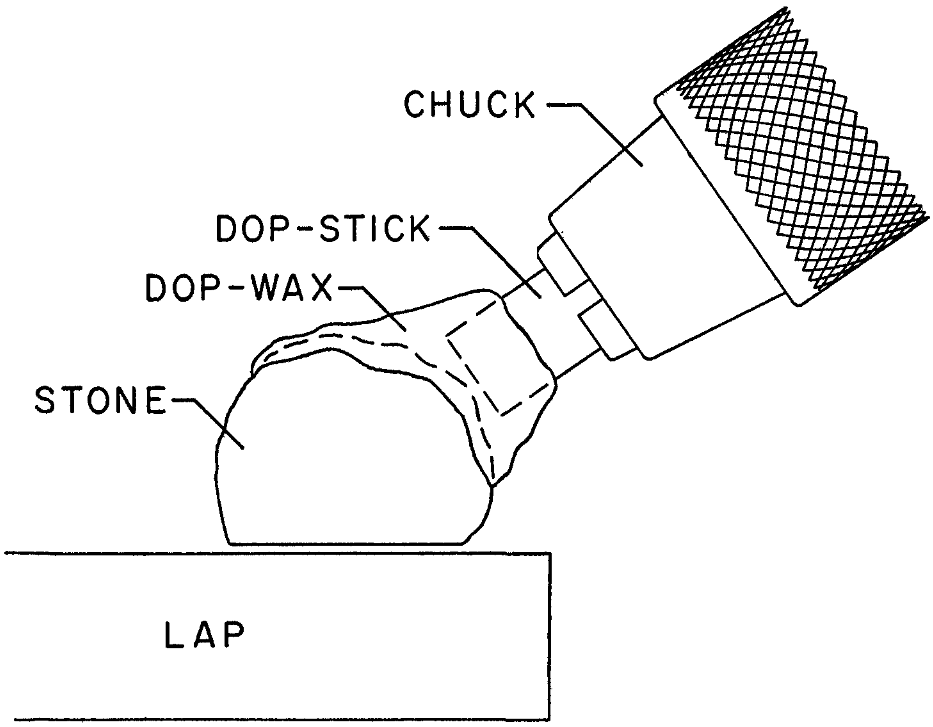

FIG. 8. Grinding the table facet on a rough stone.

lap is run wet or damp with water, as is the cutting lap, and small amounts of the polishing compound are applied to the surface of the lap while the facet is being polished. The minor scratches left by the cutting process are gradually removed, and a fine lustrous polish develops on the facet. It is especially important to take care in achieving a perfect polish on the table facet, as this facet occupies a large area of the crown of the gemstone. When the cutting and polishing of the table facet are completed, the gemstone is still rough or uncut in all portions except for this single, large, polished surface.

The gemstone is then removed from the dop-stick by melting the dop-wax and is dopped once more so that the plane of the polished table facet is perpendicular to the axis of the chuck and arm of the facet head (fig. 9). Great care should be taken by the lapidary to insure that the table of the stone is exactly perpendicular to this axis, or the proper placing of the later

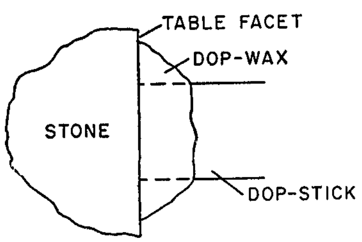

FIG. 9. Stone dopped to table facet.

facets on .the stone may become very difficult.

Once the stone has been properly dopped to the table facet, the lapidary is ready to proceed with the cutting of the outline of the stone. If it is to be a brilliant cut, the stone is ground perfectly round in outline; if it is to be an emerald or step cut, it is shaped so that it is square or rectangular in outline. This process is called preforming. The arm of the facet head is lowered on the post until it is horizontal, and the stone is worked against the cutting lap until the desired shape is obtained. When the preforming process is completed, the stone should have the desired outline of the finished gem (fig. 10).

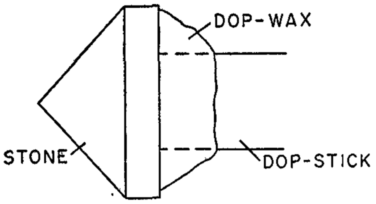

FIG. 10. Preformed stone dopped to table facet.

The lapidary is now ready to proceed with the cutting of the pavilion of the stone. The arm of the facet head is raised to the proper angle for cutting the main pavilion facets. The angle at which the main facets are cut is very critical in determining the beauty of the finished stone. The required angle at which these facets must be cut varies with the refractive indices of the different varieties of gem minerals. If the facets are not cut at exactly the proper angle, light entering the top or crown of the gemstone can pass completely through the stone, instead of being reflected back out of the crown facets. The result is a dull, lifeless stone that appears to have a "hole" or "fish-eye" in the center. Stones that are cut in this manner are greatly reduced in value. The angle at which the facets are cut is controlled by the adjustment of the height of the arm of the facet head on the post. The lapidary will continually adjust this height, because the angle between the arm and the surface of the lap changes slightly as the facet is ground down to its proper place and size.

The standard American brilliant cut will be used as an example of facet cutting. Procedure for all other cuts is essentially the same to this point. After the eight main pavilion facets have been cut, the cutting angle is changed a few degrees, the arm of the facet head rotated slightly, and the sixteen pavilion girdle facets or "skill" facets, as they are often called, are cut (fig. 11). The pavilion girdle facets should meet exactly in the center of the main facets at the girdle of the stone. The pavilion girdle facets should neither overlap, nor should there be any space between them (fig. 12). After the pavilion girdle facets are cut, the cutting of the pavilion of the gemstone is completed. The facets are then polished on the polishing lap at the same angles and in the same order as they were cut, and the pavilion of the gem is completely finished.

The stone is then removed from the dop-stick by melting the dop-wax and is re-dopped to the pavilion facets so that the crown of the stone is now exposed for cutting. Before the lapidary proceeds with the cutting of the crown, it is necessary that the stone be perfectly centered on the dop-stick and that the plane of the table facet be perpendicular to the dop-stick and to the axis of the arm of the facet head. The eight main facets are cut first, with numerous adjustments being made by the lapidary to insure that the proper angle is maintained (fig. 13). Then the cutting angle is changed a few degrees, the arm of the facet head rotated slightly, and the crown girdle facets are cut. The crown girdle facets are placed very similarly to the pavilion girdle facets except that they

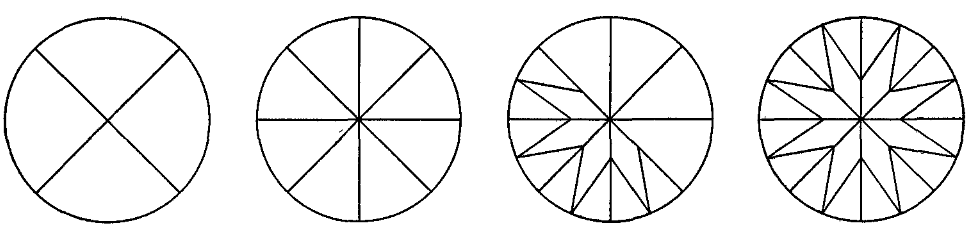

FIG. 11. Proper sequence of cutting of the pavilion facets. Left to right: four main facets; all eight main facets; half of the pavilion girdle facets; completed pavilion.

are shorter. The crown girdle facets should be joined in exactly the same way as the pavilion girdle facets. When these facets are properly cut, the cutting angle is again changed, the arm rotated, and the eight star facets are cut. This completes the cutting of the crown of the stone. The cutting lap is removed from the lap plate, and the polishing lap is secured into place. The facets are carefully polished in the same order that they were cut. After the last star facet has been polished, the stone is removed from the dop-stick. Any excess dop-wax is removed from the stone by means of a solvent, and the full beauty of the finished gem is revealed.

TUMBLED GEMS

One other method of finishing gemstones that deserves mention is tumbling. "Baroque" or "free-form" stones are produced in this manner. Loose pebbles or pieces of gem materials left over from other cutting processes are placed in a small barrel or specially constructed box with loose carborundum grit. The barrel is turned by means of a small motor, and the abrasion of the pebbles and grit against each other tends to round the pebbles and give them a finely pitted surface. Progressively finer and finer carborundum grit is used, and eventually a polishing compound. The result is several pounds of well-polished gem pebbles of various shapes and sizes. These baroque stones have found recent favor in costume jewelry of modern design. The tumbling process is rather slow, commonly requiring several days or weeks. However, little effort is involved on the part of the lapidary, and, consequently, the cost of most tumbled or baroque stones is quite modest. Only gem material that is unsuitable for cutting in other manners should be finished in this way.

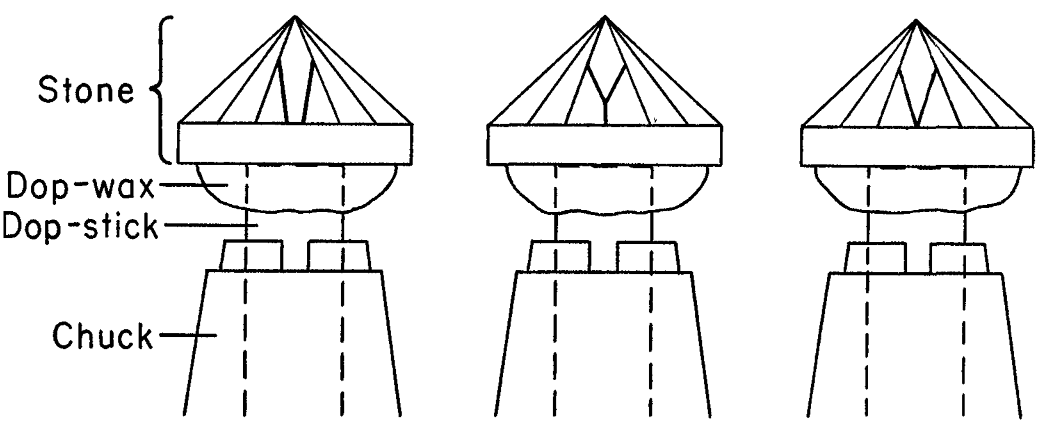

FIG. 12, Proper placing of the pavilion girdle facets. Left: facets not joined. Center: facets overlapped, joined too high. Right: correct placing.

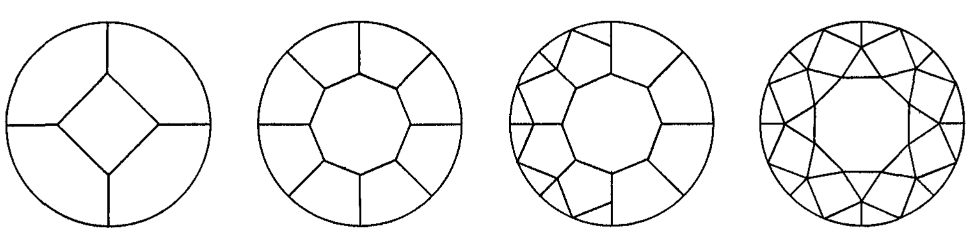

FIG. 13. Proper sequence of cutting of the crown facets. Left to right: four main facets; all eight main facets; half of the crown girdle facets; completed crown.

AMBER

Composition: fossil resin. *Crystal system:* amorphous. *Hardness:* about 2.0 to 2.5. *Specific gravity* variable, from 1.05 to 1.10. *Luster* resinous. *Color* brown, yellow, red, orange, and white. *Streak* white to yellowish to gray. *Cleavage* none. *Fracture* conchoidal. *Tenacity* brittle. *Diaphaneity:* transparent to translucent. *Refractive index* variable, about 1.54. Burns with a sweet, piney odor.

Rich brown to yellowish amber has been found near Eagle Pass, Maverick County, in Cretaceous coal and on Terlingua Creek, Brewster County. Although much of this material is translucent and the quality suitable for lapidary purposes, the pieces are seldom more than a fraction of an inch in diameter.

Occasional finds of poor quality brownish amber have been reported from the Tertiary formations of the Gulf Coastal Plain, but thus far no gem quality material has been found.

The softness of amber limits its use to brooches, necklaces, and other jewelry that is relatively safe from abrasion.

AUGITE

Composition $CaMgSi_2O_6$; may also contain iron, aluminum, and sometimes titanium. *Crystal system:* monoclinic. *Hardness:* 5 to 6. *Specific gravity:* 3.2 to 3.6. *Luster:* vitreous to dull. *Color:* dark greenish brown and greenish black. *Streak* light grayish green. *Cleavage* two directions, poor, *Fracture:* conchoidal to uneven. *Tenacity:* brittle. *Diaphaneity* opaque to translucent. *Refractive index:* variable, about 1.60 to 1.71.

Augite of gem quality occurs near Eagle Flat, Hudspeth County, Texas. Although this material is very dark greenish brown and not commonly thought of as a gemstone, lapidaries have used it to fashion black faceted stones and cabochons that resemble obsidian. Most of the augite occurs as loose pieces and crystal fragments that have weathered out of nearby igneous rocks; the augite can also be found in situ in the igneous rocks.

Specimens and pieces of cutting quality 1 inch in diameter are common, and fragments over 2 inches in diameter have been found. The augite is associated with black spinel and some dark gray to black pieces of natural glass. Although the faceted and cabochon-cut stones are not particularly attractive, some of the larger pieces of augite might be utilized for carving.

BERYL

Composition $Be_3AL_2(SiO)_6$. *Crystal system* hexagonal. *Hardness:* 7.5 to 8.0. *Specific gravity:* 2.63 to 2.80. *Luster:* vitreous. *Color:* pale blue, blue, green, yellow, brownish, pink, and colorless. *Streak* white. *Cleavage* one direction, very imperfect. *Fracture* conchoidal to uneven. *Tenacity:* brittle. *Diaphaneity:* transparent to subtranslucent. *Refractive index:* 1.56 to 1.60. *Dispersion:* low.

Gem-quality beryl has not been reported in Texas. A discussion of beryl is included herein because the writer believes it likely that beryl of gem quality will be found in Texas as a result of future investigations and exploration.

Beryl crystals have been found in pegmatite dikes in Llano, Blanco, and Gillespie counties. These crystals are commonly several inches long and exceed 1 inch in diameter but are very badly fractured. Most of the beryl crystals do not approach gem quality and are entirely unsuitable for any lapidary use. The color of the crystals found thus far is bluish, greenish, pinkish brown, yellowish, and colorless. Some very tiny colorless beryl crystals have been found that are transparent, but thus far such crystals have been too small to be cut into gems.

Fine blue beryl crystals have been found in the Franklin Mountains near El Paso, Texas. Unfortunately, these crystals are so badly flawed and fractured that they are not suitable for lapidary use.

It seems likely that careful prospecting of Texas pegmatites will reveal at least some gem-quality beryl.

CELESTITE

Composition: $SrSO_4$. *Crystal system:* orthorhombic. *Hardness:* 3.0 to 3.5. *Specific gravity:* 3.95 to 3.98. *Luster:* vitreous. *Color:* white, blue, greenish, reddish, and brownish. *Streak:* white. *Cleavage* three directions, although one of these directions is not easily developed. *Fracture:* uneven. *Tenacity* brittle. *Diaphaneity* transparent to subtranslucent. *Refractive index:* 1.62 to 1.63. *Dispersion:* moderate.

Celestite is very seldom cut into gems. Being very soft, brittle, and having three cleavages, celestite is completely unsuitable for jewelry. These same properties make this mineral exceedingly difficult to facet; however, faceted stones are seen in large collections.

Fine crystals of colorless and blue gem-quality celestite (Pl. I, A, and fig. 14) have

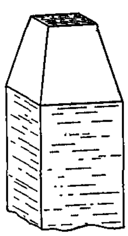

FIG. 14. Common crystal form of Travis County celestite. Same crystal form as shown in Plate I, A.

been found at Mount Bonnell and other localities west of Austin, Travis County. The celestite crystals occur in vugs or geodes in limestone. The crystals are mostly white or colorless and fractured near the base or where attached, but the tips of the crystals are commonly clear celestine blue and completely free of flaws.

Crystals several inches in length have been found, but the average size is about 1 inch. The smaller crystals are frequently more transparent and consequently better suited for cutting. It is very difficult to obtain crystals that will allow the cutting of flawless stones of more than 4 or 5 carats.

Bluish and colorless celestite of gem quality and fine crystals have been found near Lampasas, Lampasas County, and near Brownwood, Brown County, but neither of these localities has been very productive of good gem material.

Celestite geodes have been found in parts of Coke, Fisher, and Nolan counties, but these geodes contain little gem material.

DIAMOND

Composition carbon. *Crystal system* isometric. *Hardness:* 10. *Specific gravity:* 3.51 to 3.53. *Luster* adamantine to greasy. *Color* brown, colorless, pink, blue, yellow, and various other light colors; rarely deeply colored; sometimes black. *Cleavage:* four directions, octahedral, perfect. *Fracture:* conchoidal. *Tenacity:* brittle. *Diaphaneity:* transparent to opaque. *Refractive index:* 2.42. *Dispersion:* high.

There is only one well-authenticated find of diamond in Texas. A small brownish diamond was found in 1911 on section 64, block 44, Foard County (Sterrett, 1912, pp. 1040–1041). The exact weight of the stone has not been recorded, but one authority estimated that it was of sufficient size and clarity to yield a cut stone of about one-quarter carat.

The only diamond-bearing rocks known in the United States are in Pike County, Arkansas. Although many other diamonds have been found in the United States, all were loose in gravels or streams except for some stones at the Arkansas locality. The fact that one diamond was found in Foard County does not mean that the prospects of finding more diamonds in Texas are much better there than anywhere else in the State. It is highly unlikely that more than a very few diamonds will ever be found in Texas, and any stones that may be found in the future are likely to be widely scattered.

EPIDOTE

Composition: $HCa_2(Al, Fe)_3Si_3O_{13}$. *Crystal system* monoclinic. *Hardness* 6 to 7. *Specific gravity:* 3.25 to 3.5. *Luster:* vitreous. *Color:* yellowish green to brownish green and brown. *Streak:* uncolored to grayish. *Cleavage* two directions. *Fracture:* uneven. *Tenacity:* brittle. *Diaphaneity:* transparent to opaque. *Refractive index* about 1.72 to 1.77.

Llano County has furnished some green and brownish-green epidote that is suitable for cutting into cabochons. Most of the material that approaches gem quality has come from contact metamorphic zones and is associated with garnet, quartz, and some scheelite. Some small cavities in the rocks contain tiny transparent crystals of gem quality, but the largest obtainable flawless faceted stones would probably be less than 15 points.

Faceted stones of epidote are sometimes known as pistacite owing to their common pistachio-green color.

FLUORITE

Composition: CaF_2. *Crystal system:* isometric. *Hardness:* 4. *Specific gravity:* 3.0 to 3.25. *Luster:* vitreous. *Color:* violet, blue, colorless, green, yellow, brown, rose, and crimson red. *Streak:* white. *Cleavage:* four directions, octahedral, perfect. *Fracture:* subconchoidal to splintery. *Tenacity:* brittle. *Diaphaneity;* transparent to subtranslucent. *Refractive index:* 1.434.

Very fine green, transparent fluorite has been found near Voca, Mason County. The fluorite occurs as vug fillings in pegmatites, associated with crystals of pink microcline and colorless quartz. Most of the Vugs have been completely filled by the fluorite; therefore, crystals (fig. 15) of the fluorite

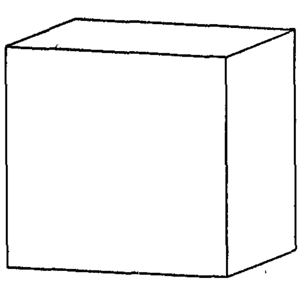

FIG. 15. Common crystal form of fluorite.

are not too common. Masses of fluorite several pounds in weight, rich green, and quite transparent have been found near Voca. Transparent pieces an inch or more in diameter are common.

Fluorite is much too soft for everyday use in jewelry and because of the low refractive index does not yield brilliant faceted stones. The perfect four-directional cleavage, relative softness, and brittle tenacity of the mineral make it difficult to facet. Faceted stones are seldom seen outside of collections. Cabochons are also difficult to cut from this material, but the rich color obtained is ample reward for the time and care necessary in cutting.

Fluorite occurs at several other localities in Texas, notably in Hudspeth, Brewster, Presidio, Llano, and Burnet counties, but not commonly in gem quality or colors that warrant its use as gem material.

FOSSIL WOOD

Wood that is buried in silica-rich sediments is commonly replaced by quartz, agate, or opal. The wood structure, including a large number of the annular rings, knots, small branches, and bark, may be preserved. This process of replacement by silica is believed to take considerable time. Preservations by other means (*see* Jet, p. 22) are known, but silica replacements are most commonly used as gem materials.

Fossil wood is often used by lapidaries as gem material when mineral replacement preserves the wood structure sufficiently well and when various impurities color the replacement material attractively.

Excellent gem-quality fossil wood (Pl. I, B) has been found at a great number of localities in Texas. Agatized and opalized wood occurs in great abundance along the outcrops of Eocene and Oligocene strata of the Texas Gulf Coastal Plain. Much of this material is very well suited for cabochons, bookends, and other lapidary uses. The preservation is especially good at numerous localities in Washington, Lee, Fayette, and Gonzales counties, and the variety of colors, such as bluish, gray, brown, red, yellow, and black, makes this material especially sought after by "rockhounds." Some of the agatized and opalized wood fluoresces yellow or green under ultra-violet light. The fossil wood is sometimes found as stumps, limb sections, or large trunk fragments, but the great majority of the gem material is found as small broken fragments or stream-rolled cobbles.

Fossil palm wood is by far the most sought after variety because this material displays "eyes" and tube-like structures that yield very attractive cabochons and cabinet specimens. Texas fossil palm wood is highly regarded by cutters from all parts of the country, and this material is thought by many lapidaries to be some of the finest gem-quality fossil wood in the United States.

Gravel pits and river gravels in Live Oak County have produced very fine agatized wood. Although the gem material does not seem to be as abundant in this area as it is in counties to the northeast, the vivid colors and excellent preservation of the fossil wood in Live Oak County have attracted collectors from all over the State. The fossil wood usually occurs as large rounded cobbles in the streams. Much of this material is quite translucent when cut and contains various shades of brown, orange, and red.

The gravels of the Rio Grande have produced some fossil wood in addition to the excellent agate that is also found there. Most of the fossil wood found in these gravels is very well preserved, but the colors are commonly dull shades of brown. Occasional fine red and yellow specimens have been recovered from the Rio Grande gravels, but these are rare.

Good agatized wood has been found in and near Palo Duro Canyon, Armstrong County, about 50 miles southeast of Amarillo. Large trunk sections are not uncommon, but most of the material of cutting quality is obtained from small fragments. The Palo Duro Canyon fossil wood greatly resembles the famous Arizona Petrified Forest wood but is not nearly as plentiful. The Palo Duro wood contains yellow, brown, red, and bluish colors most commonly. Some of the wood-producing area is within Palo Duro Canyon State Park which is, of course, closed to collecting. The surrounding area has been worked diligently by local collectors, but new pieces of wood are exposed after heavy rains.

Webb and Duval counties have also produced some good fossil wood specimens.

GADOLINITE

Composition: $Be_2FeY_2Si_2O_{10}$. (Various other rare-earth elements may substitute into this mineral structure.) *Crystal system* monoclinic. *Hardness:* 6 5 to 7.0. *Specific gravity:* about 4.2. *Luster:* vitreous to greasy. *Color:* black; in thin splinters dark bottle green. *Streak:* white to greenish. *Cleavage:* none. *Fracture:* conchoidal to splintery. *Tenacity:* brittle. *Diaphaneity:* opaque to subtransparent in thin pieces. *Refractive index* variable, about 1.77 to 1.82.

Gadolinite as a cut gem is not seen outside of large collections; however, it can be faceted into black opaque stones of little beauty but of great interest to collectors. The best known locality of this mineral in the United States is Baringer Hill, Llano County, Texas. Unfortunately, this locality was completely flooded by the completion of Buchanan Dam in 1938. Masses and rough crystals of gadolinite weighing over 100 pounds were mined from this locality. The gadolinite occurred in a large, very coarse-grained pegmatite dike associated with quartz, microcline, and fluorite, as well as allanite, fergusonite, nivenite, cyrtolite, thorogummite, and various other rare minerals. Some of the minerals in the dike occurred in very large masses. One quartz mass over 40 feet in diameter was noted, and microcline masses up to 30 feet in diameter were not uncommon. Much of the gadolinite was used by industrial firms as a source of thorium compounds, although some specimen and gem material found its way into museums and private collections. Because the locality was worked mostly from 1910 to about 1925 and because since 1938 the waters of Lake Buchanan have completely flooded the entire area, material from this locality is now exceedingly difficult to obtain. The collection of the Smithsonian Institution, Washington, D.C., contains a cut and polished gem of Baringer Hill gadolinite that weighs 8.6 carats. This mineral is radioactive because of the presence of uranium, thorium, and other rare radioactive elements.

GARNET

The garnet group of minerals is variable in composition. Listed below are the pure members of this group, but garnets found in nature are usually a mixture of two or more of these end members.

Aluminum garnet—
- Grossularite (calcium-aluminum garnet), $Ca_3Al_2(SiO_4)_3$
- Pyrope (magnesium-aluminum garnet), $Mg_3Al_2(SiO_4)_3$
- Almandite (iron-aluminum garnet), $Fe_3Al_2(SiO_4)_3$
- Spessartite (manganese-aluminum garnet), $Mn_3Al_2(SiO_4)_3$

Iron garnet—
- Andradite (calcium-iron garnet), $Ca_3Fe_2(SiO_4)_3$; may contain magnesium, titanium, and yttrium

Chromium garnet—
- Uvarovite (calcium-chromium garnet), $Ca_3Cr_2(SiO_4)_3$

Since almandite is the only variety of garnet known to occur commonly in gem quality in Texas, the following properties are for almandite except where noted.

Crystal system isometric (all varieties). *Hardness:* about 7.5. *Specific gravity:* 4.25. *Luster:* vitreous to resinous. *Color* red, deep red, and brownish red (other varieties also yellow, white, orange, pink, black, and green). *Streak* white. *Cleavage* none. *Fracture* subconchoidal to uneven. *Tenacity* brittle to tough. *Diaphaneity* transparent to subtranslucent. *Refractive index:* about 1.83.

Good crystals of gem-quality almandite garnet have been found in Llano, Blanco, Burnet, and Gillespie counties. In southeast Llano County, northwest Blanco County, and northeast Gillespie County, the stones mostly occur in stream gravels where they have collected after being weathered out of compact mica schists. Owing to the fact that most of the garnets have not been transported very far from their source, the stones commonly show good crystal form (Pl. II, A). All of the garnets from one locality commonly do not have exactly the same crystal form. The garnets are mostly widely scattered in the stream gravels but can be found concentrated behind rocks and on small gravel bars.

Many of the crystals are less than one-eighth inch in diameter; however, good crystals one-fourth to one-half inch in diameter are common. Most of the stones are too fractured or have too many inclusions to yield gems, but many transparent stones have been found. The transparent crystals usually yield flawless deep red faceted stones of 2 carats or less. Some of the stones that contain too many inclusions to facet are cut as cabochons and are then often known as carbuncle.

Small garnet fragments have been found in streams and in gneisses and pegmatites near Castell, Llano County, but they are not commonly of gem quality.

Occasional small gem-quality garnets have been found in pegmatites and contact metamorphic zones in Burnet County. Garnets have also been found in several other counties, notably Mason, El Paso, Hudspeth, and Culberson, but no stones of facet quality have been reported.

JET

Composition a variety of brown coal or lignite. *Structure:* woody. *Hardness:* 3 to 4. *Specific gravity:* about 1.30 to 1.35. *Luster:* dull. *Color:* black, brownish black. *Streak* brown to brownish black. *Cleavage:* none. *Fracture:* uneven to smooth. *Tenacity* tough to slightly brittle. *Diaphaneity* opaque. Burns with a sooty yellowish flame.

Jet is a type of fossil wood in which there has been sufficient chemical change to make the wood relatively hard and black without destroying the woody structure. The best specimens of jet polish into lustrous black cabochons.

Jet occurs in Presidio County as compressed and flattened trunks of trees in a thin layer of coal and lignite in Cretaceous strata 100 to 200 feet stratigraphically below the San Carlos beds.

Specimens of "jet" have been found in some of the lignitic Tertiary strata of the Texas Gulf Coastal Plain; however, this material is mostly soft, brownish, and not of gem quality.

LABRADORITE

Composition: $NaAlSi_3O_8$, 50% to 30%; $CaAl_2Si_2O_8$, 50% to 70%. *Crystal system:* triclinic. *Hardness:* 6.0 to 6.5. *Specific gravity:* about 2.60. *Luster:* vitreous to sometimes pearly. *Color* straw yellow, white, greenish, gray, reddish, bluish, and green. Sometimes shows a play of colors on particular cleavage surfaces. *Streak* uncolored. *Cleavage:* three directions. *Fracture:* uneven to conchoidal. *Tenacity:* brittle. *Diaphaneity:* transparent to translucent. *Refractive index:* about 1.56. *Dispersion:* low.

Very fine facet-quality labradorite has been found about 20 miles south of Alpine, Brewster County. The labradorite occurs loose in the soil as slightly weathered or frosted cleavage fragments, commonly showing one or more crystal faces (Pl. II, B). The pale-yellow or straw-yellow color of these fragments, as well as their lack of internal imperfections, makes these stones excellent gem material. Individual pieces that exceed three-fourths inch in their longest dimensions are rare. Cut stones of more than 5 or 6 carats from this locality are scarce. The source of this material is uncertain, but it is probably weathering out of an underlying igneous rock.

MICROCLINE

Composition $KAlSi_3O_8$. *Crystal system* triclinic. *Hardness* 6.0 to 6.5. *Specific gravity* 2.54 to 2.57. *Luster* vitreous to pearly. *Color* white, pale yellow, red, blue green, bluish. *Streak* white. *Cleavage* four directions, usually three of these distinct. *Fracture* uneven. *Tenacity* brittle *Diaphaneity:* transparent to translucent. *Refractive index:* about 1.52 to 1.53.

Very fine crystals of blue microcline have been found east of Packsaddle Mountain and near Kingsland in Llano County. Crystals exceeding 1 foot in length have been found, although most are only a few inches long. The color of the microcline is mostly pale blue, but some crystals are darker. Microcline crystals associated with milky or vein quartz, smoky quartz, some biotite, and rarely cassiterite occur in pegmatite dikes which vary in size from a few inches to several feet in thickness. The color of this microcline is pale in comparison to microcline from some other localities in the United States, but the Texas blue microcline does yield pleasing cabochons. Perfect crystals of this material are prized by collectors. Blue or greenish microcline is often called amazonite or amazon stone.

Bluish microcline associated with quartz and topaz has also been reported near Katemcy, Mason County.

Red microcline is common in several central Texas counties and is a primary constituent of many of the igneous rocks in those counties. Large crystals of perthitic red microcline occur in pegmatite dikes of Mason, Llano, Burnet, and Gillespie counties. Any feldspar quarry or other pegmatite mining operation in any of these counties is likely to contain large red microcline crystals and fragments. Unfortunately, the good crystals that may have been present are often shattered by blasting during quarrying operations.

Feldspar quarries in northeastern Gillespie County have yielded some good red cabochon material as well as good crystals. Here the microcline occurs with milky and smoky vein quartz, smoky quartz crystals, clear quartz crystals, greenish muscovite, and biotite. Many of the older quarries in Gillespie County have not been active for some time, and the dumps and quarry walls have been diligently searched by collectors.

Many of the pegmatite dikes near Lake Buchanan in Llano and Burnet counties have produced some good red microcline specimens and cutting material (Pl, III, A, and fig 16). Many of these crystals are

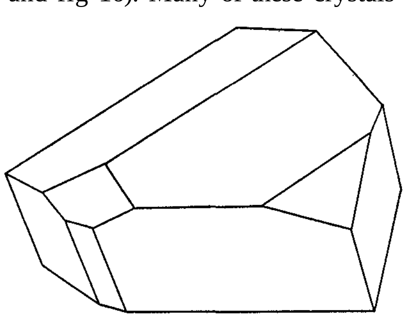

FIG. 16. Crystal faces on microcline specimen shown in Plate III, A.

more pinkish than those in Gillespie County, but this is commonly due to the fact that the crystal faces of the Lake Buchanan area crystals are somewhat more weathered than the fresh Gillespie County crystals.

Numerous other local areas in the counties mentioned, as well as some localities in Hudspeth and Culberson counties, have also produced small amounts of red and pink microcline of gem quality.

OBSIDIAN

Composition: volcanic glass. *Structure:* amorphous. *Hardness:* 5.0 to 5.5. *Specific gravity:* 2.3 to 2.5. *Luster:* vitreous. *Color:* black, dark gray, reddish, brown, bluish, and greenish. *Streak:* white. *Cleavage:* none. *Fracture:* conchoidal. *Tenacity:* brittle. *Diaphaneity:* translucent to nearly opaque. *Refractive index:* variable, about 1.45 to 1.53.

Gem-quality black and dark-gray obsidian has been found in Presidio County associated with extrusive igneous rocks. The obsidian in this area is too opaque to serve as attractive faceted stones but is found in pieces of sufficient size and quality to yield nice cabochons. Some of the small weathered pieces of this material resemble tektite in outward appearance; in fact, the "valverdites" mistaken originally for tektites are pebbles of weathered obsidian in terrace gravel of Val Verde County. Obsidian takes a high polish but is very sensitive to heat. Stones that are slightly overheated during grinding or sanding will quickly shatter.

Obsidian of gem quality has been reported also in Brewster County.

OPAL

Composition: $SiO_2 \cdot nH_2O$. *Structure:* amorphous. *Hardness:* 5.5 to 6.5. *Specific gravity:* 1.9 to 2.3. *Luster:* subvitreous to pearly. *Color:* white, bluish, pink, brown, yellow, and gray. *Streak:* white. *Cleavage:* none. *Fracture:* conchoidal. *Tenacity:* brittle. *Diaphaneity:* transparent to nearly opaque. *Refractive index:* 1.43.

Opal other than as fossil or opalized wood (pp. 20–21) occurs at the following several localities in Texas.

Approximately 16 miles south of Alpine, Brewster County, precious opal occurs in very small seams and as cavity fillings in very hard pinkish-brown rhyolite. This opal is milky or bluish and commonly exhibits small flashes of blue, green, red, and orange fire. Individual pieces of this opal are mostly quite small, rarely over one-fourth inch in diameter, and very difficult to remove from the tough rhyolite matrix. Local lapidaries have cut interesting cabochons from this material in which several small patches of opal that are close together in the matrix are included in the same cabochon.

Small finds 6f opal associated with rhyolites and basalts have come from other localities in west Texas, but the opal mostly does not display enough play of colors to warrant its use as gem material.

Near Freer, Duval County, some very attractive common opal has been found. The opal is colored various shades of pink, blue, and yellow and in certain local areas occurs as fragments that are cemented together by clear chalcedony. Various colors are commonly found in the same piece, and such material yields handsome cabochons. Although the area has never been worked commercially, it has been hunted by collectors and cutters for several years.

PEARL

Pearls are the result of the secretion of calcium carbonate by various shellfish around sand grains, parasitic organisms, shell fragments, or other foreign objects that have in some way entered the body cavity of the shellfish. Since the shellfish is unable to expel these irritating particles or organisms, it deposits successive layers of calcium carbonate around the foreign substance to make it smoother and less irritating. Although pearls are principally calcium carbonate, they also contain small amounts of an organic substance, called conchiolin, and water. Pearls are found in shellfish that live in either fresh or salt water. Few pearls are spherical in shape; most are rounded but somewhat irregular and are known as baroque pearls. Good quality pearls are the only gemstone commonly sold by the grain, a unit of weight equal to 0.25 carat or 0.05 gram. The pearl grain is not the same unit of weight as the Troy grain.

In Texas, pearls have been found in fresh-water clams in most of the major rivers and streams, notably in the Brazos, Concho, Colorado, Guadalupe, Llano, Nueces, Sabine, Rio Grande, and Trinity Rivers. Several Texas lakes have also yielded pearls, notably Caddo Lake and other lakes in north-central and northeast Texas.

Small pearls are frequently found along the Texas Gulf Coast in edible oysters and other common shellfish. Fossil pearls have also been found but because of their darkened appearance are of value only as curiosities.

The pearls thus far found in Texas have been of relatively poor quality and show little or no iridescence. These pearls have little value except as curiosities, although one writer has stated that the discovery of pearls in the Nueces River led to the original Spanish settlement of the State (Baker, 1935, p. 569).

QUARTZ

Composition: SiO_2. *Crystal system:* hexagonal. *Hardness:* 7. *Specific gravity:* 2.65 to 2.66 in crystals. *Luster:* vitreous, also waxy, greasy, and dull. *Color:* most often colorless, brown, yellow, violet; sometimes green, red, blue, and black; cryptocrystalline varieties often variously colored by impurities. *Streak:* white. *Cleavage:* indistinct. *Fracture:* conchoidal to splintery. *Tenacity:* brittle to tough. *Diaphaneity:* transparent to opaque. *Refractive index:* 1.544 to 1.553.

The quartz family gemstones can be divided into two groups for purposes of description. The first group is the crystalline varieties, or those quartz varieties that commonly occur in distinct crystals. The second group is the cryptocrystalline varieties, or those quartz varieties that occur as irregular masses that are composed of many microscopic crystals. The crystalline varieties are usually much more transparent and are most often seen as faceted stones. The cryptocrystalline varieties vary from subtransparent to opaque and are almost always cut as cabochrons.

CRYSTALLINE VARIETIES

Amethyst (violet to purple-colored quartz).—A northeastern Gillespie County locality known as Amethyst Hill has produced quite a number of fine light to medium violet amethyst crystals which occur in quartz veins and geodes associated with serpentine and talc. Many crystals have been found loose in the soil.

The amethyst tends to be very irregularly colored in zones parallel to the crystal faces. In many, the base of the crystal is colorless or white and only the termination is violet. Crystals up to 3 inches long have been found at this locality, but the average size is much less.

The surface at this locality is almost entirely depleted of amethyst, with only an occasional small crystal or fragment to be seen. However, small excavations are still sometimes productive.

Good groups of pale amethyst crystals have been found in quartz veins near the old town site of Oxford, Llano County. The occurrence seems to be much the same as the Amethyst Hill locality. Little exploration for gemstones has been done in this area, and future discoveries seem likely.

Chalcedony geodes lined with amethyst crystals have been found in Brewster, Presidio, Culberson, and Hudspeth counties, but the occurrences are scattered. The crystals are seldom large enough to yield gems of more than 3 carats and are mostly very light colored.

A few pieces of gem-quality amethyst have been found in Burnet County.

Citrine (yellow quartz).—Very little gem-quality citrine has been reported in Texas. Some small citrine crystals have been found at Amethyst Hill in northeastern Gillespie County, but few are of sufficient size or color to yield good gems.

The writer has seen one citrine crystal that was found in the gravels of a small stream in eastern Llano County near Buchanan Dam. The crystal weighs about 1 ounce and is perfectly clear, light golden yellow, and flawless. However, a further search of the stream gravels failed to produce any other citrines.

Rock crystal (colorless quartz).—Numerous localities in Texas produce this colorless variety of quartz, which is the most common variety of facet quality quartz and consequently is of little value.

Rock crystal occurs at many localities in Burnet, Llano, and Mason counties. The crystals mostly occur in pegmatite dikes or in stream gravels where they have been weathered out of their parent rock. Some fine colorless quartz crystals have been found near Voca, Mason County, in weathered pegmatite dikes and also loose in the sands of nearby streams. Crystals from this locality are often stained with reddish iron oxide on their outer surfaces. Some of the rock crystal found near Katemcy, Mason County, shows asterism when cut with the proper orientation. Fine clear colorless crystals up to 8 inches long have been found in the pegmatite dikes near Lake Buchanan in both Llano and Burnet counties. Several localities near Enchanted Rock in Llano County have also produced some good colorless crystals.

Feldspar quarries in large pegmatites in northeastern Gillespie County have yielded attractive quartz crystals, some of which contain smoky phantom crystals and tourmaline inclusions.

Some pieces of rock crystal enclosing green, needle-like actinolite crystals have been found near the Llano-Gillespie-Blanco County corner. This material is not suitable for faceted gems but does lend itself to interesting and attractive cabochons.

Colorless quartz crystals commonly are found lining small chalcedony geodes in Brewster, Presidio, Culberson, Hudspeth, Reeves, and Jeff Davis counties. These crystals are most commonly less than 1 inch long but are mostly very clear.

Rock crystal has been found in crevices of petrified wood in many east and southeast Texas counties, although the crystals are mostly quite small.

Many lesser occurrences of rock crystal, too numerous to mention, are located within the State.

Rose quartz (pink quartz).—Rose quartz occurs at various localities in Burnet, Llano, Mason, and Gillespie counties, but the amount of material is mostly small and the greater part unsuitable for gem purposes. Some good pink rose quartz occurs near Town Mountain, Llano County, but this material does not have flawless areas large enough to yield faceted stones of more than a few carats. Rose quartz is always slightly milky, or cloudy, and does not cut into brilliant faceted stones. The Town Mountain rose quartz has been cut into attractive cabochons.

Smoky quartz (brown, yellow-brown, and golden-brown quartz). — Several Texas localities have produced fine smoky quartz. Baringer Hill, a noted rare-earth minerals pegmatite locality in Llano County, contained some smoky quartz crystals that were estimated to weigh over 1,000 pounds, and the locality produced many smaller crystals that Were of gem quality. Baringer Hill was flooded by the completion of Buchanan Dam in 1938 and is presently under the waters of Lake Buchanan. A few fine golden-brown gem-quality crystals have been found along the lake shore and in small pegmatites nearby (Pl. III, B.).

Feldspar quarries in northeastern Gillespie County have produced smoky quartz crystals that exceed 1 foot in length, but these crystals are mostly flawed, possibly as a result of blasting, and mostly contain only small clear areas.

Good color smoky quartz crystals are found with topaz in the pegmatites and stream beds in Mason County, near Streeter, Grit, and Katemcy. These crystals tend to be lighter colored than those near Lake Buchanan, but they commonly contain large flawless areas.

CRYPTOCRYSTALLINE VARIETIES

Chalcedony.—When free from impurities of various oxides and other compounds, chalcedony has little to render it pleasing as a gemstone. It is mostly gray, white, brown, or bluish and commonly has a waxy luster. Some of the chalcedony found along the Rio Grande Valley and in west Texas will take dyes, and local lapidaries have had some success in dyeing this material various shades of blue, green, yellow, and red. When the chalcedony is naturally colored and variegated, usually in bands, mossy figures, or dendritic forms, it is called agate.

Agate (variegated chalcedony).—The wide variety of markings and colors available together with the ease of cutting make agate a favorite of many lapidaries. Fine agate has been found at numerous localities in west and south Texas. Fine plume agate, famous throughout the United States, is found south of Alpine. Plume agate is characterized by dendritic or treelike inclusions and is mostly cut into very handsome cabochons. The agate from south of Alpine commonly contains black, red, yellow, or brown plumes within the same piece. The variety of colors and lack of porosity of this agate make it highly desired among lapidaries. The agate occurs loose on the surface of the ground and in the soil in small nodules that have a very rough, brownish surface. These nodules are mostly less than 3 inches in diameter, although specimens of gem quality have been found that exceed 200 pounds.

Some very fine agate has been found in the vicinity of Needle Peak, Presidio County. This material is mostly green moss agate in clear chalcedony and commonly contains small yellow "sun-burst" figures. The contrasting yellow and green design makes very beautiful cabochons.

Fine agate has been found south of Marfa, Presidio County. This agate is mostly clear chalcedony with black, yellow, or variously colored plumes, moss, or "bouquet-like" figures.

Numerous other localities in Presidio and Brewster counties have produced good agate.

Various amounts of agate, jasper, and chalcedony occur in the gravels of the Rio Grande in varying quantities from Big Bend National Park downstream to Brownsville. This agate is found both in the present river gravels and in the older river gravels that now are located on nearby hills and slopes up to several miles north or south of the present Rio Grande. The greatest concentration of agate and related gem materials seems to be in the area between Laredo and Rio Grande City. Vast quantities of excellent gem material have been removed from this area for many years (Pl. IV). The agate occurs as rounded, stream-worn cobbles and commonly has a thin white coating that makes it difficult to distinguish from the abundant chert and other rocks. The agate occurs in cobbles that are mostly 3 to 6 inches in diameter, but specimens of gem quality that exceed twice this size are known. The agate varies greatly in design and color. Plume, moss, banded, and sagenitic agate occur in these gravels in a wide variety of colors. The jasper in the Rio Grande gravels is yellow, red, green, or various shades of these and is commonly suspended as angular fragments in clear chalcedony.

Good agate has also been found near Balmorhea in Reeves and Jeff Davis counties and in smaller amounts at numerous other west and south Texas localities.

Agatized wood (*see* Fossil wood, pp. 20–21).

Carnelian (translucent reddish chalcedony).—This variety of chalcedony in small quantities has been reported from near Van Horn, Hudspeth County. Small pieces of carnelian have been found in the gravels of the Rio Grande, but finds have been few and scattered.

Jasper (impure opaque or subtranslucent quartz).—Good green, yellow, red, and brown jasper has been found in the gravels of the Rio Grande at all of the localities that produce agate. The colors are quite vivid, and the material takes a fine polish. Some pieces of orbicular jasper (jasper with circular or eye-like markings) have been found in this material. These gravels commonly contain jasper as fragments that are suspended in clear chalcedony; this is called brecciated jasper and yields very handsome cabochons.

Many of the west Texas agate localities also produce jasper in quantity. Good jasper has been reported from north of Brackettville, Kinney County. Jasper is a minor constituent of the stream gravels in many parts of the State.

SANIDINE

Composition: $KAlSi_3O_8$; commonly contains some sodium. *Crystal system* monoclinic. *Hardness: 6. Specific gravity:* 2.57 to 2.58. *Luster:* vitreous to pearly. *Color* Colorless, white, pale yellow, and gray. *Streak:* uncolored. *Cleavage:* three directions. *Fracture* conchoidal to uneven. *Tenacity* brittle. *Diaphaneity* transparent to subtranslucent. *Refractive index* 1.52 to 1.53.

Some feldspars, including sanidine, show a nice blue sheen in reflected light parallel to certain crystallographic directions. Stones having this property are called moonstone. A clear yellowish sanidine showing an attractive blue sheen has been found in Brewster, Jeff Davis, and Presidio counties. The individual pieces are small, the average size being about one-eighth inch. The sanidine is found loose in the soil at some localities where it has weathered out of rhyolite, and specimens of the sanidine in the parent rock are not difficult to obtain. Very small cabochons can be cut from this material, but few lapidaries have done so because inexpensive larger pieces of moonstone can be obtained easily from foreign sources. However, the west Texas sanidine does show a blue sheen when cut and polished.

SPINEL

Composition: $MgAl_2O_4$ (magnesium may be replaced in part by ferrous iron or manganese and the aluminum by ferric iron and chromium). *Crystal system:* isometric. *Hardness:* 8, *Specific gravity:* 3.5 to 4.1. *Luster:* vitreous to sub-metallic. *Color* black, pink, red, blue, green, yellow, brown, and violet. *Streak:* white. *Cleavage:* one direction, imperfect. *Fracture* conchoidal. *Tenacity* brittle. *Diaphaneity* transparent to opaque. *Refractive index:* variable, approximately 1.72 to 2.00.

In many areas of the world, fine quality, beautifully colored, transparent spinels are found and used as gems. The only gem-quality spinel reported thus far in Texas is black and opaque. Near Eagle Flat in Hudspeth County, black spinel crystals have been found associated with augite and natural glass; these minerals are weathering out of an intrusive igneous rock. The spinel crystals have an octahedral form which is common for this mineral (fig. 17). Most of the spinels are free

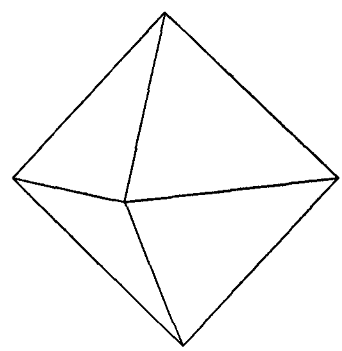

FIG. 17. Common crystal form of spinel.

of flaws, but because of their black color they have little value as gems. The crystals are found loose in the sand of streams near the outcrops of the igneous rock or embedded in the rock. They seldom exceed half an inch in diameter. These stones are primarily sought by collectors.

TEKTITE (BEDIASITE)

Composition: A natural glass, approximately 75% SiO_2, 15% Al_2O_3, 4% FeO, also MgO, Na_2O, K_2O, and traces of other elements. *Crystal structure* amorphous. *Hardness* 5 to 6. *Specific gravity:* 2.33 to 2.44. *Luster:* vitreous, often dull on weathered surfaces. *Color:* dark brown, greenish brown, appears black in thick sections. *Streak:* uncolored. *Cleavage:* none. *Fracture:* conchoidal. *Tenacity* brittle. *Diaphaneity* transparent to subtransparent. *Refractive index:* 1.488 to 1.512.

The average bediasite size is about 1 inch in diameter, although specimens approximately 3 inches in diameter are known. The uncut tektites are very interesting, showing a variety of shapes and surface features (Pl. V, A) and many exhibit contorted flow structure. The surface of many tektites is grooved or furrowed, while on others it is smooth or frosted. The Texas tektites are known as "bediasites," after place names in Grimes County traceable to the Bedias Indians who formerly lived there.

Dark brown and greenish-brown tektites have been found in Texas in gravels at scattered localities in Walker, Grimes, Brazos, Burleson, Lee, Fayette, Gonzales, Lavaca, and DeWitt counties. Outside of Texas the only other authenticated tektite localities in the United States at the present time are in Dodge and Irwin counties, Georgia. A fragment of a similar tektite has recently been reported from near Martha's Vineyard, Massachusetts. The tektites reported from Oklahoma are now known to be pebbles of obsidian.

Although tektites have little value or beauty as gemstones, they have been cut by lapidaries as both faceted and cabochon stones. Tektities take a high polish but are mostly so dark in color that they appear black.

The origin of tektites is of great scientific interest and is currently the subject of much debate. Some scientists believe that tektites are of meteoritic origin, while others believe that tektites were formed by various terrestrial processes. Since no one has actually observed a tektite to fall or form, and many of the theories of origin are difficult to prove without direct observation, the origin of tektites is likely to remain in controversy for some time.

TOPAZ

Composition: $A1_2(F, OH)_2SiO_4$. *Crystal system:* orthorhombic. *Hardness* 8. *Specific gravity* 3.4 to 3.6. *Luster:* vitreous. *Color:* pale blue, sky blue, greenish, white, wine yellow, straw yellow, grayish, pink, reddish, and orange. *Streak* uncolored. *Cleavage:* one direction, basal, highly perfect. *Fracture* conchoidal to uneven. *Tenacity* brittle. *Diaphaneity* transparent to subtranslucent. *Refractive index* about 1.60 to 1.63. *Dispersion* moderate.

Various yellow and smoky colored quartz gems are offered for sale as "Spanish Topaz," "Smoky Topaz," "Madeira Topaz," and "Topaz Quartz." These names are entirely misleading and should be dropped from usage.

Fine gem-quality white, pale-blue, and sky-blue topaz has been found near Streeter, Grit, and Katemcy, Mason County. This Texas gem material compares favorably in color, size, and clarity with topaz found anywhere in the United States. Fine crystals of topaz (Pl. V, B, and fig. 18) occasionally are found in pegmatite

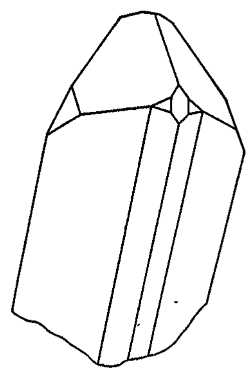

FIG. 18. Crystal faces on topaz crystal shown in Plate V, B. This crystal habit is typical of the topaz from Mason County.

dikes associated with quartz, black tourmaline, cassiterite, and pink microcline. Many of the gem-bearing pegmatites have been eroded away, leaving the topaz concentrated in the stream beds. The stones mostly occur as frosted, stream-worn, pebbles (Pl. VI, A) in the numerous small creeks in the area. The topaz is heavier than the quartz and microcline that compose the stream gravel and is commonly found immediately on top of the granite bed-rock in the bottom of the stream bed. The stones tend to lodge behind boulders Or small dikes cutting across the stream.

The white or colorless stones are by far the most common, outnumbering the bluish stones about ten to one. The color of the blue stones tends to be irregularly distributed in zones parallel to the crystal faces. Topaz that is colored in this manner should be cut with the best blue color near the bottom or culet of the gem (fig. 19). If done correctly, this will give the entire gemstone the desirable blue color.

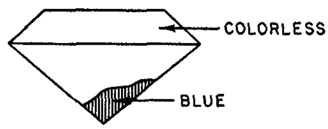

FIG. 19. Cross section showing the proper orientation of dark-color zone in a gem cut from an irregularly colored stone.

The colorless stones can be turned pale yellow, yellowish brown, or straw yellow by exposure to X-ray radiation, and some of the bluish stones will fluoresce faintly yellowish under ultra-violet light.

The largest gem-quality topaz crystal yet found in North America has come from Mason County. It is a pale-blue crystal weighing 1,296 grams, now in the collection of the U.S. National Museum. Several other large pieces, some weighing over a pound, have been found. One large crystal, exact weight unknown, was found near Katemcy. Several gem cutters have estimated that this stone could easily yield a single, flawless pale-blue gem of about 500 carats. Many large gems have been cut from topaz found in this area, including at least one stone of over 300 carats.

One obstacle in the cutting of topaz is its perfect basal cleavage. The gemstone should be oriented so that no facet of the stone will be parallel to or within less than about 5 degrees of the cleavage direction, or the facet may be very difficult or impossible to polish.

It is difficult to estimate the productivity of this area since its discovery in the early 1900's. Few systematic attempts have been made to exploit the deposits, and a great amount of the topaz thus far recovered has been found by private collectors. The Mason County topaz deposits are still very productive, and additional exploration may uncover even more gem-producing areas.

Topaz has also been found in stream gravels or pegmatites in Burnet, Llano, Gillespie, and El Paso counties but very rarely in gem quality.

TOURMALINE

Composition: $H_9Al_3(B{\cdot}OH)_2Si_4O_{19}$; hydrogen often replaced by iron, magnesium, calcium, or fluorine. *Crystal system:* hexagonal. *Hardness:* 7 to 7.5. *Specific gravity:* 2.98 to 3.20. *Luster:* vitreous to resinous. *Color* black, brownish black, brown, blue, green, red, pink, yellow, and gray. *Streak:* uncolored. *Cleavage:* two directions, very imperfect. *Fracture* subconchoidal to uneven. *Tenacity* brittle. *Diaphaneity* transparent to opaque. *Refractive index:* about 1.62 to 1.64.

Black tourmaline is called schorl; brown tourmaline, dravite.

Good crystals of black and dark brown tourmaline occur at Town Mountain near Llano, Llano County. The tourmaline crystals average about 1 inch in length, do not commonly exceed 2 inches, and are associated with white vein quartz. The quartz completely encloses the tourmaline, but the crystals can be broken free or the quartz can be trimmed away with the use of a diamond saw. The latter procedure is recommended whenever possible, for it is very easy to shatter the tourmaline crystals while trying to remove them from the quartz by other means. Many of the crystals are completely unsuitable for cutting, being too brittle or too badly cracked and flawed. However, some small crystals have been found that are of sufficient quality and size to yield flawless stones of a few carats. Few of these stones have been cut since the tourmaline is so dark that it appears opaque, and few persons find a gem of this nature attractive.

Good black and dark brown crystals of tourmaline associated with andalusite and graphite occur in the Packsaddle schist (Precambrian) near Sunrise Beach, Llano County (Pl. VI, B, and fig. 20). Although generally smaller in diameter than the crystals found at Town Mountain, they commonly exceed 3 inches in length, although the average size is a little over 1 inch. Many of these crystals are suitable

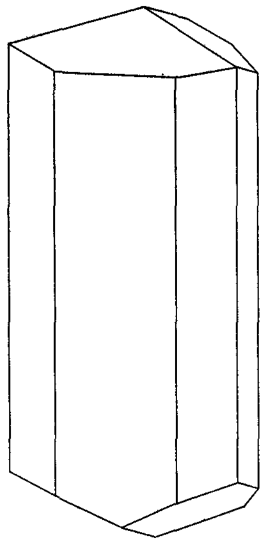

FIG. 20. Common crystal form of Llano County tourmaline.

for cutting into opaque or nearly opaque stones of about 5 or 6 carats.

Black tourmaline has also been found in Hudspeth and Culberson counties but not of sufficient quality to be used as a gemstone.

TURQUOISE

Composition: hydrous phosphate of aluminum and copper. *Crystal system:* triclinic. *Hardness:* 5 to 6. *Specific gravity:* variable, 2.6 to about 2.8. *Luster:* dull, sometimes waxy. *Color:* sky blue to greenish blue. *Streak:* white to greenish. *Cleavage:* none in massive material, two directions in crystals. *Fracture:* conchoidal to subconchoidal. *Tenacity:* brittle. *Diaphaneity:* subtranslucent to opaque. *Refractive index:* 1.61 to 1.65.

Turquoise of good sky-blue to greenish-blue color has been found a few miles southwest of Van Horn, Culberson County. Several shallow pits were dug at this locality about 1910; however, the amount of turquoise produced was small. The main occurrence of the turquoise was in seams about 1 millimeter thick along joints in the fine-grained rocks of this area. Persons who have visited Culberson County more recently report that even minute traces of the turquoise are now difficult to find at the old prospect pits. However, further prospecting in the area might yield some additional localities.

Small amounts of turquoise have been reported near El Paso, El Paso County, and also in volcanic rocks near the Jeff Davis-Brewster County line, north of Alpine.

A small amount of turquoise has been mined from several localities a few miles northwest of Sierra Blanca in the Sierra Blanca Mountains of Hudspeth County.

GLOSSARY

Amorphous—without definite molecular structure; not crystalline.
Baroque stone—an irregularly shaped, polished stone; usually applied to tumbled stones.
Baroque pearl—an irregularly shaped pearl.
Brilliancy—reflecting much light; having brightness.
Brilliant cut—a mode of arrangement of facets commonly used on round or oval stones. The standard American brilliant cut has 57 or 58 facets. Most diamonds of 5 or less carats are cut in this manner.
Cabochon—a stone cut with a flat or convex upper surface: sometimes faceted in part. Opal, star sapphire, and agate are stones that are frequently cut in this style (fig. 2).
Cambrian—a division of geologic time, estimated to be the time from 550 to 440 million years ago; the oldest time division of the Paleozoic era.
Carat—a unit of weight equal to 1/5 of a gram or 0.2 gram. One ounce avoirdupois is equal to 141.75 carats.
Cleavage—the tendency of certain minerals to split in particular directions yielding relatively smooth plane surfaces.
Conchiolin—an organic albuminoid substance found in pearls.
Conchoidal—a type of fracture having curved concavities or the approximate shape of one-half of a bivalve shell. Glass has excellent conchoidal fracture.
Cretaceous—a division of geologic time, estimated to be the time from 135 to 60 million years ago; youngest division of the Mesozoic era.
Crown—that portion of a faceted gem above the girdle; the upper portion of a facet-cut gem (fig. 7).
Cryptocrystalline—composed of very fine or microscopic crystals.
Crystal—the regular polyhedral form, bounded by plane surfaces, that is assumed by a mineral under suitable conditions. Crystals have definite external symmetry and internal molecular order.
Crystalline—possessing definite internal molecular order; not amorphous.
Cubic—in the general shape of a cube. The isometric crystal system is often called the cubic system.
Culet—the very bottom portion of a faceted gem; the point or line formed by the intersection of the lowest pavilion facets (fig. 7).
Dendritic—branching or tree-like in form.
Diaphaneity—relative transparency. The diaphaneity of a mineral is described as transparent, translucent, opaque, etc.
Dike—a tabular rock body, usually igneous in origin, which cuts across the surrounding rock strata.
Dispersion—a measure of the ability of gemstones to separate complex or white light into its component colors; often illustrated with a prism. Gemstones that are capable of separating colors of light widely are said to have high dispersion; gemstones not so capable of separating white light into colors are said to have low dispersion.
Dopping—the act of cementing a gemstone, either rough or partly finished, to a dop-stick.
Dop-stick—the wooden stick or cylindrical piece of metal to which a gemstone is cemented to facilitate handling during cutting and polishing.
Dop-wax—the agent or cement used to secure a gemstone to a dop-stick.
Emerald cut—a rectangular or square faceted stone with beveled corners whose surfaces are covered with several series of rectangular facets.
Eocene—a division of geologic time, estimated to be the time from 50 to 40 million years ago; one of the older divisions of the Cenozoic era.
Extrusive rock—igneous rock that has been extruded or forced out onto the earth's surface.
Facet—a single plane polished surface on a faceted gem.
Facet head—a device used in the cutting and polishing of faceted gems; used to control the placement of facets and their relative angles (fig. 6).
Facet table—the equipment used in the cutting and polishing of faceted gems and the table on which most of the equipment is mounted (fig. 6).
Feldspar—a group of closely related silicate minerals including orthoclase, microcline, sanidine, plagioclase, labradorite, and others.
Fire—the reflections of variously colored light from a precious opal; also the different colors of light reflected from a faceted gem owing to the dispersion of the mineral.
Fracture—the texture of a freshly broken surface other than a cleavage surface, described as conchoidal, even, splintery, etc.
Gem—a cut and polished gemstone.
Gemology—the science dealing with the study of gemstones.
Gemstone—a mineral suitable for cutting into a gem; the term gemstones is frequently used collectively to include both cut and polished stones and rough stones.
Geode—a rounded or spherical rock cavity; commonly lined with crystals.
Girdle—the portion of a faceted gem separating the crown from the pavilion; the girdle may or may not be polished and usually contains about 2 percent of the total depth of the gem (fig. 7).
Gneiss—a coarse-grained metamorphic rock having segregations of gmmilar and platy minerals that give it a more or less banded appearance without well-developed schistosity.
Grain (pearl grain)—a unit of weight equal to 0.05 gram or 0.25 carat; not the same as the Troy grain.

Granite—a granular igneous rock composed mostly of quartz, feldspar, and commonly mica and/or hornblende.

Hexagonal—having six angles and six sides; a crystal system in which the crystal faces are referred to four intersecting axes; three of these axes are equal, lie in the same plane, and intersect at angles of 60 degrees; the fourth axis is perpendicular to the other three.

Igneous rock—rock formed by solidification from a hot melt.

Index of refraction—a measure of the relative ability of a gemstone to "bend" incident light rays; sine of the angle of incidence of a light ray divided by the sine of the angle of refraction.

Intrusive rock—rock that has been pushed (usually in a molten state) among pre-existing rock strata, commonly along faults or fissures. Intrusive rocks do not reach the earth's surface but are commonly exposed at the surface by later erosion.

Isometric—a crystal system in which the crystal faces are referred to three equal intersecting axes at right angles to each other.

Lap—a disc-shaped piece of metal or other material which is impregnated with diamond dust, or some other cutting or polishing agent, that is revolved while the gemstone is worked against it.

Lap plate—a metal plate to which a cutting or polishing lap is attached, usually by means of a threaded bolt and wing nut. The lap plate is attached to the shaft which is turned by the motor under the facet table.

Lapidary—one who practices the lapidary arts; a gem cutter.

Limestone—a sedimentary rock composed mostly of calcium carbonate.

Luster—the appearance of the freshly broken or unweathered surface of a mineral in reflected light (p. 5).

Main facet—as applied to the standard American brilliant cut, one of the first eight facets cut on either the crown or pavilion of a gem (fig. 7).

Matrix—the material in which a specific mineral is embedded; also the rock to which one end of a crystal is attached.

Metamorphic rock—rock that has been changed from its original state by heat, pressure, chemical action, or some combination of these factors,

Millimeter—1/10 centimeter; approximately 1/25 inch.

Mineralogy—the science concerned with the study of minerals, including their occurrence, composition, forms, properties, and structure.

Monoclinic—a crystal system in which the crystal faces are described in relation to three intersecting unequal axes, two of which are at right angles and the third inclined.

Oligocene—a division of geologic time, estimated to be the time from 40 to 28 million years ago; part of the Cenozoic era.

Opaque—does not transmit light.

Orbicular—containing orbs or spherical or eye-like markings or structures.

Orthorhombic—a crystal system in which crystal faces are referred to three unequal intersecting axes at right angles.

Pavilion—the portion of a faceted gem below the girdle (fig. 7).

Pegmatite—a body of coarse-grained intrusive igneous rock, commonly lens or dike shaped.

Perthitic—a plaid-patterned structure resulting from intermixture of soda- and potash-rich feldspars.

Phantom crystal—a crystal outline seen within another crystal, mostly due to entrapping of inclusions during the crystal's growth.

Pleochroism—the property of transmitting different colors of light in different crystallographic directions.

Point—a unit of weight equal to 1/100 (0.01) carat.

Porous—containing pores or void spaces.

Precambrian—a division of geologic time, estimated to be all of geologic time prior to 550 million years ago; the time before the Paleozoic era.

Preform—a gemstone that has been ground to a rough outline of the finished shape of a gem.

Rhyolite—a fine-grained extrusive or shallow intrusive igneous rock of approximately the same composition as granite.

Rough—uncut, not worked by a lapidary, not cut and polished.

Schist—a metamorphic rock that contains an abundance of oriented platy minerals that enable the rock to be split with relative ease parallel to the flat surfaces of the platy minerals.

Silicified—replaced by or containing a large amount of quartz or silica.

Skill facet—a term often used for the pavilion girdle facets of the standard American brilliant cut (fig. 7).

Specific gravity—the weight in air divided by the loss of weight in water at a given temperature, or the weight of an object in air divided by the weight of an equal volume of water; also called relative density; the most commonly used standard temperature for this measurement is 4° C. or 39.2° **F.**

Star facet—one of the eight facets surrounding the table facet of a standard American brilliant cut (fig. 7).

Step cut—a mode of faceting in which the surface of the gem is covered by a series of square or rectangular facets; stones thusly cut are usually square, rectangular, or irregular with straight sides in outline.

Streak—the color of a mineral when finely powdered; usually determined by rubbing the mineral against a piece of unglazed porcelain.

Symmetry—the number, location, and balanced arrangement of crystal faces in reference to the crystallographic axes or other crystallographic planes or directions.

Synthetic gem—a gemstone manufactured by man that has *approximately* the same chemical composition and properties as a natural gemstone.

Table facet—the large horizontal facet found on the crown of many gems, often called simply the table (fig. 7).

Tenacity—the resistance of minerals to breakage, described by such terms as malleable, ductile, sectile, and brittle (p. 6).

Termination—the end of a crystal that is completely enclosed by crystal faces, the crystal end that is not attached to the matrix.

Tertiary—a division of geologic time, estimated to be the time from 60 to 1 million years ago; the Tertiary includes the Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs (from oldest to youngest).

Tetragonal—having four angles; a crystal system in which the crystal faces are referred to three axes at right angles to each other, two of which are equal and the third longer or shorter.

Translucent—allowing the passage of light but diffusing it sufficiently so that objects on the other side cannot be clearly distinguished.

Transparent—clear, allowing free passage of light so that objects on the other side can be readily distinguished; opposite of opaque.

Triclinic—a crystal system in which the crystal faces are referred to three unequal axes, none of which are at right angles.

Tumbling—a process of polishing irregularly shaped gemstones (p. 17).

Vein—a tabular, irregular, or twisting mineral deposit that is thin in relation to its length and breadth, usually the result of solution or hydrothermal activity.

Vitreous—having luster, general appearance, or physical properties similar to glass.

Vug—an unfilled rock cavity, commonly lined with crystals; may later become filled by minerals owing to solution or hydrothermal activity.

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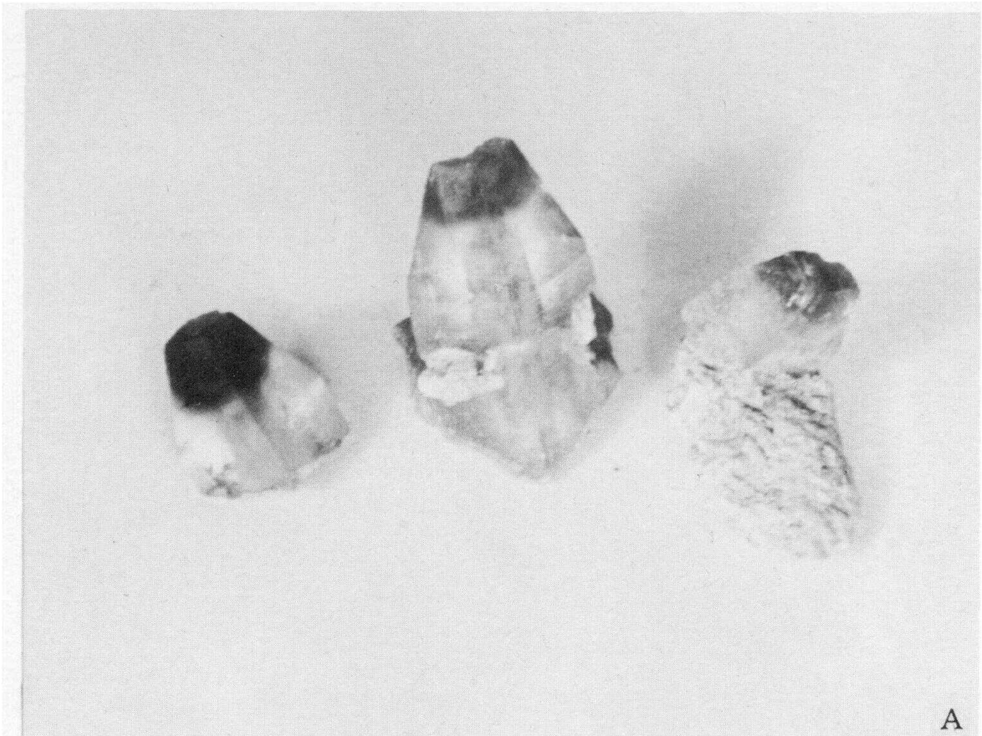
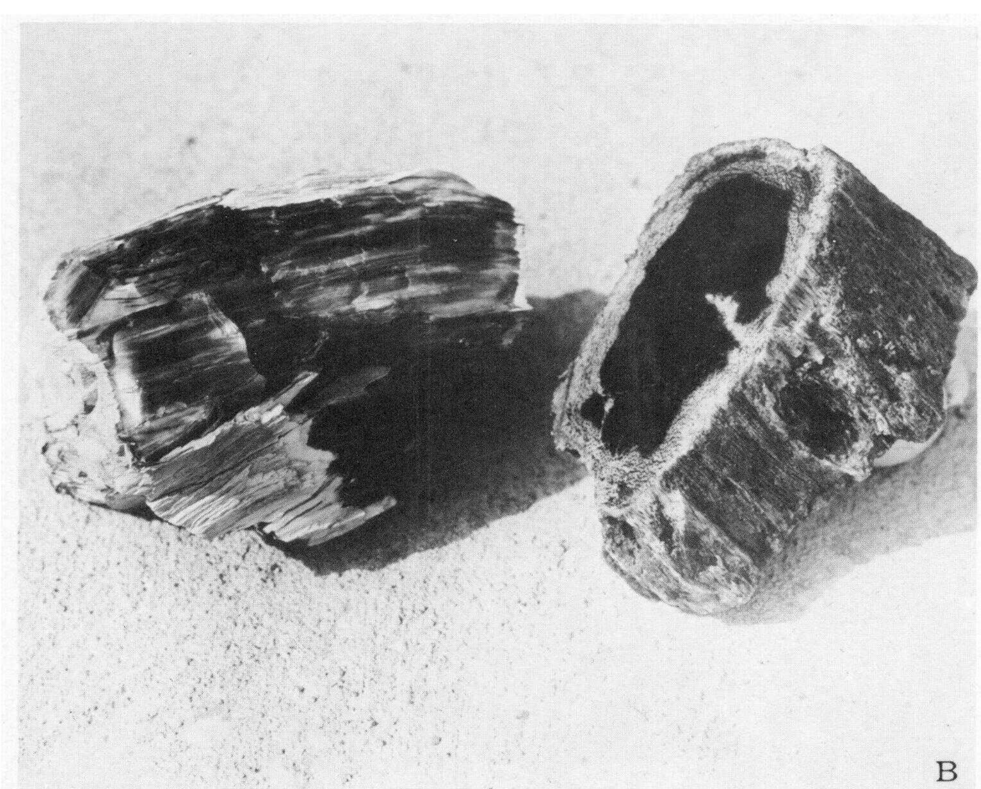
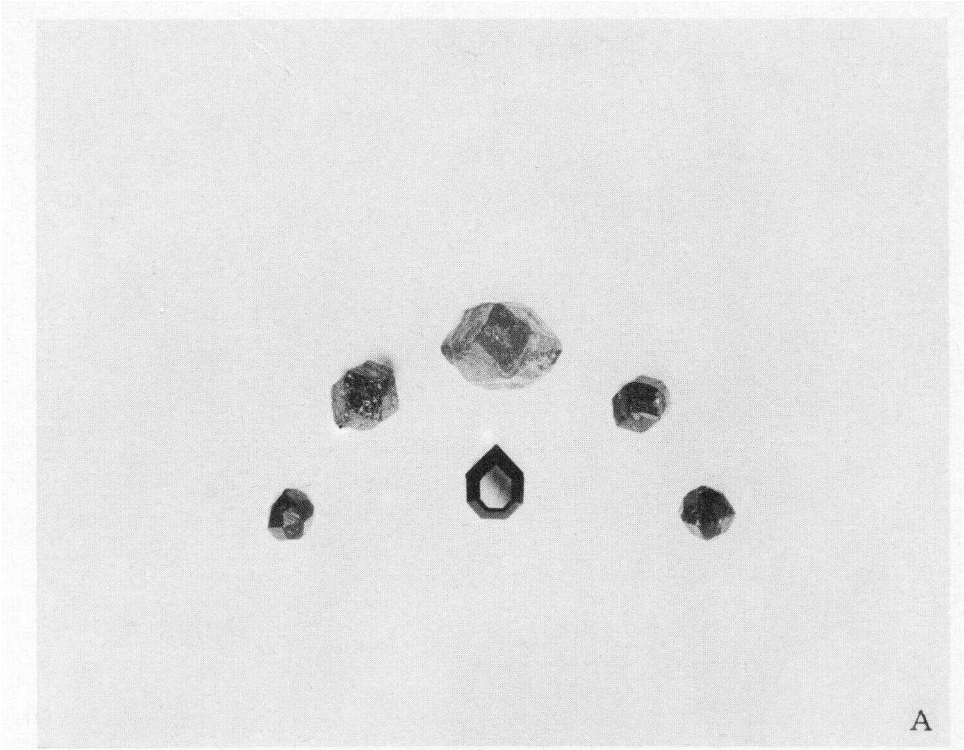


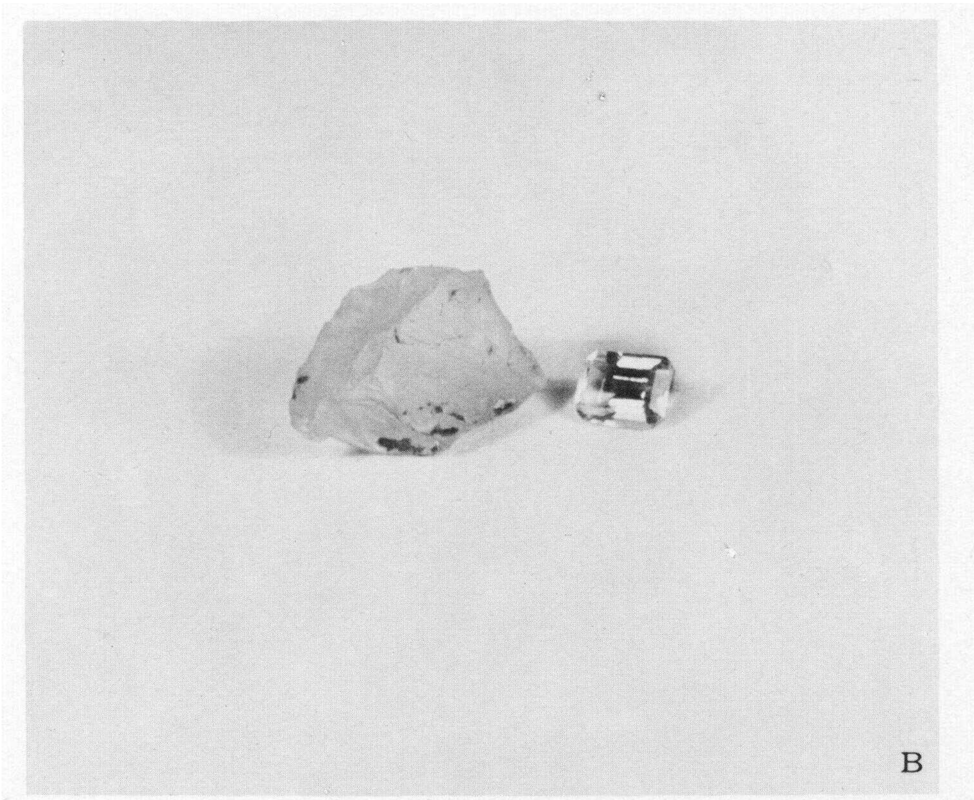
Gem-quality celestite crystals from Travis County, Texas. Twice natural size. Lower portion of the crystals is colorless; the tips are dark blue.



Opalized wood from the Texas Gulf Coastal Plain. Specimen at left is rich brown and tan; specimen at right is fossil palm wood and is black, reddish brown, and white. One-third natural size.



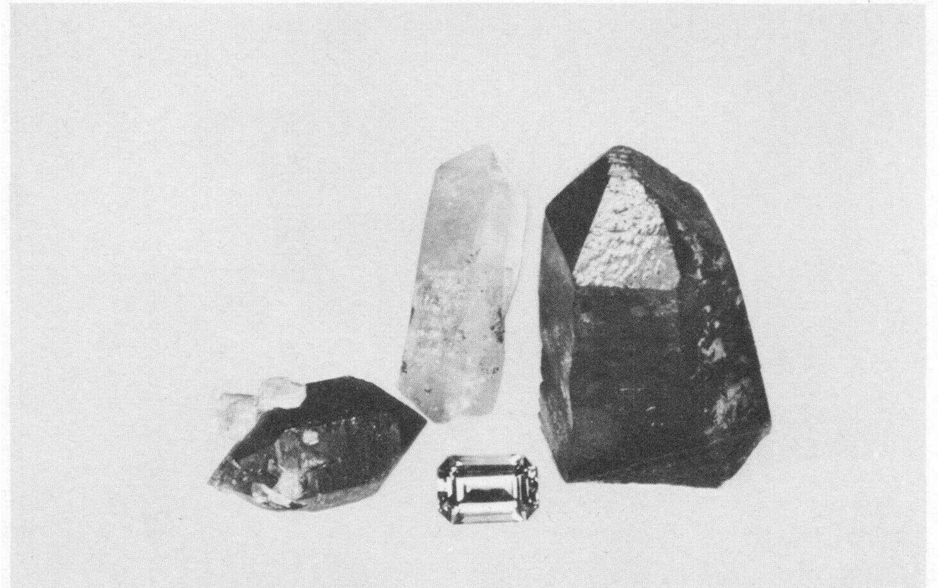
Gem-quality garnet crystals and faceted gem from Gillespie County, Texas. Natural size.



Labradorite from Brewster County, Texas. Both stones are pale yellow. One and a half times natural size.

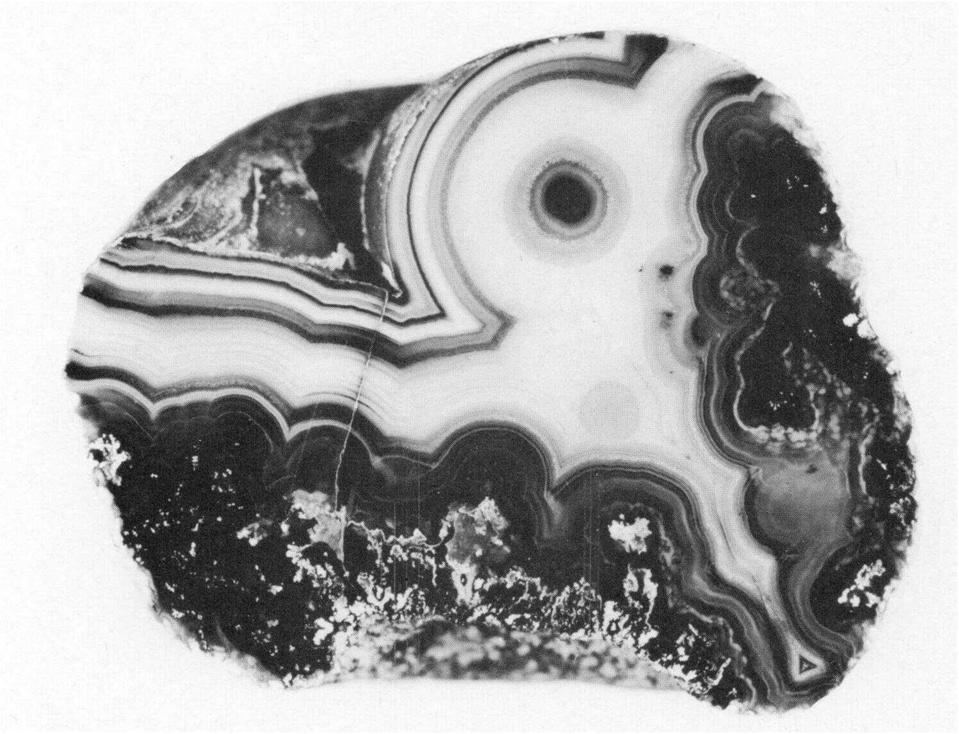
A

Pink microcline crystal from Burnet County, Texas.

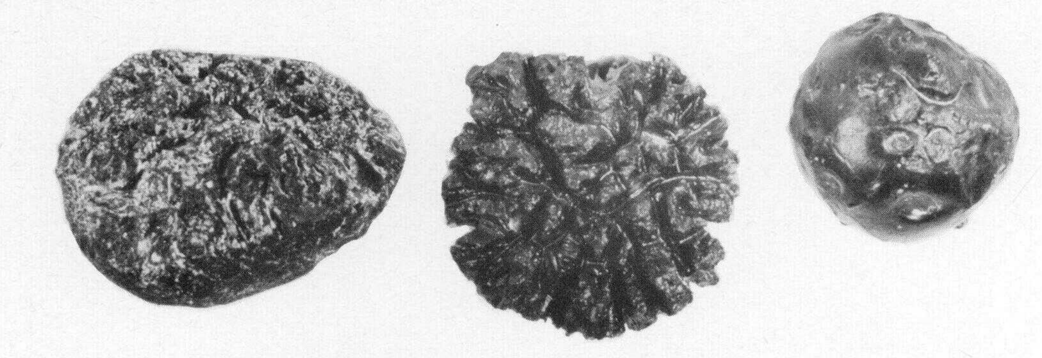


B

Smoky quartz from Burnet County, Texas. Natural size. Colorless crystal at center back is included for color comparison.



Polished agate from gravels of the Rio Grande near Zapata, Zapata County, Texas. Bands are blue and gray; other inclusions are brown, yellow, and reddish. One and a half times natural size.

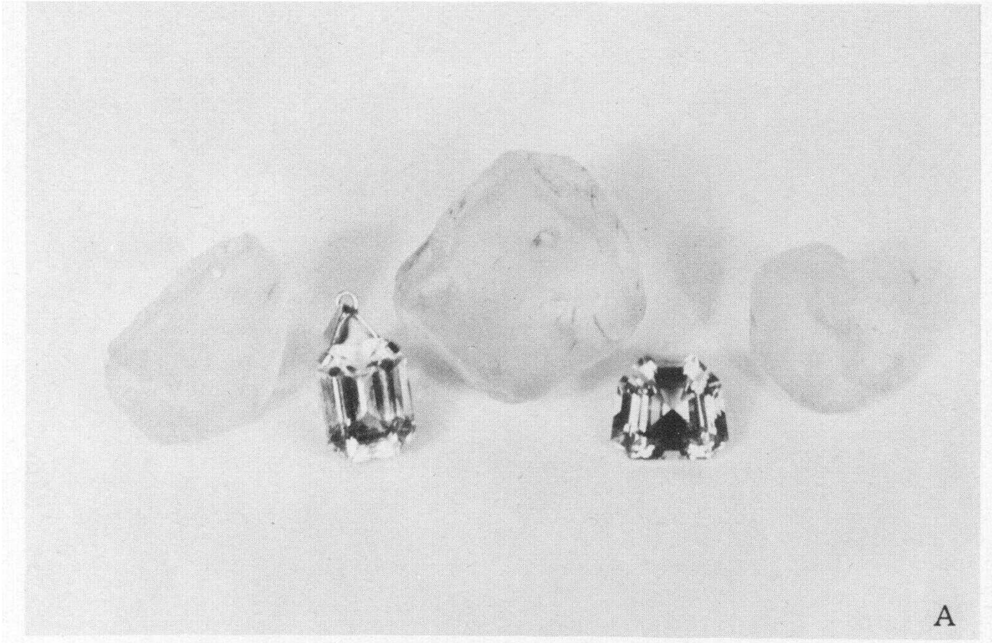


A

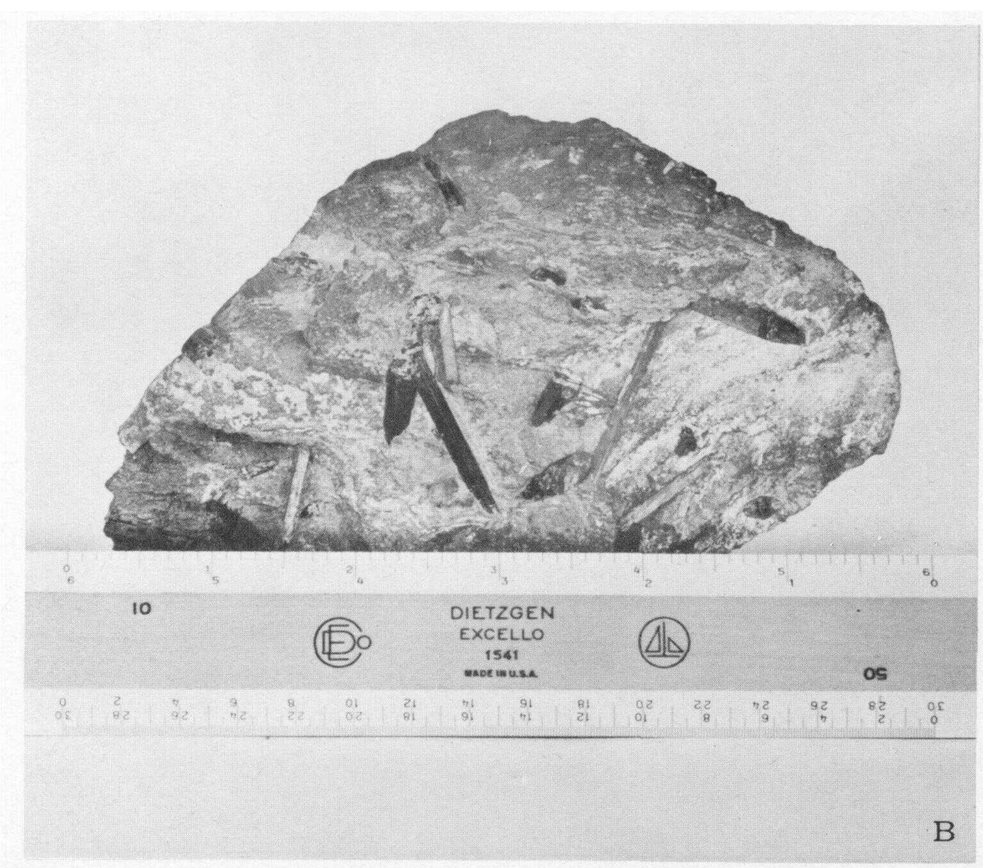
Texas tektites (bediasites) showing variety of surface features. Natural size.

B

Topaz crystal from a pegmatite dike near Streeter, Mason County, Texas. Natural size. Measurements: 1-1/2 by 1-5/8 by 3 inches; weight: 194 grams (970 carats) ; pale blue; mostly gem quality.



Topaz from stream gravels near Streeter, Mason County, Texas. Natural size. Left to right: colorless worn pebble; emerald-cut pale-blue topaz, weight 10 carats; pale-blue worn pebble, weight 205 carats; step cut sky-blue topaz, weight 13 carats; pale-blue worn pebble.



Tourmaline crystals in schist from Llano County, Texas.

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