AMETHYST DEPOSITS OF ONTARIO

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Amethyst Deposits of Ontario

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Please do not smoke or light fires in the bush because of the hazard of forest fire.

Cover: *Amethyst occurs in brecciated granitic rocks at the Thunder Bay Amethyst Mine. Young visitor selects a sample from the mine stockpile. (Courtesy Ont. Min. Industry and Tourism).*

Photo 1. *Crystal clusters require tender care in the extraction process. This cluster shows dark purple crystals of 2 to 3 inch (5 to 7.5 cm) diameter at the base. (Photo I. Kay).*

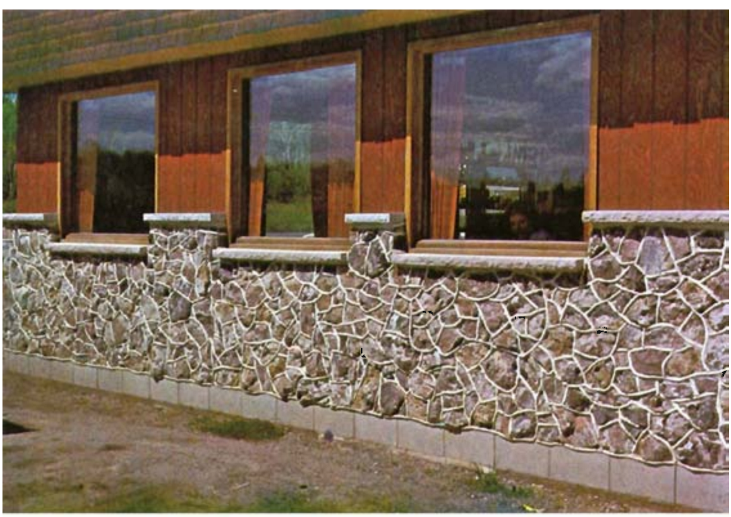

Photo 2. *Decorative and durable wall facing is a popular use of amethystine rock as shown in this picture of a highway restaurant at Sibley.*

AMETHYST DEPOSITS OF ONTARIO

by M.A.Vos

Geological Guidebook No. 5

ONTARIO DIVISION OF MINES
MINISTRY OF NATURAL RESOURCES

INTRODUCTION

The purpose of this guidebook is to give an account of amethyst, describing its properties, lore, uses as a gemstone, and decorative material for those who wish to learn more about Ontario's official mineral.

Purple has been considered a royal colour for centuries. The ancient Greeks and Romans used a purple dye to colour cloth for garments. The colour was obtained from large numbers of small marine snails and only persons of imperial or royal rank could afford to wear the purple coloured robes. Ontario has recently[1] chosen amethyst, the purple variety of quartz, to be the official mineral for this province. It is particularly fitting that a mineral has been designated as part of the symbolism of Ontario, for this province has had a long association with minerals. The search for mineral wealth resulted in the establishment of many settlements in northern Ontario and the development of the arterial transportation system which serves them. Also many of Ontario's towns were founded or have been largely supported by the mining of minerals. This province has had a long acquaintance with quartz and its many varieties. The presence of these varieties is expressed in a large number of place names across Ontario, from the utilitarian aspect of quartz remembered in "Grindstone Island" and "Grindstone Point" to the aesthetic appreciation of the clear crystal referred to in names like Amethyst Bay in Thunder Bay or Quartz Lake in Maria Township in Renfrew County.

Many coloured varieties of quartz or silica also appear as Ontario place names: agate is used eleven times; amethyst is used five times; flint is used nine times; jasper is used six times; and opal is used once.

Amethyst, a variety of quartz, brings to the transparency and glassy lustre of quartz the added attraction of colour in shades of purple and violet. Through the ages, the beauty of these colours has made amethyst an item cherished by mineral collectors and jewellers. Amethyst, though not as hard as some precious gems, lends itself well to cutting and polishing for ornamental purposes. Amethyst adorns the attire of many a devotee. In natural form, crystal clusters of amethyst highlight mineral collections the world over. The author hopes that

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[1] The Honourable Leo Bernier announced in the Ontario Legislature on May 14, 1975 that amethyst would be Ontario's official mineral.

users of the guidebook will enjoy visiting the mineral locations as much as he did. Although every attempt was made to stop at known deposits, it was not possible to visit them all.

ACKNOWLEDGMENTS

The author acknowledges the generous help received from many quarters in the preparation of this guidebook. The help and hospitality of mining men and government geologists in Thunder Bay and the assistance and support received from jewellers and the Royal Ontario Museum in Toronto is gratefully acknowledged. Wherever possible, the names of individuals who gave freely of their time and expertise are given in the text.

Special thanks are due Miss Tanya Abolins, who contributed much to this guidebook in the form of research and text, and to Mr. Ralph Bulloch, who proved to be an able assistant and congenial companion in the field. Valuable help in editing was provided by Mr. E.B. Freeman of the Ontario Division of Mines.

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Amethyst and its Properties

Amethyst is a variety of one of the most common rock forming minerals, the transparent and glassy mineral quartz. In mineral collections, amethyst competes for beauty and attractiveness with other varieties of quartz[1], like agate, chalcedony, jasper, and onyx, or with clear and well formed crystals of quartz. Transparent quartz crystals are simply referred to as "Bergkristall" (mountain-crystal) by German collectors, and striking examples are traded internationally. Use of the word "crystal" meaning "ice" originated from the belief held by ancient philosophers that this form of quartz was water congealed at the extremely low temperatures which existed at high altitudes.

Macrocrystalline quartz, which includes amethyst, citrine, rose quartz, and rock crystal, forms large distinctive crystals or crystal grains. The "habit" of amethyst is interesting; amethyst prefers to form in groups of crystals which have about the same size, and show nothing but points or pyramidal tops on the surface. These groups are referred to as crystal aggregates or clusters.

Cryptocrystalline quartz is widespread and abundant, forming masses composed of a multitude of very minute crystals, too small to be seen clearly even under moderate magnification. Examples are; chalcedony, bloodstone, carnelian, chrysoprase, agate, jasper, flint, and onyx. These latter varieties of quartz are much used for cutting into inexpensive gemstones for brooches, tie clips, ashtrays, bookends, and other art objects.

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[1] It is suggested that the reader check the glossary near the back of this guide book for explanation of unfamiliar terms.

Photo 3. *These book-ends were made by A. Castagne of Thunder Bay. A high gloss as on these samples requires up to 6 weeks of polishing on the lapidary wheel. (Photo T. Abolins).*

Photo 4. *Castagne's Rock Shop on Highway 17, eighteen miles (29 km) east of Thunder Bay. A list of mineral dealers serving tourists in the Thunder Bay area is appended at the back of this Guide Book.*

Photo 5. *Crystal aggregates on display at Gagnon Falls quarry on Noyes' property.*

Amorphous quartz or hydrous silica occurs rarely, solidifying from a colloidal gel that has no apparent crystalline structure. The only known variety is opal, and even opal frequently shows slight evidence of crystallinity under extreme magnification. Opal is rarer, and more expensive to obtain than the forms of cryptocrystalline quartz already listed.

The basic properties of amethyst are as follows:

Colour: purple
Hardness[1]: 7
Specific gravity: 2.7
Index of refraction: low
Refraction: double
Cleavage: none
Fracture: uneven and/or conchoidal
Solubility: insoluble in all acids except hydrofluoric acid

These properties will be further discussed in the following section.

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[1] Hardness is measured by the Mohs scale and 10 minerals have been chosen as representatives of this standard scale. The mineral with the lowest number is talc (1), and the mineral with the highest number is diamond (10); diamond is the hardest natural mineral. Mohs scale of hardness indicates that any mineral listed can scratch all those of a lower number and can in turn be scratched by all the minerals listed higher in the scale.

Crystal Structure

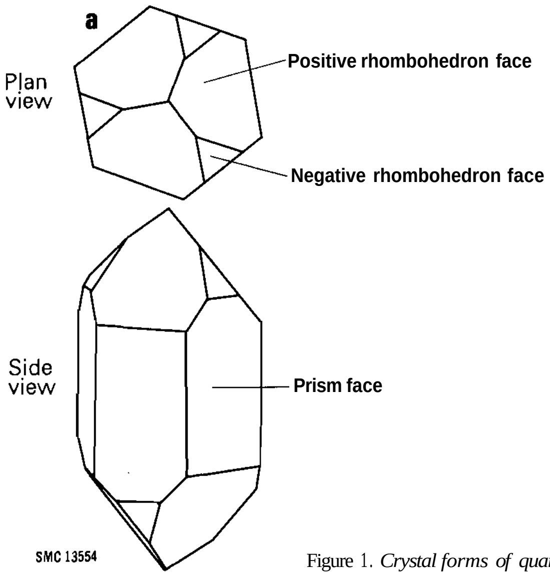
Few minerals exist as a chemical element (i.e., composed of just one kind of atom). Those minerals that do are referred to as native elements and include: gold, silver, diamond, copper and graphite. The vast majority of minerals occur as compounds of more than one kind of atom. Quartz is one example among hundreds of minerals.

The composition of quartz is SiO_2 or silicon dioxide; it is made up of two oxygen atoms to every silicon atom. Quartz crystals show their characteristic form because of the order in which the atoms of oxygen and silicon are arranged. It is this definite internal orderly arrangement of the atoms that controls the plane surfaces of a crystal and its optical characteristics.

However, the arrangement of silicon and oxygen atoms in quartz allows for the free development of additional crystal faces besides those illustrated in Figure la. These additional faces may be steeper negative rhombohedra occurring on the crystal and are seen in one of the forms shown in Figure 1b. The fact that amethyst tends to grow in a crowded fashion, or aggregate of individuals also encourages unequally sized crystal faces. Occasionally, the faces of one rhombohedron are so large that they replace the other rhombohedra and prism faces.

The atoms of silica and oxygen in quartz bond together during crystallization so that every silicon atom is surrounded by four oxygen atoms to form fundamental units called SiO_4 tetrahedra. One SiO_4 tetrahedron is shown in Figure 2, and tetrahedra like this one form the building blocks of the quartz structure. A three-dimensional framework is formed when each tetrahedron is linked by all four corners. This gives twice as many oxygen atoms as silicon atoms and the chemical representation of quartz is SiO_2. The atomic fit is neat and precise; the atoms are locked strongly together by means of ionic bonds; the SiO_4 tetrahedra form a pattern consisting of a series of linked spirals parallel to the prism faces of the crystal. The linked SiO_4 tetrahedra may spiral either to the left or right as illustrated in Figure 3.

The different three-dimensional patterns of atoms possible in crystals develop from seven shapes of unit cell, which give rise to the seven crystal systems. The seven symmetry systems



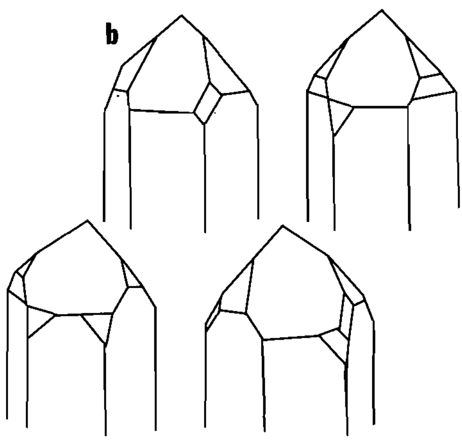


Figure 1. *Crystal forms of quartz showing how complex forms are related to the typical six-sided prism capped by a double rhombohedron: a, Basic form; b, Additional faces*

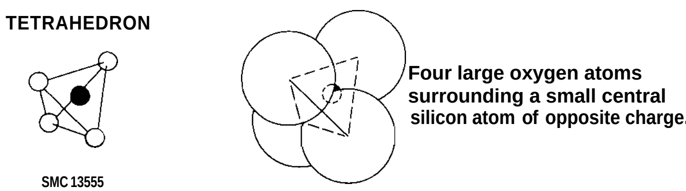


Figure 2. *Model of a SiO_4 tetrahedron, building block of the quartz structure. (After Sinkankas 1964, p.29).*

Photo 6. *Detached from a cluster, amethyst crystals show the typical plane faces of the pyramidal tops. (Photo J. Kay).*

are divided further into thirty-two classes and cover all possible manifestations of the internal structure of crystals. Each system and class has a characteristic set of symmetry elements; these elements consist of planes, axes and centres of symmetry.

When amethyst grows without interference, the regular atomic arrangement forms a beautiful, evenly proportioned crystal of the Trigonal System. The Trigonal System has the same crystal axes as the Hexagonal System, but has a lower symmetry. The six fold symmetry of the "C" axis is reduced to three fold symmetry in the Trigonal or Rhombohedral System. A typical result of the lower symmetry is the uneven development about the three fold (triad) axis of the six faces tapering to a point at the termination of the prism in Figure 1a. In the Trigonal System, such faces belong to two separate rhombohedra, each with its own capacity for growth at the time of crystallization. Uneven development of faces in crystals is common however. Determination of symmetry requires knowledge of the angles between faces. The angle between faces of a crystal form is always constant, even when the faces develop unevenly.

The internal structure of the amethyst crystal as mentioned earlier consists of spirals of SiO_4 tetrahedra. The pattern of the SiO_4 tetrahedra can be compared to the treads of a spiral staircase; each crystal is composed of multitudes of staircases,

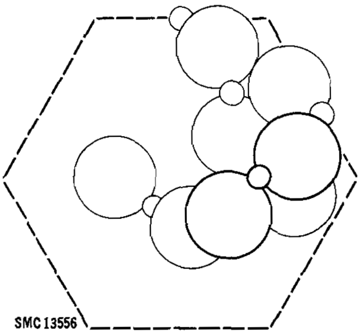


Figure 3. *Spiral structure in quartz, determined by the stacking order of the* SiO_4 *tetrahedrons. (After Sinkankas 1964, p. 133).*

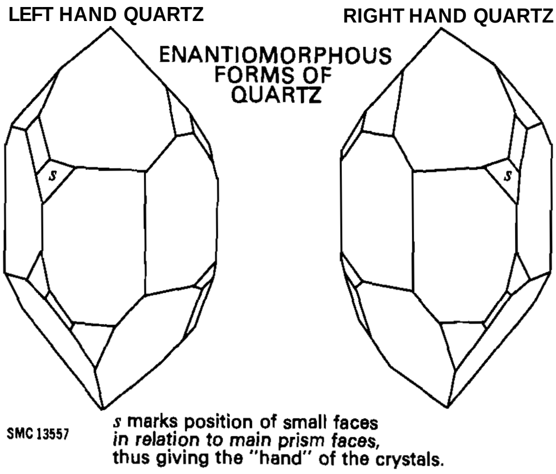


Figure 4. Effect of spiral structure on position of crystal faces. S-face indicates whether spiral turns right or left. The forms are called enantiomorphous. (After Sinkankas 1964, p. 101).

oriented parallel to the length of the prism. Similar to staircases, spirals may turn to the left or to the right. Quartz crystals commonly show evidence of spiralling in both directions, making crystals look like mirror images; these are referred to as left-hand quartz and right-hand quartz. (Figure 4). This contrast is referred to as enantiomorphism, and its presence is evident in the crystals by the position of small trapezohedral faces.

Deviation from ideal growth in single crystals is expressed in several ways. The addition of layers of atoms to a crystal face may occur piecemeal, causing mounds or hillocks on faces which are otherwise flat (Figure 5). These mounds do not stand up very high and can only be detected by shadows caused by strong side light.

The "phantom" or "ghost" crystal, another form of defective growth, is a result of the environment in which the crystal grew. Suspended in the centre of some crystals can be seen what appears to be a series of other crystals, one inside the other, mimicking the form of the parent crystal. This is caused by minor deposition of another mineral at various stages during growth of the crystal. When the crystal resumes its interrupted growth, these impurities are trapped in the crystal, and are preserved forever.

The most common form of freedom or imperfection of growth is twinning. It is present in almost all crystalline quartz as a result of two or more crystals existing in contact with each other in accordance with some established rule or law. Twinning laws state the relationship between the atomic structures of the crystals involved. The most conspicuous twinning mode is called Dauphiné, which shows zig-zag offsets on prism and terminal faces. A second mode, Brazil twinning, is more difficult to detect since its effects are internal and surface signs usually absent.

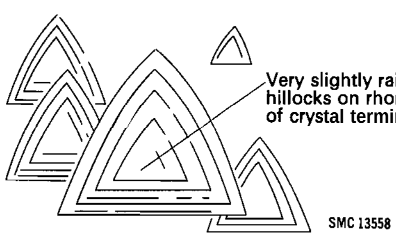


Figure 5. *Uneven or spiral growth causes growth hillocks on crystal faces. (After Sinkankas 1964, p. 71).*

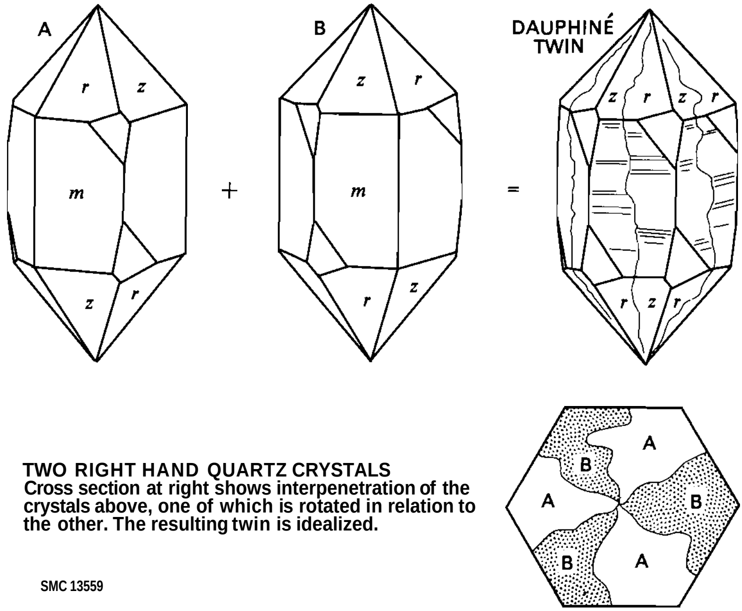


Figure 6. *Dauphiné twinning in quartz. (After Sinkankas 1964, p.102).*

In Dauphiné twins, two right-handed or two left-handed crystals are merged, but one is rotated 180° (Figure 6). This rotation makes prism and pyramidal faces coincide, resulting in an irregular or sutured twin boundary which may be visible on the prism face. It may also be expressed in areas of different glossy appearance on the shared rhombohedral face.

Brazil twinning is an intergrowth of a crystal with its mirror image (i.e., right-handed crystal with left-handed crystal), as if the twin plane constituted a mirror which reflects the internal structure of the original crystal (Figure 7). This type of twinning is sometimes described as the growth of lamellae (layers) of one hand in a host crystal of the opposite hand. On a fractured rhombohedral surface, this appears as a rippled or finger print mark. In polarized light, using special equipment, this twinning appears as alternating light and dark bands in basal sections of amethyst. Colour banding, commonly present in amethyst, occurs parallel to the twin bands in Brazil twinning (Schlossin and Lang, 1965, p. 289 and 294). Sketches of etched cross sections of both types of twinning in quartz are shown in Figure 8. Other types of twinning can occur in quartz crystals, but are not described here. The reader is referred to several of the excellent textbooks listed in the section "References".

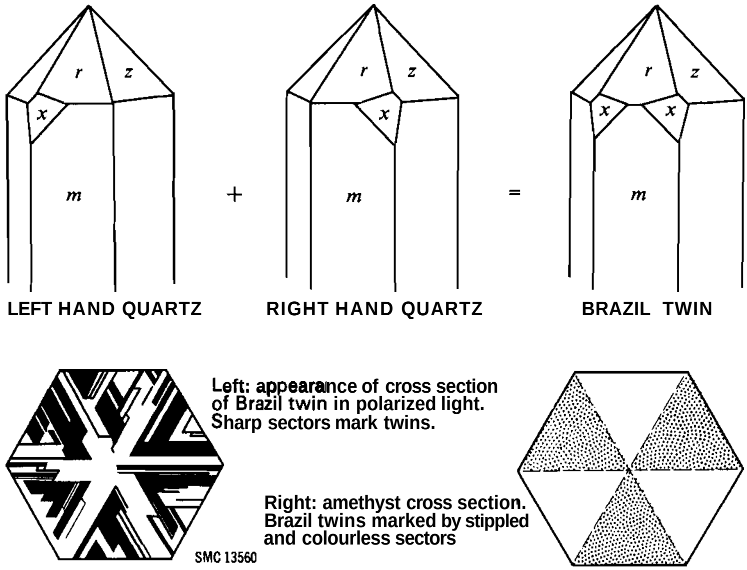


Figure 7. *Brazil twinning in quartz. (After Sinkankas 1964, p. 104).*

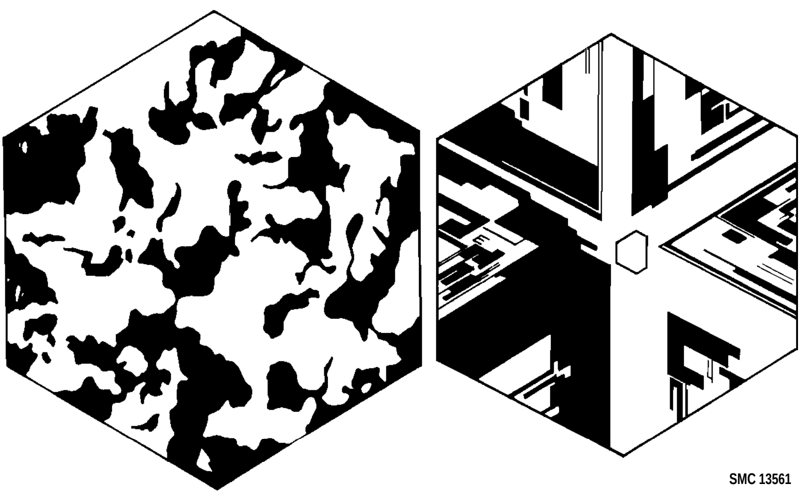


Figure 8. *Etching affects the transparency of thin slivers of a crystal. In twinned crystals it shows the contrasting character of Dauphiné twinning (left) and Brazil twinning (right). (After Leydolt 1855).*

Colour

Some minerals not only transmit light of a different colour from that which is reflected, but also transmit different colours when polarized light passes through them in different directions. Amethyst has the property of transmitting two colours which is called dichroism; the colours are bluish violet and reddish violet. The brown heat-treated amethyst, to be described in a later section, does not show dichroism, thus treated stones may be detected from those of natural brown or yellow colour. Amethyst shows practically no luminescence; however, a blue glow has been seen when some amethyst was bathed in short-wave ultra-violet light.

The range of colour of natural amethyst ranges from pale or almost colourless tints of reddish violet to the deep, rich tones of pure dark bluish purple. Because of the various defects in crystals, such as banding caused by twinning, it is not uncommon for amethyst to show patches of different shades of colour or colourless portions side by side with those of violet colour.

The colour of amethyst has been attributed to the presence of various substances, contaminants, or pigments present in an extremely finely divided state that is intermixed with colourless quartz. Individual granules of pigment were not recognized under the highest power of the microscope. This failure was ascribed to the presence of pigment in only extremely small amounts. The pigment, according to Bauer (1969), is most commonly considered to be manganese. However, potassium ferrocyanide, ferric thiocyanide, or some organic substance have also been proposed. Another theory holds that the colour is caused by the concentration of different molecules along the contact zones of twinned lamellae in the crystal.

The importance of iron, now generally regarded as the major factor in the development of amethystine colour, was recognized as early as 1729 (Hassan, p 223). In the opinion of some researchers (Dennen and Puckett 1972) it is now "convincingly shown" that replacement of some silicon by iron in the regular crystal structure followed by irradiation is necessary to allow colour development. The total number of replacements cannot be very large since in many crystals of amethyst there is less than one iron atom for every 10,000 atoms of silicon and oxygen.

Some precious stones, when subjected to the action of heat, either lose their colour completely or the colour is changed; the original cause of colouring is in the one case destroyed and in the other altered. This process is known as "burning" and is often employed for increasing the natural colour of many stones, for rendering it more permanent or for removing patches. The change in colour of amethyst upon heating is not always predictable and stones from different sources may behave differently. The heat treatment of amethyst must be carried out under carefully controlled conditions if the desired colour is to be obtained.

When exposed for a short time to a gentle red-heat in a mixture of sand and iron-filings, amethyst loses any darkly coloured patches it may have had; after strong and prolonged heating to redness, the violet colour is changed to brownish yellow, the stone then being known as 'burnt amethyst'.

The heat treatment of amethyst to a golden yellow colour is carried out extensively and nearly all yellow quartz marketed today is heat-treated amethyst. Most of this treated yellow quartz is sold under the misnomer 'topaz' which should not be confused with true topaz; nor should the yellow quartz be confused with true yellow quartz of rarity, citrine. The names given to this yellow heat-treated amethyst are 'citrine', 'yellow quartz', 'quartz topaz' and 'topaz quartz'. The heat-treated yellowish brown and reddish brown amethysts with a lighter hue are known as 'Palmyra topaz' in the gemstone trade and the more reddish brown stones are known as 'Madeira topaz' although the reddish stones have also had the name 'Spanish topaz'' applied to them.

The usual colour of heat-treated amethyst is a brownish yellow or garnet-red, but if heated enough, the stone becomes colourless. According to Webster (1970), a schillerization or irridescent lustre sets in and a simulation of moonstone is produced. In some cases, a green colour is induced, such as in the treatment of Brazilian amethyst, which when treated to a green colour has been cut and sold under the name 'Prasiolita' or 'Prasiolite'. Some greenish quartz crystals, often part-coloured violet and green, have been found in Rhodesia and it is thought that the heat of the sun may have caused the change in colour.

The topic of heat and colour is further discussed in the section on "Geology of Amethyst Deposits".

Amethyst Substitutes

There are other minerals which have a true amethyst or heat-treated amethyst colour.

Transparent corundum resembles several precious gemstones in colour, and takes on the gemstone's name with the prefix "oriental". Thus, the corundum with bright violet-blue colour is called "oriental amethyst". If the colour is purplish red, the name of the stone is "amethyst sapphire". The "oriental amethyst" is distinguished from the true amethyst by its stronger dichroism as well as being harder and heavier. In artificial light, true amethyst appears slightly grey, whereas under the same conditions "oriental amethyst" retains its beauty of colour.

The fluorspar is often substituted for more valuable precious stones which it resembles in colour, and is known in the trade by the name of the precious stone it resembles in colour with the prefix 'false'.

Fluorspar or fluorite is too soft for use as a precious stone, but is sometimes worn as a ring stone or other ornament for the sake of its colour.

True amethyst is distinguished from the violet fluorspar, "false amethyst," by its double refraction, greater hardness and lower specific gravity. Fluorspar is also cleavable and is often fluorescent.

Amethyst is imitated by glass, but the double refraction of true amethyst distinguishes it from violet coloured glass, which is not distinguishable from the genuine stone on appearance alone. Purple garnets have occasionally been called amethyst too.

It was learned from members of the Canadian Gemmological Association (Toronto), that the U.S.S.R. has now manufactured artificial amethyst. The Russian product is so much like the real thing that one cannot distinguish it from true amethyst, even by gemmological means.

Amethyst as a Gemstone

Gem materials, compared with other minerals of economic value, are little altered for their end use. Most gemstones are reshaped and polished to enhance their desirable characteristics, whereas some are used in their natural form. The most important specifications of gem material, according to Jahns (1960) are beauty, durability, rarity, and portability.

Beauty in a gemstone is related to the properties of colour, transparency, indices of refraction, and dispersion as well as freedom from visible imperfections. Few amethysts are free from part-colouration, or angular zones of colour, and even in heat-treated stones zonal marking can be seen. Owing to such variations in amethyst, a large, good quality, deep and uniformly coloured crystal is difficult to find for gem cutting; therefore, cut gems tend to be small. High quality amethyst

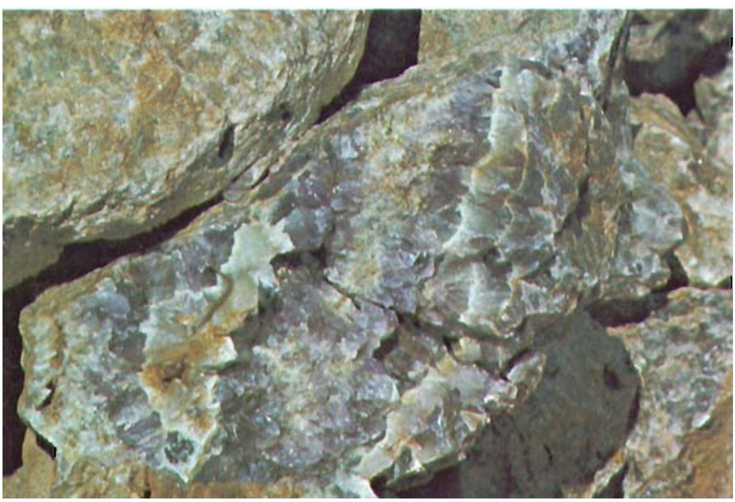


Photo 7. *Zoning of amethyst and quartz in mineralized breccia of the Thunder Bay Amethyst Mine indicates changing conditions in the mineralization process. (Courtesy Ont. Min. lndustry and Tourism).*

Photo 8. *Specimen of Mexican amethyst from Guerrero with pronounced prismatic habit. (Courtesy Rÿksmuseum van Geologie en Mineralogie, Leiden, the Netherlands).*

gems over twenty carats in weight are rare and expensive. Nevertheless, pale coloured and patchy specimens which are almost worthless as gems, can be used for the manufacture of low-cost ornamental objects.

Durability or resistance to abrasion, chipping and splitting determines the extent to which a finished stone retains its details of form during normal use. Amethyst, as mentioned before, is rated 7 on Mohs scale of hardness and can therefore be considered to be durable and lasting. However, amethyst is brittle, and may be chipped if care is not taken during fashioning. For fashioning, it is classified as a medium stone by Bauer (1969), and is therefore ground on copper or tin with lead emery and usually polished on tin with tripolite or on zinc with putty powder.

Rarity, as well as quality, determine the value of gems. There are large known deposits of amethyst in Ontario, but most of the material is not suitable for high quality cut gemstones. Future findings may prove more successful.

Finally, the "make" of the finished product is an important factor in its value. This includes perfection of surface finish, the symmetry and accurate positioning of facets or faces, and the degree to which the general proportioning of the gemstone permits the most effective display of its optical properties.

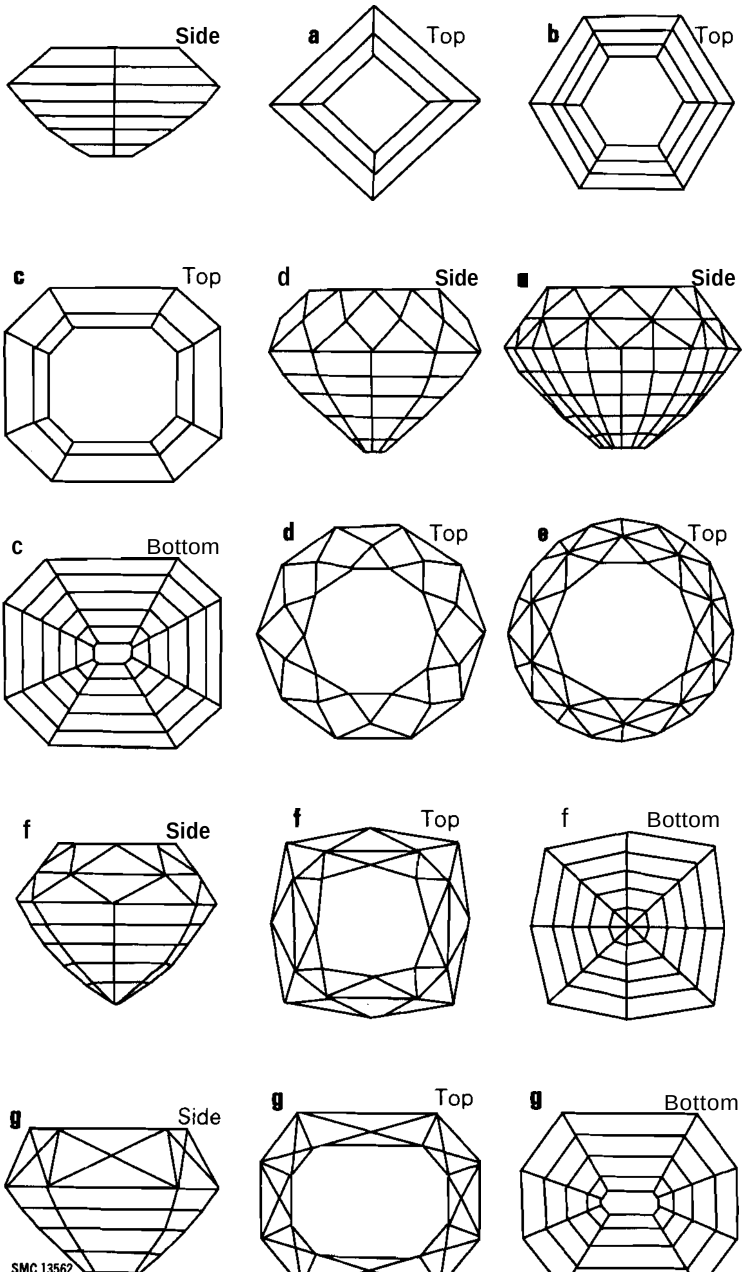


Figure 9. *A variety of shapes is developed in gemcutting. In the trade these are known by the following names: a) Stepcut, four-sided,b) Step-cut, six-sided, c) Step-cut, eight-sided, d) Mixed-cut, e) Cut with double facets, f) Cut with elongated brilliant facets, g) Maltese CTOSS.*

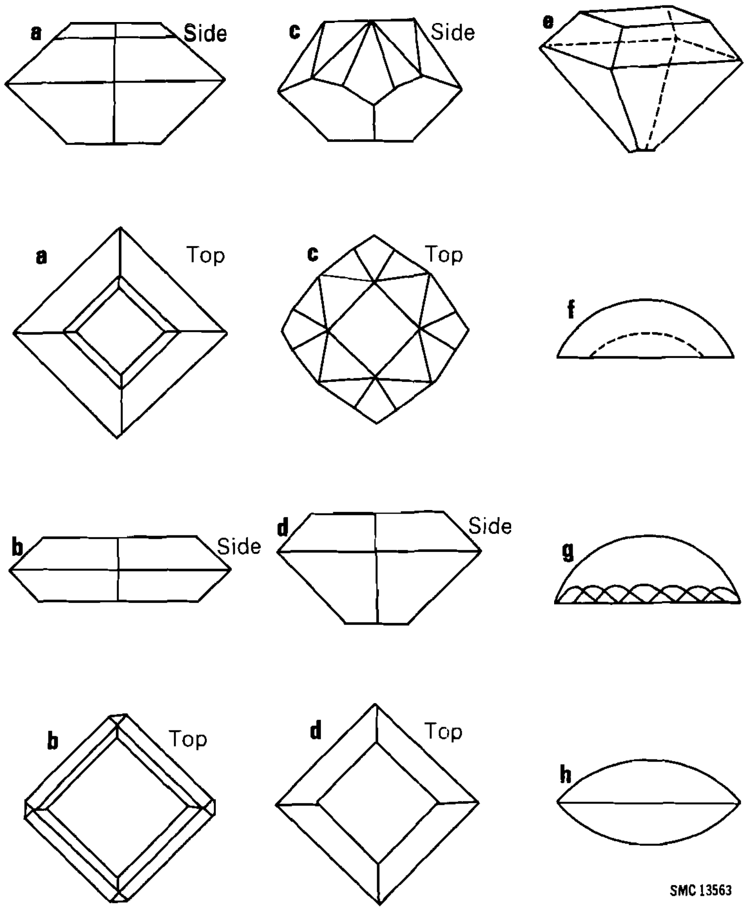


Figure 10. *Other forms of cut stone created for optimum reflection of incident light are: a) Table-stone, b) Thin-stone, c) Table-stone, with brilliant form above, d) Thick-stone, e) Original table-cut, f) Cabachon, simple, g) Cabachon with facets, h) Double cabachon.*

Amethyst is cut most frequently in the step-cut or trap-cut methods with variations. (Figure 9).

Amethyst is also cut as a table-stone, the basic shape shown in Figure 10. This cut may have many variations both in the depth of the stone, and in the outline of the setting edge such as in Figure 10 a to e.

The cabachon is a popular method of fashioning an amethyst (see Figure 10f). The stone is not faceted, but only ground to form a round and smooth stone with a convex upper surface and an either flat, convex, or concave lower surface. A cabachon is circular, elliptical or oval in outline. This form was

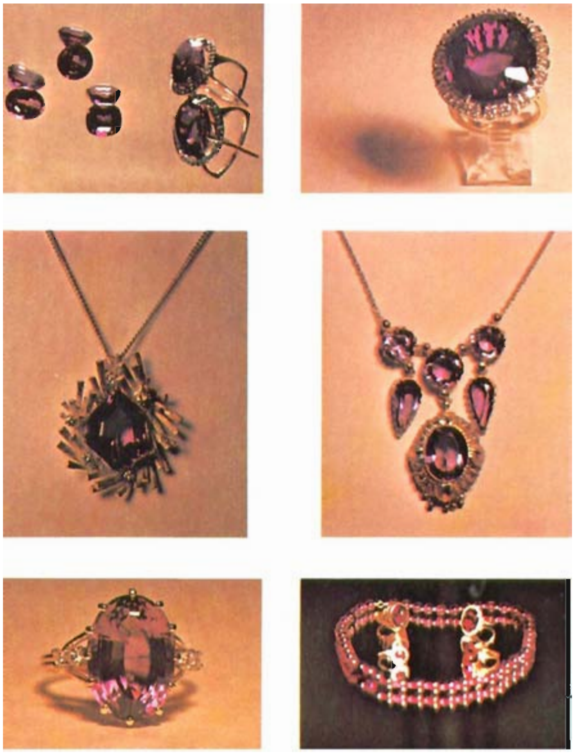


Photo 9. *Jewellery made of amethyst. (Photo T. Abolins, courtesy Birks, Henry and Sons Ltd., Perren, S.R. Ltd., Secrett Jewel Salon).*

well developed before facet cutting became popular and produces an equally beautiful gem.

Stones of a deep, uniform colour are mounted 'a jour'; the metal is in contact with the stone at a few points only along the margin, so that the stone is exposed to view on all sides, and allows an object to be seen through it. Stones that are pale or patchy are mounted in a closed setting on top of a thin foil of the desired colour, and then fitted into a metal receptacle of the same size and shape as the base of a specimen to enhance colour.

The standard unit of weight now used for the more valuable gemstones and cut gems is the carat. One carat is equivalent to 0.2 g, that is 200 mg or 3.0865 grains (Jahns 1960, p. 433). The less costly gemstones, including amethyst, are sold in rough form by grams or pounds.

The value of the most precious gems is based upon their rarity, tradition, and make or finish: whereas for gems of lesser stature, value is also influenced by fashion, superstition, royal or church sponsorship, national pride, fear of imitations, publicity campaigns, and world economic situations (Jahns 1960, p.434).

Prices vary tremendously for precious and semi-precious gems. According to members of the Canadian Gemmological Association (personal communication 1975), a poor diamond sells for $100 per carat and an excellent quality diamond may sell for $10,000 per carat. An excellent emerald can sell for about $6,000 per carat. The amethyst is only a semi-precious

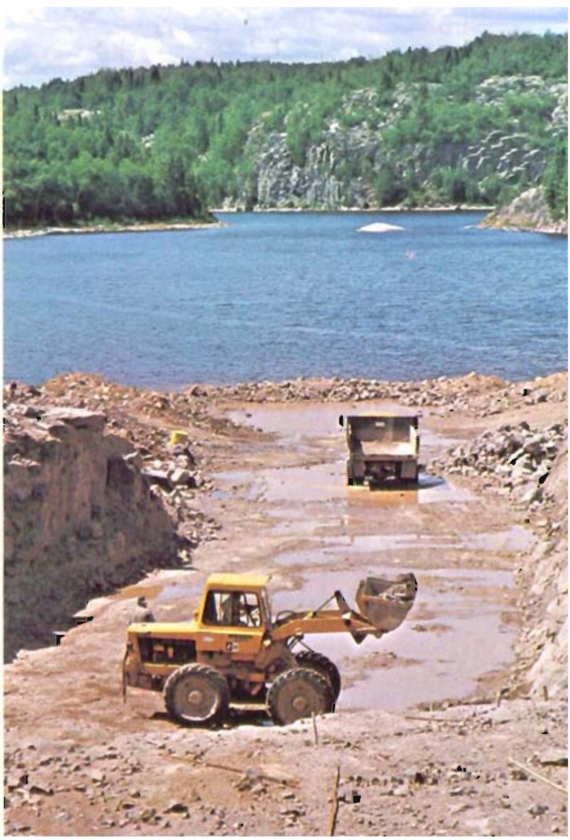


Photo 10. *The Thunder Bay Amethyst Mine in 1972. Amethyst is found in several breccia veins in the floor of the quarry and again on the shore of Elbow Lake in the left background. (Courtesy Ont. Min. Industry and Tourism).*

gem, and does not sell for anywhere near these amounts. A good quality cut stone of one carat would sell for between $2 and $3, or may go up as high as $8 per carat. An excellent quality cut stone can go for as much as $50, according to Toronto jewellers. These amethysts are from Brazil, Siberia and some are from Australia. The majority of amethyst sold is Brazilian.

In rough form, small geodes from most amethyst sources sell for about $5 (U.S.). Ontario rough amethyst is sold locally for $1.25 to $2.00 per pound.

Amethyst was more valuable in earlier times than at present. At the beginning of the nineteenth century, the celebrated amethyst necklace of Queen Charlotte of England was valued at £2,000, but today it would be difficult to find a buyer at £100. (Bauer 1969, p.486). Such a decline in value was mainly caused by the large amount of fine material discovered during the nineteenth century in South America. Before these discoveries amethyst was a costly material used for superior jewellery, now it is used principally for simpler and cheaper ornaments. The larger transparent and flawless stones are still valuable, but sometimes other minerals of the same colour (i.e., “false” amethysts), are used. If and when artificially produced amethyst is sold world-wide, the price of true (occidental) amethyst may change, however this can only be determined in the future.

Commercial amethyst is obtained mainly from Uruguay and Brazil. The export of amethyst from Brazil, according to Hassan (1972), is said to have begun in 1727. Fine quality amethyst is found in the Urals where it occurs in quartz veins in granite, and also from the gem gravels of Ceylon.

In Canada, some amethyst is found in Nova Scotia, but the Thunder Bay region of Ontario has long been noted for its quantity of splendidly crystallized amethyst that occurs in several silver, lead and zinc veins. Almost every important mineral collection contains specimens from this area. Few amethyst crystals are of good gem quality throughout, in spite of their abundance, but portions of crystals are flawless, and have yielded superb faceting-grade material (Steacy 1974). Much of the Thunder Bay amethyst is mined by the Thunder Bay Amethyst Mining Company Limited. Although amethyst mining is only a small industry, it is an important one, especially as a tourist attraction.

Uses of Amethyst

For thousands of years the attractive appearance of certain gem materials has led to their extensive use for decorative purposes; such uses are often affected by superstition, by decrees of church and state, by personal interpretations of religious significance, and by various presumptions concerning medicinal value and influence on human behaviour (Jahns 1960, p. 393).

The earliest known written reference to amethyst is in a fourth century B.C. book, "On Stones". The name "amethyst" is derived from a Greek word meaning "not drunken", reflecting the mistaken belief that anyone who drank wine from a cup made of amethyst was protected from the effects of overindulgence. Alternatively, "amethyst" meant a stone's colour was nearly, but not quite that of red wine. The Greeks tell how the god Dionysus, angered at some insult at the hands of man, vowed that he would let loose his tigers upon the first human being that crossed his way. The first to cross was a young girl on her way to worship at the shrine of Diana. When she saw the tigers springing toward her, she asked the goddess Diana for protection. Diana responded, and changed the girl into a rock crystal. Dionysus, full of remorse for his cruelty, poured an offering of wine to the vanished maiden into a crystal glass. According to the legend, the crystal was stained with the purple wine and to this day has been credited with the power to prevent drunkenness (Barr 1953). An amethyst stone could also be worn on the person for the same purpose.

The Hebrew word for amethyst is ahlamah which means "dream". According to Kunz (1913), the stone caused lovely dreams and visions. The tribe of Benjamin had the honour of having its name engraved on amethyst. Amethyst was included as one of the twelve gemstones adorning the linen bag worn by the High-Priest during special services. The stone is associated with Bethel, the place of dreams where Benjamin was born.

Amethyst was used for Egyptian amulets of the earliest period, up to the XII dynasty (2,000 B.C.). In "The Book of the Dead", a heart made of hemag (amethyst) is mentioned, and two such heart-shaped amulets are preserved in the Cairo Museum.

In mediaeval and later times, the idea of the magic quality of all engraved gems had become so deeply rooted that in many cases a magical character was ascribed to them entirely foreign to the intention of the engraver. A bear, if engraved on amethyst, had the virtue of putting demons to flight and defended and preserved the wearer from drunkenness. Legend has it that the ring of St. Valentine was made of amethyst and engraved with the figure of a cupid.

Also in Greek literature, a gem-city, the City of the Islands of the Blessed, was described by Lucian in his "Vera Historia". The walls of this city were built of emerald, the temples of the gods were formed of beryl, and the altars in the temples of single amethysts of enormous size. The remainder of the city itself consisted of gold.

Each of the twelve apostles was associated with a precious gem; amethyst was the emblem for Matthew.

The significance of the Apocalyptic gems is given by Rabanus Maurus, Archbishop of Mainz (786-856) from whose writing the following phrase is taken: "in the amethyst, the constant thought of the heavenly kingdom in humble souls." (Kunz 1913, p.305).

In ecclesiastical circles, amethyst has always been held in high esteem, and many of the finest specimens of this gem are set in the finger rings of bishops or part of the vestments of priests.

In the fifteenth and sixteenth centuries, many other qualities were attributed to amethyst. For Leonardo da Vinci, it had the power to control evil thoughts, to quicken the intelligence, and to render men shrewd in business matters. For some, an amethyst worn on the person had a sobering effect not only from alcoholic beverages, but also from the passions of love which over excited some. It was said also to preserve soldiers from harm, and give them victory over their enemies, and was claimed to be of great assistance to hunters in the capture of wild animals.

Amethyst was often used for seal-stones and was engraved with various devices, besides being fashioned into larger objects such as vases, cups, and a bust of Trajan which was carried off by Napoleon from Berlin. (Bauer 1969, p.486).

Amethyst is also considered the representative birthstone for the month of February, the gem for Wednesday, the gem of Jupiter, and the gem of Pisces.

Toronto's tribute to Queen Victoria on the occasion of her Diamond Jubilee (Ryrie Bros., 1897) was an address of congratulations enclosed in a silver casket. The materials for the box were all Canadian, except for the six diamonds, one for each decade of Her Majesty's reign. The casket, designed and built in Toronto, has twenty-two varieties of Canadian semi-precious stones set in it, of which amethyst is one.

In 1974 during the 20th annual show of the Tucson Gem and Mineral Society in Tucson, Arizona, the U.S. Postal Service unveiled designs of four mineral stamps, to be issued as a set, to commemorate America's Mineral Heritage. The stamps depict amethyst, rhodochrosite, tourmaline, and petrified wood which were cut and polished as gems. (Thunder Bay Lapidary Society 1974).

Today, good gem quality amethyst is used for jewellery. Less perfect specimens are used in the manufacture of inexpensive personal ornaments, crystal balls, table-tops, book-ends, vases, mosaics, statues, as well as for indoor and outdoor decorative uses such as fireplace mantles and building facing stone.

Geology of Amethyst Deposits

The relative scarcity of amethyst, compared to more common minerals, shows that special circumstances of geological environment are required for its growth. The formation of minerals depends on three basic factors; raw material availability (flow of mineral-bearing solutions), pressure, and temperature. In a major study of amethyst and smoky quartz, undertaken by Holden (1925), six groups of occurrences were distinguished. Five of these were listed by Holden (1925) according to a supposed decrease in the pressure and temperature of crystallization. Holden (I 925) considered the temperature and the chemical composition of the parent mineral solution to be critical factors in the growth of amethyst.

Occurrence

Before discussing the crystallization of amethyst from percolating solutions, the reader should be acquainted with the origin of cavities in which amethyst is found. Such cavities occur in the earth's crust for several reasons. In some cases, gas bubbles leave round or oval-shaped cavities in lava called vesicles; and in granitic rocks, pockets or cavities occur at the centre of very coarse grained bodies. Faults and fissures may open, owing to movements in the earth's crust which allow escape of hot waters and gases from below.

If round cavities are completely filled by minerals, as for example agate, they form globular masses known as nodules. If however empty spaces remain in their centres, as is frequently the case, these cavities become lined with well-shaped crystals and are referred to as geodes, provided that the globular mass can be separated from the surrounding rock. When a geode is opened the viewer sees beautiful layers of different colours and mineralization. The fillings or linings are usually of chalcedony on which may be deposited drusy quartz or amethyst. Chalcedony is deposited at low pressures and temperatures, and often coats or replaces earlier mineralization. The varieties of colour and patterns as well as the mode of formation are almost endless. The outstanding geode specimens occur in basalts and diabase, but more commonly occur in the former named rock.

Figure 11 shows a cut-away section of a geode. The granular material nearest the wall consists of numerous small crystals with fewer but larger crystals towards the centre. In some instances, there is little drusy growth and just single crystals or small groups of crystals are present in an otherwise bare cavity.

Minerals such as amethyst may also be deposited in fissures and faults to form veins. Many veins show progressive changes in their mineralogy because of a changing supply of ingredients, or because of changing temperatures of crystallization within the fissure. Cavities in veins are sometimes filled with projecting crystals of a mineral type similar to those in the surrounding rock. Such a cavity is called a druse. The drusy crystals, often quartz, frequently show a layered "toothy" pattern termed comb structure caused by successive deposition of crystal layers from wall to wall of the vein (Figure 12). If the rock cavity is lined with projecting crystals of different

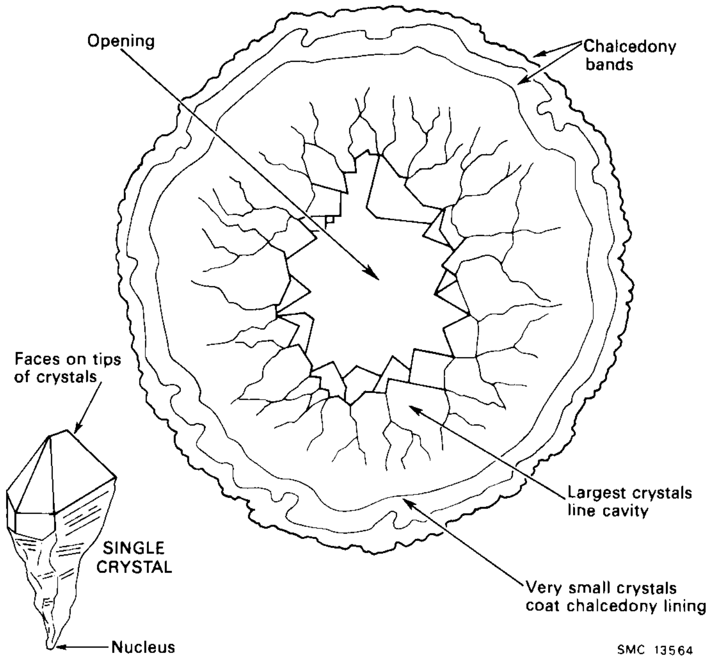


Figure 11. *Diagram of typical amethyst geode. (After Sinkankas 1964, P. 91).*

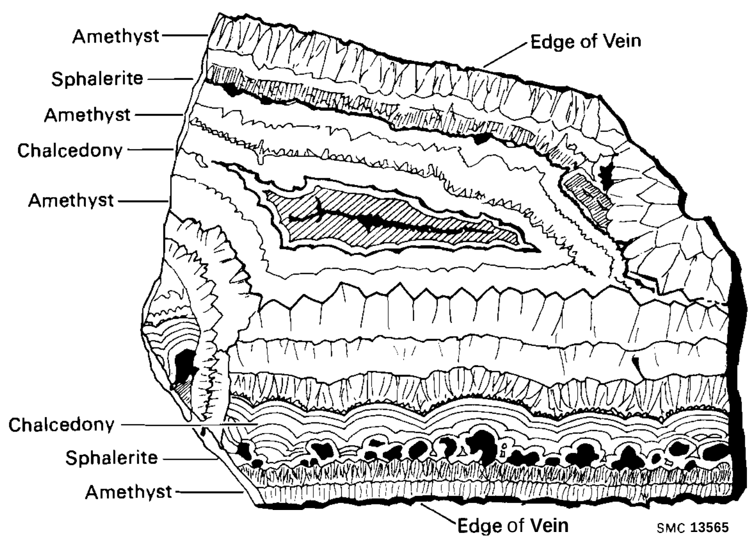


Figure 12. *Diagram of ore vein with amethyst in typical comb structure. (After Sinkankas 1964, P. 92).*

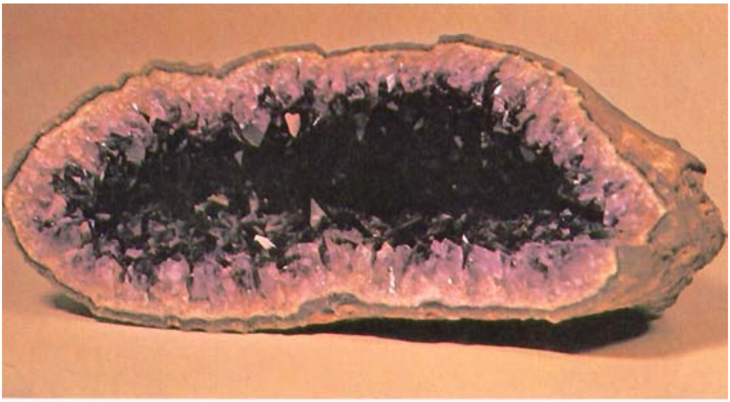


Photo 11. *Geode lined with amethyst. (Photo T. Abolins, courtesy Royal Ontario Museum).*

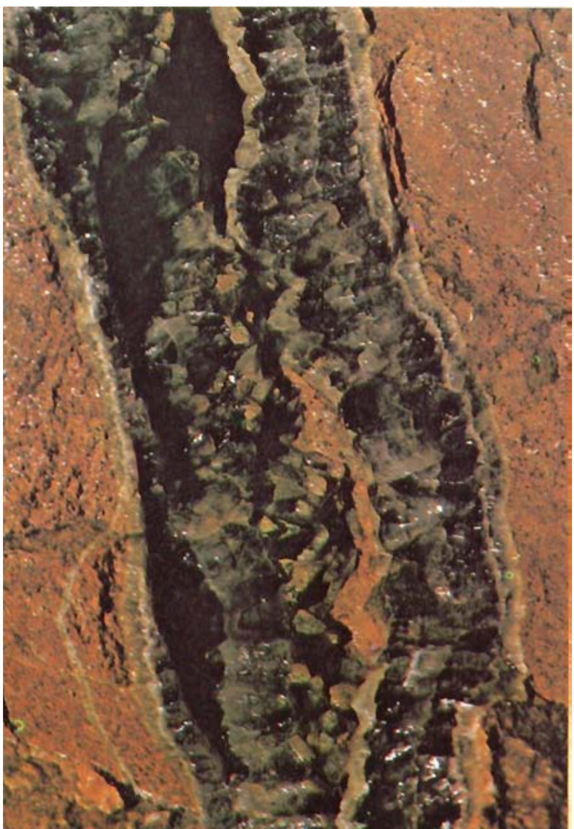


Photo 12. *Vein of amethyst in granitic rock at Thunder Bay Amethyst Mine (Courtesy Ont. Min. Industry and Tourism).*

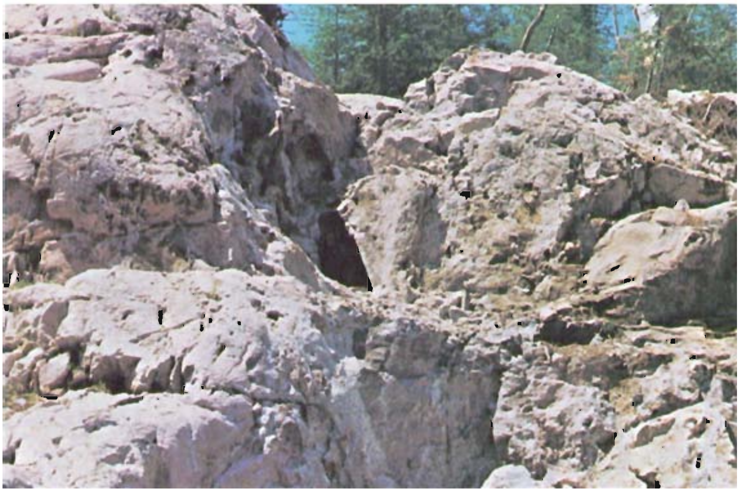


Photo 13. *Rocks have been washed to show amethyst veins and vug on Thorsteinson's property near Nagunagisic Lake. (Photo J. Scott).*

mineralogical composition than those in the surrounding rock, the cavity is called a vug. Vugs can be either a closed cavity, or have an opening in connection with the fissure in which they occur.

The five principal types of occurrence in which amethyst-bearing cavities can be found, according to Holden (1925) are:

1) Plutonic igneous rocks, i.e. pegmatite and granite.
2) Quartz veins associated with pegmatite and/or granite.
3) Alpine-type veins, ascribed to hot ascending waters which leach mineral constituents from the adjacent rocks; in these veins amethyst is always accompanied by iron-bearing minerals such as limonite, ankerite, siderite or chlorite. The associated quartz has a colour change that reflects the elevation at which it is found.[1]
4) Metalliferous ore veins, (i.e. silver veins formed near the surface as at Schemnitz, Hungary or Guanajuato, Mexico), or veins formed at intermediate depths as at

[1] In the central Alps, a brown colour in quartz becomes noticeable between 1,400 m (4,590 feet) and 1,500 m (4,920 feet). Typical smoky quartz is found above an elevation of 2,300 m (7,560 feet) and a deep coloured morion, a black variety of smoky quartz, occurs at 2,900 m (9,500 feet). Holden considered the quartz in veins at 1,400 m to have been deposited at a temperature 45°C higher (since at greater depth) than the quartz at 2,900 m, and that this temperature range was sufficient to explain the colour differences.

Pribram, Bohemia and the north shore of Lake Superior. These veins probably formed from hot ascending waters, supposedly related to bodies of magma, and often contain carbonates, sulphide minerals, barite and/or fluorite associated with amethyst.

5) Mafic volcanic rocks; amygdaloidal cavities in mafic lavas such as basalt may contain amethyst and a variety of other minerals. According to Holden (1925) when amethyst is present, agate and chalcedony have formed earlier than the amethyst, and datolite, zeolites, calcite and other minerals formed later. These minerals were probably deposited in the gas bubble holes by late-stage volcanic fluids, or from percolating meteoric waters shortly after the extrusion of the lavas.

To these five groups Holden (1925, p.212) adds a group of miscellaneous occurrences of amethyst and smoky quartz in calcareous rocks, sandstone and quartzite, and of amethyst occurrences in the agatized trees of Yellowstone Park and Arizona that resulted from silicification by "cool waters of meteoric origin."

Origin

The probable conditions under which amethyst grows have been the subject of further study since they were listed by Holden (1925). Dennen and Puckett (1972), in a study of the chemistry and colour of amethyst, concluded that for amethyst to grow the depositing solutions should be iron-rich and aluminium-poor, and of an oxidizing nature. Moderate temperatures and below normal pressures apparently allowed the larger iron atoms (Fe^{3+}) to replace the smaller silicon atoms (Si^{4+}) in the SiO_4 tetrahedral structure. Dennen and Puckett (1972, p. 455) maintain that the presence of iron by itself is not enough; radioactivity and irradiation is necessary to develop the amethyst colours, a conclusion shared by Hassan (1972).

Relationships between irradiation and colour in minerals have been studied extensively since radium became available. For example, it was found that the colour in amethyst can be restored by irradiation if loss of the original colour was caused by heating. On the other hand, exposure of colourless quartz to x-rays will generally produce smoky brown quartz, and only rarely the violet colour of amethyst.

Growth of an amethyst crystal from a colourless base to later zones of intense colour is subject, according to Dennen and Puckett (1972, p. 452), to the following possible changes in geological environment:

1) Change from reducing to oxidizing conditions.
2) Change of solution from iron-poor, aluminium-rich to aluminium-poor, iron-rich.
3) Change from low to high radioactivity.
4) Rise in temperature.
5) Drop in pressure.

Limitations to the maximum temperature at which amethyst can grow have been determined by heating experiments. Holden (1925, p.230) described the colour stages through which amethyst progresses upon heating and their approximate temperature limits. Holden found that for most specimens of amethyst the colour remains stable below a temperature of approximately 260°C, although a temporary change from violet to grey-violet may occur. Upon continuous slow heating a large amount of decolourization is completed at approximately 310°C. Further heating produces a colourless stage between 300°C and 500°C; some specimens begin to turn yellow, the colour of citrine, at about 400°C; first changes to an opaque milky white quartz occur at 500°C; finally, at about 675°C, all yellow quartz is replaced by milky white quartz.

The results of heating experiments and the study of liquid and gaseous inclusions in amethyst led Holden (1925, p.249) to conclude that amethyst forms at temperatures between 90°C and 250°C, under lower pressure and higher temperature than is normal for the depth of crystallization. The inclusions supply information on the composition of fluids surrounding amethyst at the time of crystal growth. A variety of mineral salts are found to be present besides silica and carbon dioxide (CO_2). Although the fluid is generally thought of as a dilute solution, Norman[1] (personal communication, May 1974) nevertheless estimates the concentration of salts, primarily NaCl , to have been as high as 25 percent. The minerals which may result upon crystallization from this fluid are listed by Holden (1925, p.214) in order of their time of crystallization. Earlier than amethyst are tourmaline, beryl, micas, and rare earth minerals. Earlier than amethyst or contemporaneous with amethyst are apatite, orthoclase, microcline, albite, and

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[1] David I. Norman, University of Minnesota, Minneapolis, Minnesota. U.S.A.

adularia. Contemporaneous with or later than amethyst are calcite, chlorite, zeolite minerals, apophyllite, and pectolite. Fluorite is later when present. Crystallization of colourless or white quartz, agate, chalcedony, rutile, anatase, and brookite is generally earlier than or contemporaneous with amethyst, but is on occasion later than amethyst. Hematite, limonite and goethite are contemporaneous with or later than amethyst, but on occasion are earlier than amethyst.

Ontario Amethyst

The major amethyst occurrences in Ontario have been found in an area of unique geologic character along the north shore of Lake Superior. This area contains the transition from the Lake Superior Basin to the Canadian Shield. The present lakeshore conforms to, or parallels an old and deep-seated structural line which formed the boundary of a sedimentation basin developed on ancient folded Archean (Early Precambrian) rocks. The presence of amethyst in the Thunder Bay area has been known for a long time, and was reported amongst others, by Logan (1846). The place names named after amethyst are all found in the Thunder Bay district. By 1887 an active trade had developed in amethyst that according to Kunz (1887-8, p. 70) amounted to “thousands of dollars worth” of amethyst annually sold to tourists, and similar amounts were shipped to dealers in Niagara Falls and abroad.

Since 1967 this trade was reactivated on a substantial scale with the opening of the Thunder Bay Amethyst Mine. The mine was operated in a limited way in its early years, but output since then has risen markedly. The mine is open to visiting tourists. Collector’s specimens, as well as material for the building trade are shipped from the mine to customers in Canada and abroad. Rock shops in the Thunder Bay area provide a local trade and service to tourists. Attractive jewellery and some highly polished bookends of amethystine material are sold in stores along highways throughout Ontario. A list of dealers in the Thunder Bay area is included in the Appendix to this guidebook.

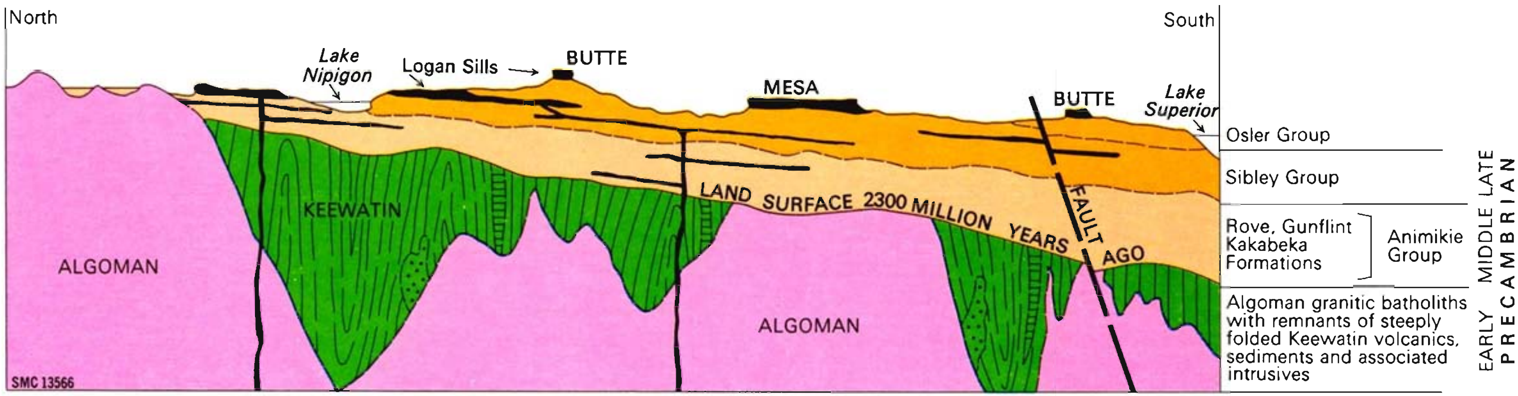


Figure 13. *Schematic section showing geologic relationships of Archean and Proterozoic (Animikie and Keweenawan) rocks north of Lake Superior*

The geologic history of the north shore of Lake Superior has been described by Pye (1969). It begins with the formation of a series of ancient sedimentary and volcanic rocks of Early Precambrian (Archean) age. Minor periods of metamorphism and intrusion were associated with these periods of volcanic activity. As Figure 13 indicates, all these rocks today occur in near vertical attitudes, which were the result of metamorphism and folding associated with intrusion of the last rocks to form in the Early Precambrian, the Algoman granitic rocks. Age dating by means of radioactive isotopes reveals that intrusion of the Algoman granitic rocks took place about 2,600 million years ago, at the time of the Kenoran period of mountain building or orogeny.

Following the Kenoran orogeny, these rocks were exposed to at least 200 million years of erosion which exhumed the Algoman granitic intrusions, and created the land surface of 2,300 million years ago shown in Figure 13.

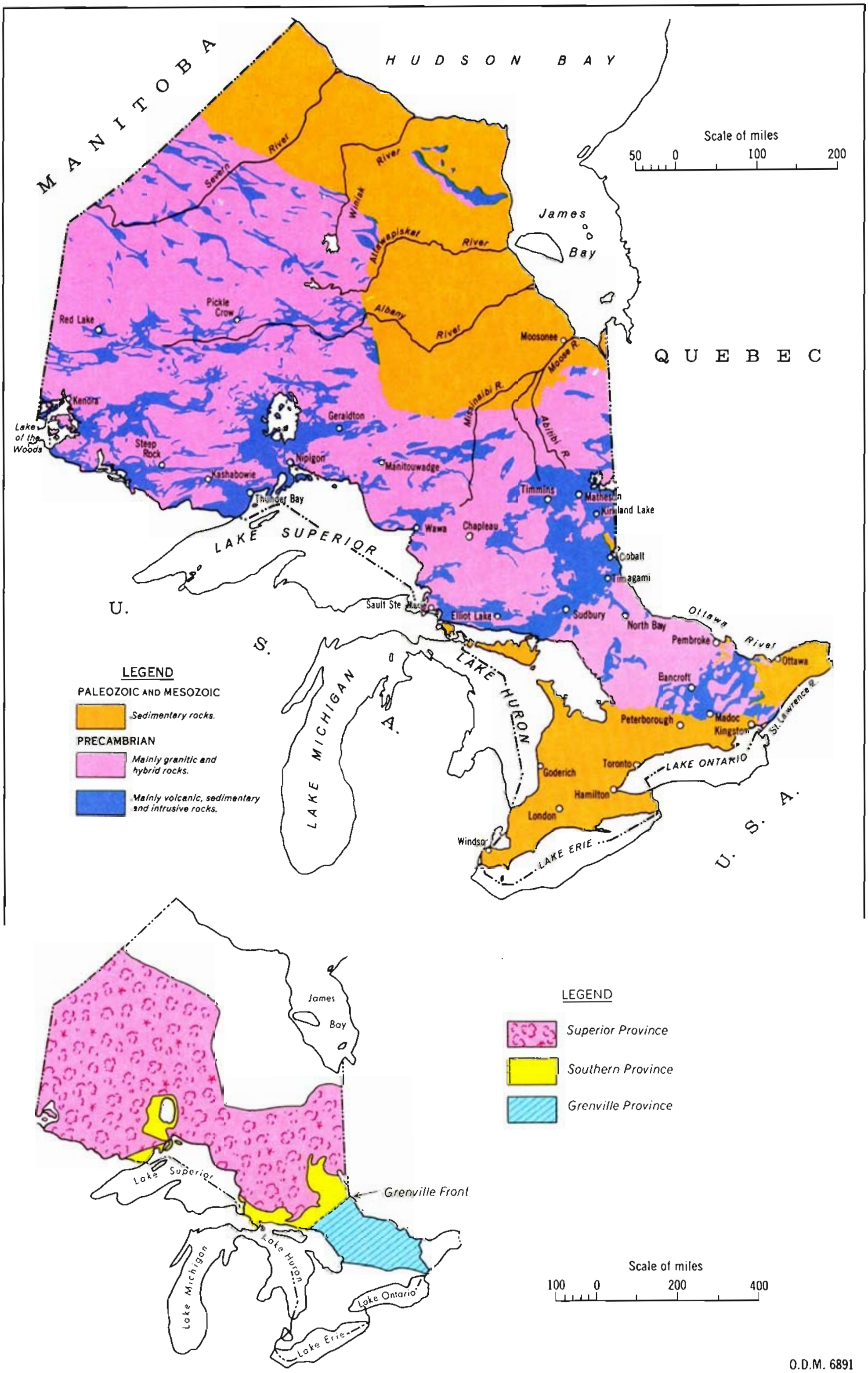
Where exposed today, this surface consists primarily of granitic rocks with only small and irregular remnants of the older vocanic and sedimentary rocks occurring like "islands in a vast granitic sea" (Pye 1969, p. 11). The granitic rocks are a variety of rock types in which quartz monzonite is the major rock type; also occurring in them are syenite, diorite, feldspar porphyry and quartz porphyry (Pye 1969, p. 8). In McTavish Township simple pegmatite dikes are a common associate with granitic rocks (McIlwaine 1971). Less massive in appearance than the granitic rocks but of similar composition are the Archean gneisses and migmatites of the granite migmatite complex such as those in the Dickison Lake area north of Rossport (Carter 1975). In both areas, a muscovite- or white mica-bearing type of granitic rock represents the latest intrusive activity. It is described by the respective authors Mcllwaine (1971) and Carter (1975, p. 13) as a sill-like body of muscovite-bearing quartz monzonite in McTavish Township and a pink muscovite granite in the Dickison Lake area. Some 2,000 million years ago, sediments of the Animikie Group began to be deposited in the protobasin of Lake Superior upon the eroded Early Precambrian surface. The Animikie Group of sedimentary rocks is composed of a basal conglomerate, the Kakabeka Member, overlain by the Gunflint Formation, an iron-rich formation which in Canada contains shale, tuff, carbonate rocks, chert-carbonates, and taconite (an iron-rich chert). Algal remains in chert of the Gunflint Formation have been dated at approximately 1,800 million years, and are of interest because they are the earliest known organisms on earth capable of fixing carbon photosynthetically. Deposited on top of the Gunflint Formation is the Rove Formation, which is composed largely of thin bedded dark shales. The Animikie Group is in some places up to 975 m (3,200 feet) thick (Morey 1967).

Animikie sedimentary rocks were derived from erosion of the surrounding Early Precambrian rocks. Much of the sedimentary rocks younger than the Animikie Group were in turn derived from erosion of the uplifted Animikie Group rocks.

Geographically, these younger rocks are found to the east, and also far to the north of the Animikie Formation, inferring an eastward shift and northward extension of the Lake Superior depositional protobasin. The younger rocks consist of a basal conglomerate which overlaps different formations of the Animikie Group as well as Algoman granitic rocks, followed by a sequence of white quartz sandstone and brick red shales and shaly carbonate rocks. This sequence, named the Sibley Group, represents shallow water deposits and may have been deposited by streams as flood plain detritus (Pye 1969, p. 19). The fact that oxygen was present in the earth's atmosphere at this time is indicated by the oxidized red colour in some of these sediments due to the mineral hematite. These reddish sedimentary rocks gave the community of Red Rock its name, and are well exposed at the Red Rock Cuesta.

Overlying the shallow water sedimentary rocks of the Sibley Group is the Osler Group, a succession, up to 3,000 m (10,000 feet) thick, of amygdaloidal basaltic lava flows, interbedded with conglomerate, crossbedded sandstone, and shale. The dip of the lava flows and their thickening toward the lake suggests that further rapid subsidence of the area under Lake Superior occurred in conjunction with the volcanic activity.

Franklin (1970, p. 284) described steep tensional faults with slight vertical movements which parallel the present shore of the lake and divide the rocks into blocks tilting slightly toward the lake centre. The faulting, diagrammatically represented in Figure 14, shows that the faults are not necessarily open fissures or continuous. A representative fault is also shown in Figure 13, which is the schematic representation of the known geologic history of the area. These faults record the last geologic event of the Precambrian era in this area, and are



Map A. *The generalized geology of Ontario. The inset map shows the distribution of the geological provinces.*

related to the period of igneous activity responsible for the formation of the Osler volcanic rocks, Logan sills, diabase dikes, and gabbroic bodies some 1,200 to 900 million years ago.

Amethyst and ore mineralization along the north shore of Lake Superior is related to both volcanic rocks and faulting during this last event of the Precambrian era. The presence of agate nodules in the Osler volcanic rocks is well known, and many nodules have been collected from the bottom of Lake Superior. Some of these nodules have a cavity at the centre and are therefore classified as geodes. Crystals of light purple amethyst up to 1/2 inch (1.3 cm) in diameter have been seen lining the opening of such geodes[1].

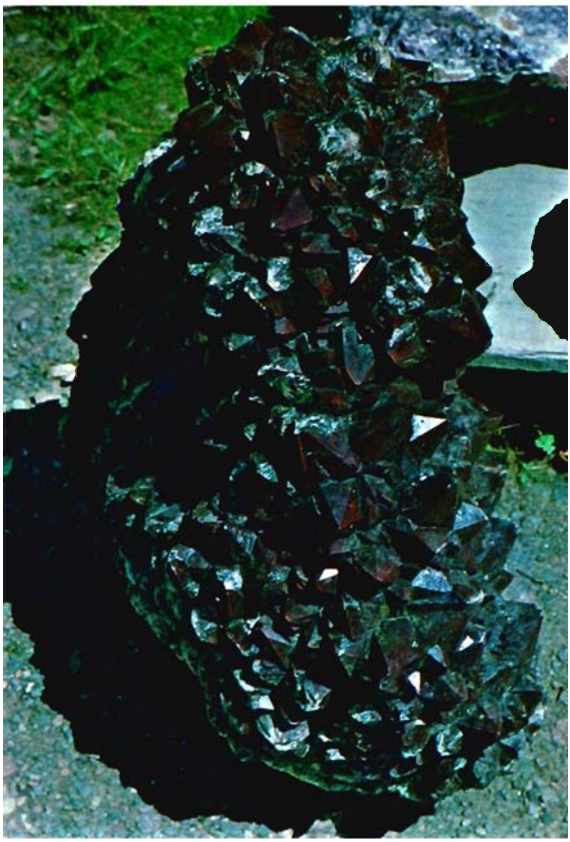


Photo 14. *Large undamaged crystal clusters are rare. A 3-foot (1 m) high specimen can be seen in the lobby of the Alpine Motor Hotel near Thunder Bay. (Courtesy Ont. Min. Industry and Tourism).*

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1 Personal communication from H. Wallace. Geologist, Geological Branch. Ontario Division of Mines (November 1974).

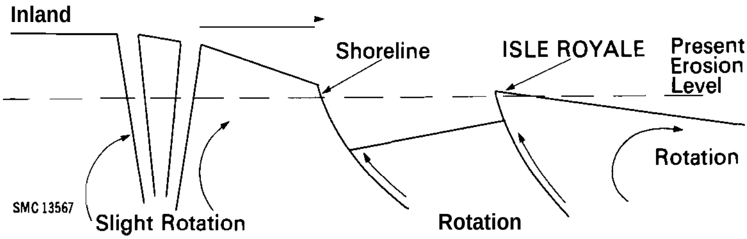


Figure 14. *Model interpreting observed and inferred faulting in the northwestern Lake Superior area. (After Franklin 1970).*

Photo 15. *A small brook rises from this vug on the Dorion Amethyst Mine property. Amethyst occurs in massive lenses in calcite.*

Faults in the Lake Superior district, as elsewhere, have been important localizers of mineral concentrations. The association in vein deposits of silver, lead, zinc, calcite, barite, amethyst, and other minerals is widespread. Valuable amethyst samples have been retrieved from the walls of open vugs lined with crystals, or from massive lenses of amethyst surrounded by calcite. The quantity of amethyst in these veins, however, is limited, mainly caused by the narrowness of the veins. Larger areas of amethyst mineralization are found where faulting and brecciation have broken broad zones of neighbouring granitic rocks.

In Holden's classification, a distinction is made between Alpine-type veins, with mineral concentrations caused by leaching of the adjacent rocks, and ore veins genetically linked to underlying granites. Holden assigned the ore veins of the north shore of Lake Superior to the latter group. However, current views suggest that mineralization here is also caused by leaching of the neighbouring rocks as discussed by Franklin (1970). Franklin (1970, p. 125) found that many ore veins dip steeply and branch or curve along strike. Silver veins are up to 1,500 m (5,000 feet) long, 30 m (100 feet) wide and usually not more than 150 m (490 feet) deep. Many veins pinch out above the 150 m (490 feet) level, while some exceed it, for instance the Shuniah vein which goes down to more than 245 m (800 feet). Franklin stressed the association of silver veins with Rove shales, and the nearness of lead-zinc-barite veins to the contact of coarse clastic Sibley Group sedimentary rocks with Early Precambrian rocks. Amethyst is found in association with both types of veins, but it is particularly common in the downward extension of veins below the contact of the Sibley Group with Early Precambrian rocks (Franklin 1970, p. 186).

Mineralization in the veins may thus have depended upon the presence of sedimentary rocks as much as that of igneous rocks. Holden (1925) thought that the vertical veins and faults indicated that the source of near-surface mineral concentrations was in hot magma chambers, but Franklin (1970) argued that the Rove shales and Sibley sedimentary rocks most likely provided the source of the respective ore minerals. Igneous activity provided the temperature, pressure and structural conditions which permitted migration of meteoric waters to dissolve and redeposit certain elements in tensional fractures. Silver veins typically occur in proximity to diabase where the Rove shales were baked, but lead-zinc-barite veins are linked to

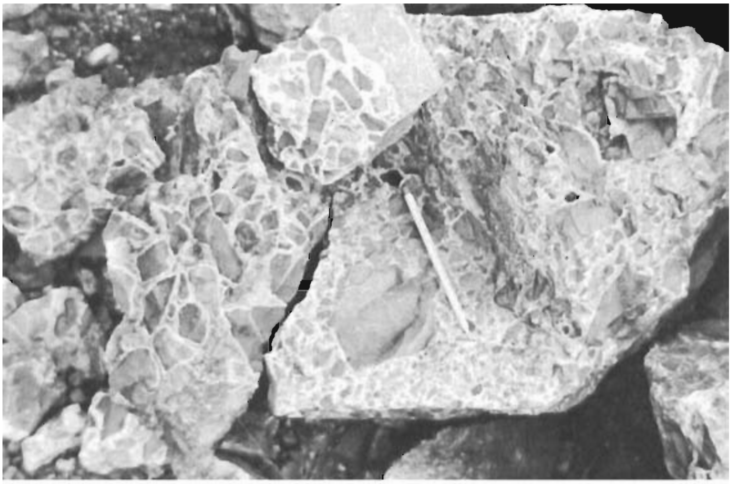


Photo 16. *Samples of breccia at the Thunder Bay Amethyst Mine suggesting size sorting of the fragments.*

Photo 17. *Color contrasts and size sorting give the amethystine breccias at the Thunder Bay Amethyst Mine an attractive appearance.*

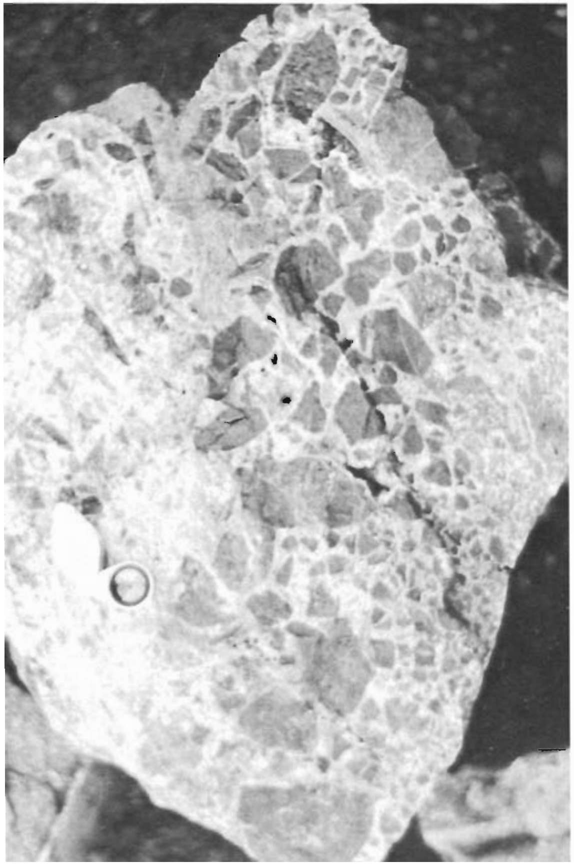


Photo 18. *Coarse fragments in middle portion suggest size sorting caused by transportation in this sample of a breccia vein.*

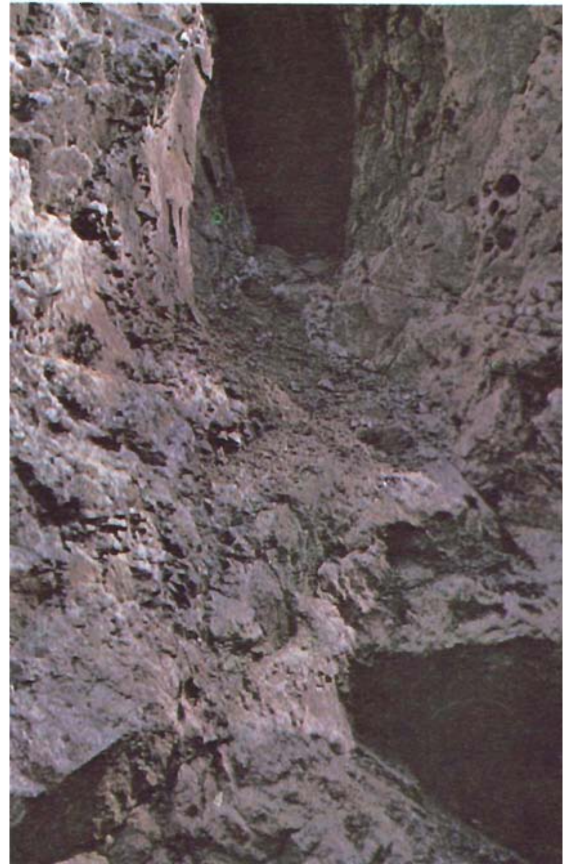


Photo 19. *The mineralized zone in Noyes' West Pit. The vugs in this picture are up to 2 feet (1/2 m) wide. According to Mr. Noyes a fine plastic clay found on the bottom of these vugs when first uncovered hardened into a solid mass after two or three days exposure.*

the basal permeable unit of the Sibley Group. This may indicate that dilute watery solutions, travelling through the Sibley Group rocks, migrated along an impermeable Archean surface until a tension zone was reached. Here the escape of volatiles to the surface and drop of temperature may have caused deposition of the mineral load.

A peculiar feature of some silver-bearing veins is that they are 10 feet (3.0 m) wide in the soft, incompetent Rove shales and become extremely narrow, 6 inches (15 cm) wide, and barren, in the overlying competent diabase sill (Franklin 1970, p. 136). Although the diabase sill probably was intruded at the conclusion of a tectonic event, and subject after consolidation to only the last stage of fracturing, it is also conceivable that the narrow vein in the diabase sill represents the initial width of the tension fracture. In the underlying shales, this fracture subsequently may have grown wider by continuous loss of fine shale particles passing, together with gas or liquids, to the surface through the narrow crack in the diabase. A mechanism of this nature would explain an apparent lack of fine-grained material in the abundant vein breccias in Archean granites. Typical examples can be studied in material of the Thunder Bay Amethyst Mine, (Photos 16 and 17). Other indications of displacement of material and apparent size sorting in the breccias (Photo 18) have been found by quarry operators. One instance is related by Mr. Gunnard Noyes, a local amethyst producer, who frequently observed on opening a vug, that the bottom of the vug was filled with a deposit of very fine plastic clay mixed with loose crystal fragments of amethyst, all of which, after two or three days exposure, became cemented into a solid mass. This suggests moreover that the vugs, after being filled with gas or liquid and clay, became hermetically sealed. The sealing may have occurred after, during, or even before the growth of amethyst. The conditions in the vugs may have been similar to those in a pressure cooker in which crystallization of amethyst does not occur until initial cooling near the earth's surface has caused mineral deposition in, and sealing of, the fissure. Continued cooling would create the below normal pressures conducive to growth of amethyst (see section on "Origin") in the underlying vugs. Whether or not the growth of amethyst in some of these vugs still proceeds at present is a question that would be argued favourably for by at least one of the operators in the Thunder Bay area (Noyes, personal communication).

Prospecting for Amethyst

In the discussion on the geology of amethyst, features relevant to prospecting were mentioned. It was established that deposits are associated with faulting which occurred as a late geologic event in Precambrian time. Wherever Precambrian rocks are exposed, the traces of faults are visible at surface. Their location can frequently be determined from aerial photographs; thus photographs are a principal guide for the prospector.

The presence of a fault hidden in a river-bed or in areas of glacial drift may be suggested by indications of faults in neighbouring areas, or by lineaments such as those seen on aerial photographs. Speculations need to be checked carefully, however, and here the second most important indicator for prospectors, the presence of amethyst-bearing rock fragments in drift adjacent to or overlying a deposit, may be useful.

An example of a deposit which owes its discovery to the presence of amethystine float is the Galarneau Deposit at Kabamichigama Lake (Photo 20). T. Galarneau of Nipigon related how pieces of amethyst-bearing granite exposed in a section of road which passed near the northeast arm of the lake caught his attention (personal communication 1974). T.

Photo 20. *Mr. Galanneau (right) draws the author's attention to surface samples of amethyst The presence of such samples in float led Mr. Galarneau to the discovery of his deposit. (Photo J. Scott).*

Galarneau traced the source of the float, which proved to be a vein system that passed almost at right angles underneath the road. Although trenches exposed a southward extension of the veins, most of the amethyst was found north of the road; some of it is exposed on a ridge barely covered by glacial drift or moss. The measured width of the vein system, according to T. Galarneau, is 22 m (72 feet).

A third important characteristic of amethyst deposits in the Thunder Bay area is that deposits of economic interest occur in granitic rocks near the contact with overlying Sibley sedimentary rocks. Bearing this in mind, prospectors should consult available geological maps in order to limit their search to the most promising areas. Prospectors will be aware, though, of the likelihood that erosion has removed all of the Sibley sedimentary rocks over large areas, but little of the harder granitic rocks underlying the imaginary contact. In other words, large areas of exposed Early Precambrian rocks, ranging far beyond the limits of Sibley sedimentary rocks on the geological map merit close attention.

The search for amethyst-bearing vugs is rewarding. Valuable crystals can be pried loose with simple tools, wrapped carefully, and put in a backpack. These crystals can be sold in this natural state either in roadstalls along the highway (see Photo 21) or in established rock shops in the area.

Photo 21. *Amethyst for sale. The large table in this highway stand is decked with numerous samples of amethyst and other rocks and minerals from the area.*

Amethyst for sale in roadside stands probably has not been obtained from the immediate area. The material has frequently been brought in from a long distance away. A prospector often obtains his material from a property which is not easily accessible to the public.

Amethyst Deposits

The discovery of many amethyst occurrences in the Thunder Bay area of Ontario was a result of prospecting for silver, copper and lead-zinc ore. In the literature the association of amethyst with these sulphide minerals is frequently mentioned, notably by Tanton (1931). Other deposits were claimed and developed solely for the purpose of producing amethyst. In this section principal occurrences such as producing properties and properties held for amethyst potential, are described. Following these is a list of occurrences known to contain amethyst, but not necessarily known to be a primary source of this mineral. The principal amethyst properties, shown in Map B may be visited only with the consent of the owners.

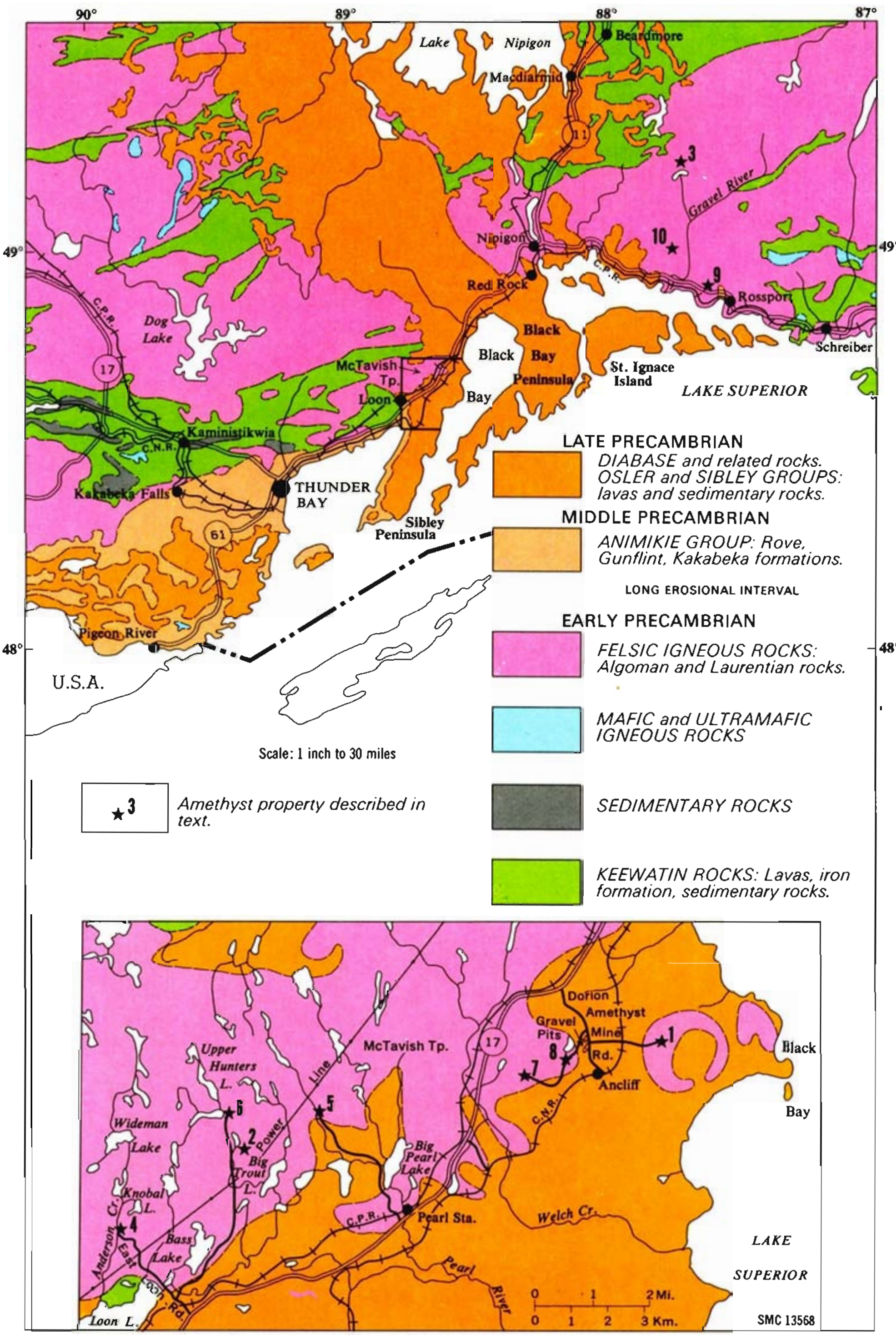
Producing Properties

1) Dzuba, N.

Two claims were staked by N. Dzuba of Pass Lake in Mineral Lots 5 and 7, McTavish Township, to cover both ends of a wide vein adjacent to an outcrop of quartz monzonite.

Access

The vein location can be reached by following the Dorion Amethyst Mine Road which turns southeast off Highway 17 between Dorion and Pearl and is indicated by a road sign at about 5.3 miles (8.5 km) northeast of Pearl. At the second gravel pit along this road, 1 mile (1.6 km) from Highway 17, a



Map B. *The generalized geology of part of the north shore of Lake Superior, with inset showing details of McTavish Township. Major amethyst properties are located in this area.*

Photo 22. *The source of amethyst often remains well hidden by the successful prospector.*

Photo **23.** *Quartz monzonite ridge adjacent to a mineralized fault zone (foreground) on Dzuba's property, Mineral Lot 7, McTavish Township. Locally the quartz monzonite is brecciated and mineralized as indicated by the excavation.*

bushroad turns sharply east and can be followed for 2⁄3 mile (1.0 km) to the railway track. There is no level crossing here, but a path 2,000 feet (600 m) long leads to the first outcrop of granitic rock on Mr. Dzuba's property, claim TB352386, Mineral Lot 7, McTavish Township. The outcrop is the start of the ridge of quartz monzonite northwest of the mineralized fault zone described below. (Photo 23).

General Geology

The following description of the vein on Dzuba's property, the largest known vein in the area, is taken from Tanton (1931, p. 172). When reading the description, the term "quartz monzonite" should be substituted for granite consistent with the results of detailed mapping and reclassification of rock types by W.H. McIlwaine and assistants (McIlwaine 1971).

"The largest of the known veins is near the middle of lot 7 [McTavish Township] and has been traced discontinuously, along a curving northeasterly course, for 2,000 feet [600 m] to the northwest corner of mining claim TB4714 in lot 5 [McTavish Township]. The vein occupies a fault, the northwest wall is of granite, the southeast wall is of red fragmental rock and quartz sandstone of the Sibley series. For distances of several hundreds of feet the vein is naturally exposed on the southwestern side of granite cliffs which rise as much as 50 feet [15 m] above the rock on the downthrow side of the fault. At several places part widths of 10 feet [3 m] can be measured across the vein. At one locality the vein is 30 feet [9 m] wide with branching veins distributed through a further width of 30 feet [9 m]. The greater part of the vein material is coarsely crystalline, white and pale grey calcite, locally there are bands up to a few feet in width of white, pale green and amethystine quartz more or less intimately associated with calcite and barite. Near the northeastern end of the vein, as exposed, there are lodes within the wide calcite vein in which the calcite is well mineralized with finely disseminated chalcopyrite for widths up to one foot [0.3 m]. Old workings at these localities indicate that the lodes had lengths of about 50 feet [15 m] or less. Galena and sphalerite are very sparsely disseminated through parts of the main vein, and relatively rich concentrations occur in certain narrow bands in branching veins and veinlets as exposed in one trench extending south from the main vein. A

Photo 24. *In the excavation on Dzuba's property (see photo 23) semi-cylindrical blocks of quartz monzonite are exposed. The blocks have curved slickensides as indicated by the hammer head. Movement took place in a near vertical direction.*

Photo 25. *Adit in 12-foot (3.5 m) wide calcite vein on Dzuba's property, Mineral Lot 5, McTavish Township. A 3-inch (7.5 cm) wide vein of amethyst is present in the roof of this adit.*

very considerable tonnage of pure, coarsely crystalline calcite is available in this vein; possibly commercially valuable concentrations of metallic constituents may be revealed by further exploration".

Mineralization

The westerly 125 feet (38.1 m) of the ridge of quartz monzonite northwest of the fault, which rises to a height of 50 feet (15 m), is mineralized. The mineralized rock is about 25 feet (7.6 m) wide, and includes 10 feet (3 m) of breccia in which the fragments partly consist of Sibley sedimentary rocks and another 15 feet (4.6 m) of fractured quartz monzonite containing veins and vugs with an abundance of crystals of smoky quartz and amethyst.

Northeast of the mineralized area, the rocks are well exposed. The ridge continues to rise to the northeast, and the

Photo 26. *Logs are jammed into the mouth of a vug, or "cave," on Dzuba's property, Mineral Lot 7, McTavish Township in an attempt to protect the large amethyst crystals lining the walls inside. Crystals near the entrance measure up to 5 inches (12 cm) across. The "cave" lies near the top of an outcrop of calcite in the upper left hand corner of the photograph.*

quartz monzonite becomes more massive with little room for introduction of vein material. The explanation of this difference is suggested by structural features in the mineralized section. Here, the quartz monzonite adjacent to the fault zone is broken up in semicylindrical blocks. The shape is apparent in the semi-circular cross section of the boundary of one of

Photo 27. *Crystal cluster from "cave" on Dzuba's property, Mineral Lot 7, McTavish Township. Crystals in this 85 pound specimen measure up to 8 inches (20 cm) across at the base.*

Photo 28. *Main outcrop and quarry on Dzuba's property in Section 4, Concession VI, McTavish Township.*

these blocks shown in Photo 24. The near vertical attitude of this slickensided boundary indicates a movement parallel to that of the major fault zone. Apparently, the quartz monzonite adjacent to the fault zone, was locally fractured and brecciated. The brecciation of quartz monzonite has created the proper environment for deposition of smoky quartz and amethyst. In other areas the mass of quartz monzonite adjacent to the fault remained undisturbed and mineralization is restricted to the major fault zone in which calcite and barite are concentrated.

The amethyst displays a variety of colours from pink to medium dark purple. In some samples specks of hematite near the surface of relatively clear quartz give it a reddish brown cast. Samples of smoky quartz are remarkable for the contrast of an extremely clear transparent fringe with a dark core. Crystals at this location, as far as could be determined, are not larger than about 1 inch (2.5 cm) at the base, but the deposit is worthwhile because of its rich and colourful variety of amethyst and smoky quartz.

An adit, a nearly horizontal passage into a hillside, is situated at the northeast end of the quartz monzonite outcrop on claim TB132986, Mineral Lot 5, McTavish Township. The adit was filled with water and ice when it was visited by the author, but it is estimated to be 20 feet (6 m) long, 10 feet (3 m) high and about 5 feet (2 m) wide. In the roof of the adit, a 3-inch (7.5 cm) wide vein of amethyst can be seen with light violet crystals up to 2 inches (5 cm) wide at their bases. The vein is surrounded by white and light grey calcite which is frequently found to be fluorescent.

Between the above mentioned outcrops, the vein can be followed along the base of the ridge of quartz monzonite. At one location, quarrying has exposed masses of white and green quartz and violet amethyst in a 13-foot (4.0 m) wide zone filled with calcite. A vug, the entrance of which is blocked with logs, can be seen part way up the slope in Photo 26. The vug was examined earlier by C. Kustra (1969) who gave the following report:

"At the west end of the workings, blasting operations have exposed a 2- by 3-foot [0.6 by 0.9 m] wide vug-opening, leading into a spectacular "room", at least 25 feet [7.6 m] long, up to 2 feet [0.6 m] wide, and high enough for the author to stand erect. The floor of the vug is packed with red clay holding fragments of amethyst. The vug is lined with large amethyst "points" several inches in length and diameter."

Amethyst crystals at the entrance of the vug measured 5 inches (12.5 cm) at their base. A crystal cluster weighing 85 pounds (38.6 kg) with crystals measuring 8 inches (20 cm) in diameter at their base, has been extracted from the "cave" by the owner and is shown in Photo 27. It shows purple amethyst with reddish brown crystal terminations.

Mr. Dzuba intends to preserve the vug in its natural state and would like to prepare it as a tourist attraction for sightseers rather than use it as a source of raw material.

2) Dzuba, N.

Access

A single claim owned by N. Dzuba, TB287820 in the SE1/4 of Section 4, Concession VI, McTavish Township, is accessible from the road that leads to the Thunder Bay Amethyst Mine. This road is the East Loon Road which runs north from a point 4.1 m (6.6 km) southwest of Pearl on Highway 17. After 3 miles (4.8 km) there is a parking lot and a steep incline. Half a mile (0.8 km) beyond the parking lot, a side road to the right leads directly into the outcrop on Mr. Dzuba's property south of a small lake (Photo 28).

General Geology

Claim TB287820 was staked on a 30-foot (9 m) wide breccia zone in quartz monzonite with a strike of N38°E. The individual quartz veins in this zone are up to 4 feet (1.2 m) wide, nearly vertical, and contain some galena and pyrite as well as quartz and amethyst. Owing to stripping and trenching carried out by the owner, the breccia zone is exposed over a distance of 700 feet (200 m). The northeast part narrows to 17 feet (5.2 m) and strikes N30°E.

Mineralization

Amethyst of light to medium violet colour lines the vugs which are frequent in the quartz veins. Orange-brown or pink crystal terminations are common even colouring samples of clear quartz. Purple amethyst and clear quartz with rainbow colours caused by internal reflection, are also found.

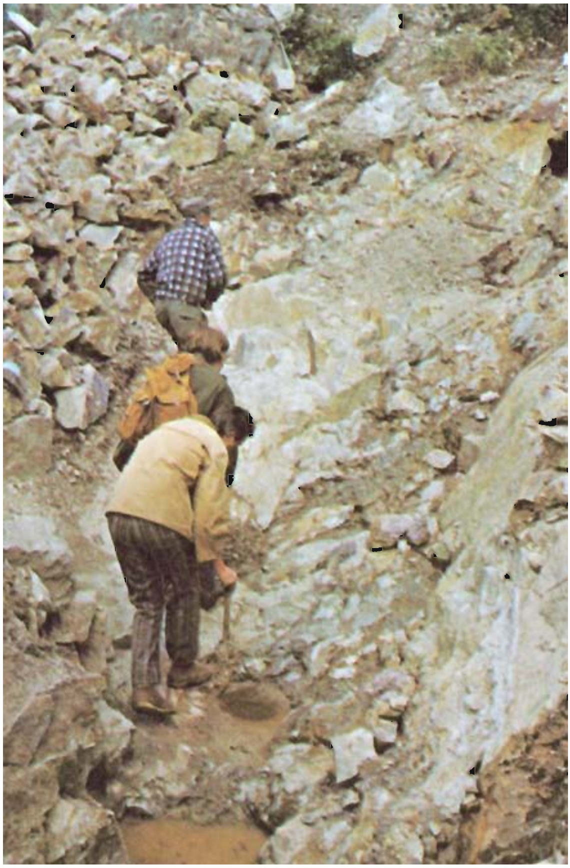


Photo 29. *The vein here exposed in the bottom of the Little Bear Quarry contains large vugs at depth, according to Mr. Galarneau. (Photo J. Scott).*

Production

Production from this claim was started in May 1974. An opening 90 feet (27 m) long and 25 feet (7.6 m) wide follows the contours of the outcrop in 6-foot (1.8m) benches. The vein system probably extends along strike beyond the boundaries presently exposed.

3) GALARNEAU, T.

Access

The property of T. Galarneau of Nipigon consists of a block of contiguous claims, 28 miles (45.0 km) north northwest of Rossport. Lying north of the northeast arm of Kabamichigama Lake it is reached via a Domtar Woodlands road. This is an unsurfaced private road north off Highway 17 at Kama Bay, about 10 miles (16 km) due east of Nipigon. The entrance is just west of a spectacular outcrop of a massive diabase sill overlying sedimentary rocks of the Sibley Group. The road follows the base of this outcrop for about 5 miles (8 km) and continues in a northerly direction. After another 11 miles (18 km) a sideroad to the right, if followed for a similar distance, leads to the Little Bear Quarry and T. Galarneau's cottage on the lakeshore. The name of the quarry refers to the little black bear which visited the site when the amethyst was first discovered some years ago. The bear cub decided to stay, and was raised to maturity by T. Galarneau and family.

Although the first sign of amethyst was found in loose material in the road bed, as described previously, (see section "Prospecting for Amethyst") a quarry was opened in an outcrop 1/4 mile (0.4 km) north of the road after trenching had indicated the presence of amethyst in several places.

General Geology

Amethyst occurs in a zone of quartz veins striking almost due north. The major outcrop on claim TB222596 shows alternating quartz veins and highly altered biotite granite in which feldspar has frequently been altered to clay or sericite. Pegmatite bodies are associated with the granite.

These quartz veins, with areas of grey chert in between, are variable in width and contain vugs up to 2.5 feet (0.75 m) wide lined with amethyst. Particularly striking is a 1 to 2 foot (0.3 to 0.6 m) wide, near vertical, parallel vein of milky white quartz just east of the main mineralized zone. Although locally barren, this vein is occasionally traversed by small amethyst-bearing quartz veins.

The geology in the area has been mapped by Carter and assistants (Carter 1975). Early Precambrian formations locally consist of metasediments in gradational contact with felsic igneous rocks, composed primarily of biotite granite with occasional pegmatite or aplite. A pink muscovite granite is a later intrusion into this complex. No indication exists of Sibley Group sedimentary rocks in this location, however, remnants of Sibley rocks can be found in the glacial drift.

The mineralized zone at the Little Bear Quarry can be traced in outcrops for a distance of 1/2 mile (800 m). The fault zone, of which it is a part, is of much greater length. Carter (1975) indicated the presence of two faults locally. Veins in the quarry strike almost due north. An outcrop near the road has veins that strike N40°W. The total width of mineralization may be wider than 72 feet (21.9 m) observed in the quarry area.

Production

The present quarry has been operated on an annually renewable permit since 1972. It is about 75 feet (22.9 m) long, 25 feet (7.5 m) wide and 20 feet (6 m) deep. In other parts of the claim, according to T. Galarneau, careful probing with drill steel has indicated vugs up to 8 feet (2.5 m) wide and 20 feet (6 m) deep.

4) JOHNSON, F.

F. Johnson of Thunder Bay holds quarry permit No. 5264 which allows him to extract 100 cubic yards of material annually. The quarry is located along Anderson Creek, McTavish Township, 1 mile (1.6 km) north of Loon Lake. It can be reached via the East Loon Road and a bushroad which continues north of the lake.

5) NOYES, G.

Access

The old railway station at Pearl, presently Gunnard Noyes' residence, is reached via Road No. 5 turning north from Highway 17 at Pearl, McTavish Township. The road continues as a bushroad past the residence and in a direction opposite to the driveway. The road passes by several outcrops of amethyst-bearing veins listed elsewhere in this report, (see "Amethyst Occurrences") including the Detroit-Algoma property with two old mine shafts (McIlwaine 1971). It ends after 2.8 miles (4.5 km) and some steep climbing, at the major outcrop on Mr. Noyes' claims. This is the Gagnon Falls location on claim TB276469 (see Property 17, McIlwaine 1971). The area directly east of here is covered by Quarry Permit 5068, with a quarry located at the top of the hill. In the opposite direction the present claim and claim TB221168 cover what may be considered a westward extension of the mineralized zone, with exposures on the slope above the falls, at the West Pit on top of the hill, and at the extreme west, the Hydroline Location, where the hydroelectric transmission line crosses the veins.

Geology and Mineralization

The outcrops mentioned above occur over a length of approximately 1/2 mile (800 m), and the strike of the veins varies from N45°E at the quarry to N63°E at Gagnon Falls, N60°E on the west slope, and N104°E at the Hydroline Location. Locally, a vein in the West Pit strikes N36°E. Lack of exposure makes it impossible to determine whether the outcrops represent a single vein following a curved strike, or a mineralized zone having a ramifying vein system. The measured width of mineralization varies from 50 feet (15 m) at the Hydroline Location to 67 feet (20 m) at Gagnon Falls.

At the Hydroline Location, several 2- to 3-inch (5 to 8 cm) wide quartz veins containing amethyst are exposed on the north side of an outcrop of massive quartz monzonite, just above the level of the adjacent swamp. The veins are vertical and locally widen and enclose vugs approximately 1 foot (0.3 m) in width.

A 1-foot (0.3 m) wide muscovite pegmatite dike in the outcrop, partly splits into separate units, and runs parallel to the vein. Mineralization at the Hydroline Location consists of amethyst crystals generally about 1 inch (2.5 cm) or less in diameter. The amethyst crystals have an outstanding deep violet-blue colour, occasionally hidden under brown crystal terminations.

Between the Hydroline Location and the West Pit are some old trenches. These trenches are overgrown and filled with muck, and extend across the supposed continuation of the veins. The West Pit is located on top of a hill at the end of a side road which branches off from the road to the Gagnon Falls location. The side road crosses the creek below the falls. The West Pit is about 60 feet (18 m) long, and follows a 5-foot (1.5 m) wide mineralized zone into a ridge of quartz monzonite (see Photo 19).

Mineralization in vugs at the West Pit consists of a lining of amethyst crystals that are up to 3 inches (8 cm) wide at their base. The crystals exhibit a variety of colours which range from light violet to a very dark, nearly black purple. The crystals are frequently coated with a reddish brown hematitic layer.

Several outcrops of amethyst-bearing quartz veins can be

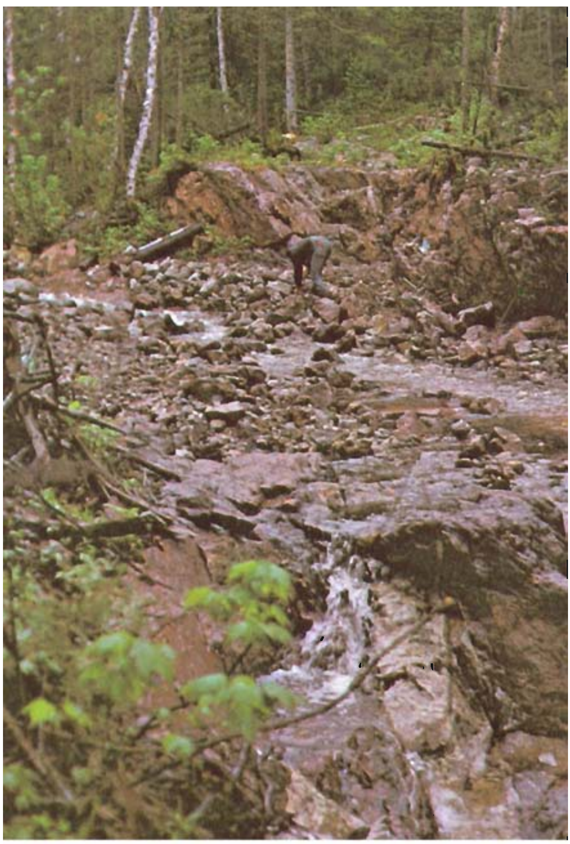


Photo 30. *Gagnon Falls location, Section 3, Concession V, McTavish Township. Picture shows vein striking at a slant across the creek towards quarry on east side.*

found on the slope between the West Pit and the Gagnon Falls location. These outcrops indicate that the mineralized rock is about 60 feet wide (18 m).

The Gagnon Falls location shows quartz veins crossing the bed of the creek. (Photo 30). One vein strikes N63°E and dips 68° southeast. At this angle, the observed mineralized rock, is 72 feet (21.9 m) wide and represents a true width of 67 feet (20.4 m). In a report on this deposit, C. Kustra (1969) described it lying in a fault zone on the contact of Archean granitic rocks and Sibley dolomitic and argillitic sedimentary rocks. A check on radioactivity produced a count of not more than 1.5 times background radiation (Kustra 1969, p. 44).

Quarrying for three or four years on the main vein in the eastern side of the creek bed has established a pit 62 feet (18.9 m) long, and about 12 feet by 12 feet (3.7 m by 3.7 m) in cross section. One side of the bottom of this pit opens into a vug several feet in diameter filled with water.

The rock contains crystals 2 to 3 inches (5 to 7 cm) at their base which line the entrance to this vug. The author saw a variety of well-preserved crystal clusters of light and medium purple amethyst with evenly grown crystal terminations and an occasional red-brown coating (see Photo 5) on display at the quarry site.

The eastern outcrops of the mineralized zone on Noyes' property occur on the slope rising east of the creek bed. An opening near the top of the hill, referred to as the "Quarry", exposes a vein of irregular width which contains vugs up to 1 foot (0.3 m) wide and strikes N45°E. The mineralized zone, which contains additional quartz veins and breccia with fragments of Sibley sedimentary rocks, appears to be about 60 feet (18 m) wide.

Mineralized rock visible in the walls of the "Quarry" includes amethyst crystals up to 3 inches (7 cm) wide at their base. Light violet samples with a glassy lustre are common. In places, chalcopyrite-rich zones in the vein are associated with rusty stained or clear quartz crystals. Purple amethyst with reddish brown crystal terminations is also common in this outcrop.

6) THUNDER BAY AMETHYST MINING COMPANY LIMITED

Access

The Thunder Bay Amethyst Mine, open to visitors from May 1 to November 1 every year, is located on the east shore of Elbow Lake, 4.5 miles (7 km) north of Highway 17. The mine can be reached via the East Loon Road which branches north off Highway 17 at a point about 30 miles (50 km) northeast of Thunder Bay. Before reaching Loon Lake, the visitor should turn to the right. At 3 miles (4.8 km) from the highway a sign tells visitors to park trailers and any other large vehicles in a lot on the side of the road. The road follows a steep slope which takes visitors at least 200 feet (60 m) higher than the parking lot and across one of the major northeast-southwest faults in the area. The view, after completion of the ascent is rewarding. However, anticipation of a visit to the largest amethyst mine in Ontario, now only 1.3 miles (2.1 km) away, tempts the ardent mineral collector onward. At the mine, the road opens on a wide level area which serves as a parking lot and yard for product stockpiling. In the initial stages, leveling of this area was accomplished by using mine waste rock. Since then, uses of

Photo 31. *In the display area of the Thunder Bay Amethyst Mine tourists are welcome to select their own rock samples. (Courtesy Ont. Min. Industry and Tourism).*

amethystine material and brecciated rock for decorative purposes in the building trades have made this material so popular that the owners may well mine the parking lot.

It is mine policy at present to leave a sufficient amount of broken rock and amethyst at hand in the parking lot to allow visitors to choose samples of their own liking. There is a choice of size, shape and colour of amethyst and rock specimens. It is best to search for an attractive piece rather than to try and shape one with hammer and chisel. This exercise rarely improves what looked attractive in the first place, and very often the brittleness of the quartz or host rock supporting the amethyst will bring about destruction of the coveted sample.

Display specimens of greater merit are available from the rock shop at the far end of the parking lot. Access to the mine and workshops beyond is not possible for safety reasons.

In the rock shop there is a choice of rough samples, crystal clusters, single crystals, cut stones, and polished stones made into jewellery.

General Geology

The mine is located in an east-west fault zone passing north of the parking lot, linking the shore of Elbow Lake to the hill where initial discovery of the amethyst occurred when a road to a local firetower was built. Quarrying has progressed for a distance of 550 feet (170 m) from this hill to the lakeshore (Photo 32). On the hill itself, stripping and some blasting have

Photo 32. *Mining in the Thunder Bay Amethyst Mine has progressed down to approximately the level of Elbow Lake. Mineralized breccia is exposed in the quarry floor.*

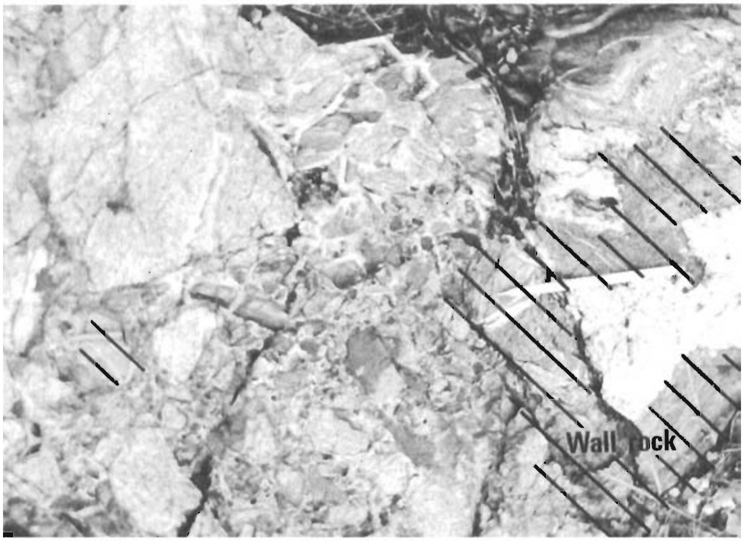


Photo 33. *Breccia exposed on the shore of Elbow Lake contains fragments of biotite gneiss and quartz monzonite. Wall rock is biotite gneiss in this instance.*

exposed another 150 feet (46 m) of the fault zone which may here be examined by visitors. A pocket in this zone, 17 feet (5.2 m) wide, exposed at the time of visiting, contained 85 percent amethystine vein material.

The mine area is covered by patented claims TB102356 and TB96197. License of occupation has been obtained on these claims. Claim TB286557, adjacent to and west of TB96197, covers the westward extension of the fault zone into Elbow Lake.

On the southern shore of Elbow Lake, in an extension of the fault zone approximately 2,000 feet (600 m) west of the mine, an outcrop of mineralized breccia occurs in which fragments of pink quartz monzonite and grey biotite gneiss intermix (Photo 33). This mixture of the two rock types shows that transport of fragments in the fault zone was common.

Spectacular breccias can be seen in the floor of the quarry in a zone cutting red to pink quartz monzonite and occasional pegmatite. These breccias form the host rock for the quartz veins and vugs with amethyst. Many samples of breccia on display in the stockpile area derive their attractive appearance from the seemingly regular distribution of equal-sized fragments evenly spaced by the intervening quartz amethyst vein material. The contrast of buff or reddish brown breccia particles of Sibley sedimentary rock with a red or pink quartz monzonite host rock, accentuated by amethyst in shades of lavender, lilac or mauve, presents an irresistible colour combination (see Photo 17). In some samples the impression that fragments were subjected to transport in the veins is given by size sorting, larger fragments concentrated towards the middle of the vein (see Photo 18). A statistical analysis would be required, however, to prove that a form of size sorting actually governed the distribution. In other samples the angular fragments of quartz monzonite barely changed position after having been dislodged by the brecciation process. The fragments are separated by narrow veins which in some instances simply pervade the igneous rock in a ramifying network.

Mineralization and Production

A major east-west fault dipping 70° to 75° south forms the north wall of the mine opening. North of this fault a northeast-striking quartz vein with amethyst can be seen in the outcrop, thus producing a total width of mineralized rock in the mine area of well over 80 feet (24 m).

At the time the author visited the mine, the open cut had an average width of 60 feet (18 m), and a height varying from 10 feet to 35 feet (3 m to 11.5 m) in different sections. Mineralization in the mine, mine operation, markets and uses of mine products have been reported by Kustra (1968, p. 47-48) as follows:

> ***"Description of Mineralization:*** Individual amethyst veins vary in width from 1/4 inch [6.4 mm] to 4 feet [1.2 m] and include numerous cavities lined with purple crystals. The cavities attain lateral (and) vertical lengths of 10 feet [3 m] and widths of 4 feet [1.2 m]. Well formed pyramidal crystals (points) line the cavities and vary in size from 1/4 inch [6.4 mm] diameter to giants that measure 9 inches [22.8 cm] from tip to root and 6 inches [15.2 cm] in diameter.
>
> Colouration of crystals and the more massive material is dark purple. Variations in intensity of purple colour occur, and locally, colourless and smoky-coloured material is found. Post-amethyst pyrite dusts the surface of amethyst crystals locally.
>
> ***Mining Operations:*** Mining operations began several years ago [1967].
>
> Subsequent to blasting a 10 to 12 foot [3 to 3.7 m] bench, crystal material is hand-cobbed, washed and sold as crystal

clusters. A front-end loader removes the remaining material to a stockpile from which rough amethyst stone is extracted, some of which is packed in 45-gallon [204.6 l] steel drums and exported. Separation of wholly granitic rock and amethyst material is made.

Markets and Uses: Much of the amethystine and granite rock are used locally by the construction industry. Exports have been made to various parts of Canada, United States, Japan, and Finland.

The bulk of the quarried rock is used by the construction industry for exterior wall facings; some material has been employed as landscaping stone. Mineral collectors and lapidarists purchase a good portion of crystalline material, which in addition to being exported, is also sold at the site."

In 1969, Kustra (1969, p. 46) published spectrographic analyses of quartz and amethyst from the Thunder Bay Amethyst Mine, performed in the laboratory of the Laboratory Branch, Ontario Department of Mines. The following results were obtained:

	White quartz ppm	Purple quartz ppm
Fe	150	500
Ca	30	200
Al	200	100
Mg	50	100
Mn	ND	4 (by atomic absorption)
Cu	2	5
Ti	ND	5
Be	10	2

Abbreviations:
ppm — parts per million
ND — not detected

7) WILLIAMSON, E.J.

Access

The property of E.J. Williamson of Dorion, in Mineral Lot A, McTavish Township, was reached via the Dorion Amethyst Mine Road which turns south off Highway 17 about 5.3 miles (8.5 km) northeast of Pearl. A branch of this road follows the natural gas pipeline west of a gravel pit mentioned in section on N. Dzuba. At a distance of 2.3 miles (3.7 km) from Highway 17, a right-hand turn leads to the mine parking lot. One thousand feet (300 m) further west, on claim TB129263, the collector will find an area stripped of trees and overburden. A small shed and a caravan were located on this site when the author visited it in 1974; the owner was engaged in constructing a road to the occurrence.

Geology and Mineralization

The major showing of amethyst on the property occurs in a near vertical calcite vein. The vein is up to 15 feet (4.6 m) wide, and contains pockets of barite and stringers of pyrite and chalcopyrite. Amethyst occurs as quite evenly coloured, deep violet crystals grown together in dense clusters. Individual amethyst crystals are up to 3 inches (7.5 cm) in diameter. The surrounding calcite is coarsely crystalline.

The outcrop is exposed over a length of approximately 75 feet (23 m); at the lowest point in the centre of the outcrop a little brook springs from a large open vug. The brook flows south and presumably represents the underground drainage of an area of higher ground north of the calcite vein. Several hundred feet north of this point marshy ground borders on a lake. However, the area has not been prospected sufficiently to establish the underground course of this brook.

The calcite vein in this outcrop, striking N76°E and surrounded by conglomerate and sandstone of the Sibley Group may be assumed to continue westward, with minor variations in strike, to coincide with an outcrop of amethyst in calcite on claim TB129262, at a distance of approximately 1,000 feet (300 m). Here, the vein is 8 feet (2.4 m) wide and nearly vertical, and strikes N94°E. It is flanked on the north side by a wall of quartz monzonite. Sibley sedimentary rocks appear as breccia fragments in the vein. Amethyst is found about 12 feet (3.6 m) up the slope occupying 3-inch (7.6 cm) wide selvages surrounded by friable or easily crumbled calcite. The friable calcite appears as a coarse sand in the central part of the vein where seams of amethyst alternate with 1-inch (2.5 cm) wide veinlets or vugs lined with transparent calcite crystals. Barite occurs in lenses in the calcite. Massive, coarse crystalline calcite forms the walls of the vein.

Between the two outcrops described above, several trenches have been dug across the strike of the vein. Subsequent slumping of the walls of these trenches did not allow the extent of the vein to be established, however, scattered amethyst crystals found in the debris from the trenches indicates the vein's likely continuity.

Initial prospecting of the claims was for copper. Thirteen diamond-drill holes, totalling 1,809 feet (551.3 m) in length were drilled in 1967. The diamond-drill holes were drilled at an angle of 45 degrees from south to north across the vein, and intersected the following: Sibley shale; a brecciated zone with quartz-calcite veins and occasional stringers of pyrite and chalcopyrite; and relatively massive, coarse-grained "granite". Breccia fragments consist predominantly of Sibley sedimentary rocks or "granite", depending on their position in the brecciated zone. The zone measures 78 feet (23.8 m) horizontally according to one of the holes.

A third outcrop of amethyst on E.J. Williamson's property is located 350 feet (110 m) southeast of the outcrop on claim TBl29262. This outcrop shows two vugs in quartz monzonite near the contact with Sibley sedimentary rocks. The vugs are lined with transparent, light purple amethyst crystals 1 inch (3 cm) in diameter. The area of outcrop is too limited to determine more than a very local strike of N94°E. A major cross fault would have to be assumed to bring this outcrop in line with the previously described calcite vein.

Non-Producing Properties

8) DZUBA, P.

In June and August of 1974, P. Dzuba of Pass Lake, Ontario, staked two claims in Mineral Lot 13, McTavish Township near Ancliff. The property is located east and west of the Dorion Amethyst Mine Road, 3/4 mile (1.2 km) northeast of the Dorion Amethyst Mine.

Geology and Mineralization

The Ancliff amethyst occurrence is on Claim TB404862 east of the road. Quartz-amethyst veins are found at the base of a hill of quartz monzonite over a width of 270 feet (82 m) across strike, here varying from N65°-80°E. In the north slope of this hill several vugs are exposed at different elevations. These vugs, occurring in quartz veins in brecciated quartz monzonite, are 1 foot to 2 feet (0.3 to 0.6 m) wide and lined with amethyst. Crystals are 1.5 inches to 2 inches (3.8 cm to 5 cm) in diameter at their base. Similar vugs in quartz veins in quartz monzonite at the top of the hill (Photo 34) have been opened by blasting. Many samples of amethyst at this location show a variety of colours, which frequently alternate even in a single specimen. Besides this colourful aspect, many crystals reflect light from internal fractures or from crystal boundaries, thus contributing to a sparkling appearance in the crystal clusters.

The hill of biotite-quartz monzonite containing the Ancliff Occurrence rises steeply to a height of approximately 250 feet (76 m) above a small lake occurring only 900 feet (270 m) to the north. The visitor has, after climbing to the top of the hill, a fascinating view of the surrounding area (see Photo 34). Particularly enchanting is the panorama of low swamplands and granitic outcrops covered with evergreens unfolding in the direction of Enterprise Bay, backed by the open water of Black Bay beyond. Parts of this view also can be enjoyed from lower elevations where the slope of the hill crosses the boundary with Mineral Lot 11 to the east.

In Mineral Lot 11 only a little amethyst is found in one or two narrow quartz veins. The area, nevertheless, is interesting for other reasons. The foot of the hill is mantled by raised boulder beaches (Photo 35). Three terraces can be distinguished occurring at intervals of approximately 5 feet (1.5 m) and 10 feet (3 m) from top to bottom. The boulders consist of quartz monzonite, and are derived from the underlying bedrock. Wherever beach deposits are lacking, blocks of quartz monzonite, occasionally of formidable dimensions, are dislodged and partly piled on top of each other, and form caves of various shapes and sizes. The beaches are located on crown land directly south of land held by the Ministry of Transportation and Communications as pit 695 in Mineral Lot 11. The raised beaches and the spectacular piles of dislodged blocks of bedrock, together with the presence of veins and vugs with amethyst, give the area a special and interesting character.

Photo 34. *View from the top of the Ancliff amethyst occurrence, Mineral Lot 13, McTavish Township. Crystal clusters in this outcrop sparkle with a variety of colours.*

9) HALONEN, J.

Outcrops along Highway 17, 17.5 miles (28.5 km) northwest of Schreiber, contain small amounts of violet amethyst and red-stained quartz. However, the purple colour in the pink granitic rocks visible from a passing car is caused by the mineral fluorite. The location is marked on the Ontario Department of Mines geological map, Map 2232, as a fluorite-barite occurrence. Claim TB350791, covering this amethyst-bearing outcrop, is held by John Halonen of Schreiber, Ontario.

10) THORSTEINSON, D.

Claim TB350313 was staked by D. Thorsteinson of Beardmore, Ontario, in June 1973 on a new discovery of amethyst on the northwest shore of Nagunagisic Lake, 24.5 miles (39.5 km) due east of Nipigon. Three other claims in the area, TB350310-12, 3⁄4 mile to 1 mile (1.2 km to 1.6 km) to the northwest, are held by D. Thorsteinson for their interest as a gold prospect. In the summer of 1974, claims flanking TB350313 to the southwest and northeast were staked by A. Castagne of Thunder Bay, Ontario. There is no record of outcrops of amethyst on the latter claims.

Photo 35. *Raised beaches consisting of boulders of quartz monzonite near the Ancliff occurrence.*

Access

A bush road follows the Gravel River, and passes east of Nagunagisic Lake at a distance of approximately 1 mile (1.6 km). However, it is more convenient to fly in from Pays Plat or Thunder Bay as the terrain between the lake and the road is very rough. A careful pilot will be able to land an Otter aircraft on the lake and take off again under favourable weather conditions. Flying time from Thunder Bay is about one hour.

Photo 36. *Amethyst mineralization on Thorsteinson's property near Nagunagisic Lake.*

Geology and Mineralization

The area of Nagunagisic Lake is included on Ontario Department of Mines Map P. 690 (Carter, 1971). The geology is similar to that at Kabamichigama Lake. The predominant rock types form part of a granite-migmatite complex of Early Precambrian age with recognizable remnants of greywacke and sandstone described by Carter (1971). Pink granitic rocks alternate with metamorphosed dark grey greywacke and pale yellow or white sandstone. Both granite and gneiss are rich in biotite and quartz. The following description of the amethyst occurrence is given by Fenwick[1] (Unpublished report, Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay).

"The main amethyst occurrence is located 250 feet [76 m] west of the shore of the lake and occupies a vuggy breccia zone that strikes N85°E. This zone is about 110 feet [34 m] long and varies in width from 10 to 37 feet [3 to 11.3 m] and consists of an inter-connecting system of veins that enclose angular fragments of the granitic rocks and the biotite-quartz-feldspar gneiss. Numerous cavities or vugs were noted and one vug-opening was 1 [0.3 m] by 2½ feet [0.76 m] wide and at least 12 feet [3.7 m] deep. Locally, the veins attain a width of 2½ feet [0.76 m] and where the material forms vugs, amethyst crystals up to 3 inches [7.6 cm] in diameter occur. The vein material consists of an outer, border zone of quartz, and a central core of amethyst. Well-formed pyramid-shaped crystals (points) bounded by six faces, line some of the cavities. In places the amethyst has been stained a deep-red colour by hematite.

The second zone, which is approximately 550 feet [170 m] west of the main zone, is about 20 feet [6 m] long, and 2-4 feet [0.6-1.2 m] wide. This vertically dipping breccia zone strikes S65°E. Beautiful deep purple amethyst crystals were noted in this zone".

Vugs and amethyst crystals in the major occurrence are shown in Photos 13 and 36. Deep purple amethyst in the second zone offers an exciting perspective reflected in the gaze of the beholder in Photo 37.

At the time of visiting the author found veins with amethyst in two additional locations on claim TB350313, both along the

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[1] K. G. Fenwick, Regional Geologist. Thunder Bay District.

lakeshore. One outcrop shows a vertical vein with a 1-foot (0.3 m) wide vug in granitic host rock. The vug is lined with light purple amethyst crystals up to about 1/2 inch (1.3cm) in diameter. The strike of the vein is east-west and in view of its location it may well be an extension of the major vein, adding another 250 feet (76 m) to the total length. An attempt to find a continuation of mineralization on the opposite (east) side of the lake failed.

A second occurrence along the lakeshore occurs approximately 1,000 feet (300 m) northeast of the first, along the base of a large outcrop of granitic rock jutting out into the lake. Here, in a 5-foot (1.5 m) wide vertical breccia zone striking N80°E several quartz veins contain vugs up to 6 inches (15 cm) wide. The vugs are lined with dark purple, red and reddish brown coated amethyst crystals. The place is a favoured camping spot for prospectors in the area (Photo 38).

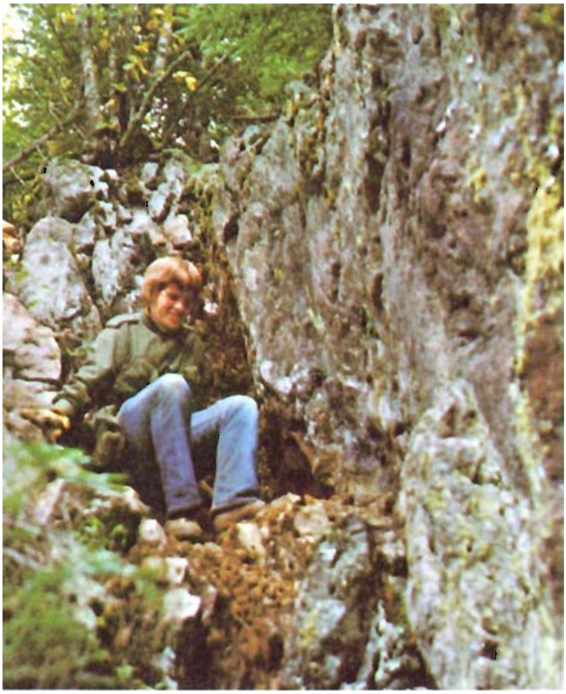

Photo 37. *Vug lined with dark purple amethyst was found in vein alongside massive wall of granitic rock on Thorsteinson's property.*

Photo 38. *Answering the call of amethyst prospects in the Ontario northland.*

AMETHYST OCCURRENCES

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Hastings	Faraday Tp.	Highway 62 roadcut, 2 1/2 miles (4 km) NNW of Bancroft			Occurrence of augite, diopside, amethyst, hornblende, apatite, calcite.	Gibson, Ontario Division of Mines 1975
	Monteagle Tp.	Near Hybla, 7 miles (11 km) NNE of Bancroft		Plunkett Feldspar Mine	Occurrence of amazonite, peristerite, amethyst, hatchettolite (formerly ellsworthite, betafite), sphene.	Gibson, Ontario Division of Mines 1975
Nipissing	Boulter Tp.	Con. XIII, 1 1/2 miles (2.4 km) E of township boundary			Narrow (less than 1 inch) vein with quartz and amethyst in granite outcrop.	E. Freeman, personal communication
	French Tp.	East of Indian Lake, 19 miles (30 km) NE of North Bay			Amethyst find reported but not examined by author.	Lumbers, ODMNA 1971, p. 94
Thunder Bay	Arrow Lake Area	Mining location R277 (W of Lismore Tp)			Veins of amethyst, calcite, & fluorite on north shore of Arrow Lake. Veins 30-45 cm and 10 cm wide.	Tanton, GSC 1931, Memoir 167, p. 108
	Arrow Lake Area	Mining location T11			Amethyst and chalcedony in stringers at east side of Frog Lake. Stringers 1-5 cm. wide.	Tanton, GSC 1931, Memoir 167, p.108

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	Little Gull Lake Area	Mining location R367 & mining claim TB4417 (W. of Strange Tp.)			Amethyst with coarse-grained calcite and quartz. The vein material occupies an approximate width of 180 cm in two separate brecciated fault zones of 180 cm each through taconite & iron formation.	Tanton, GSC 1931, Memoir 167, p. 105.
	Little Gull Lake Area	Mining location X124			Veinlets up to 7.5 cm wide traverse 6 m wide zone in granite. Wider parts of veins show bands of quartz, calcite & fluorite with free growing amethyst crystals projecting into central vugs.	Tanton, GSC 1931, Memoir 167, p. 107.
	Loon Lake Area	West of McTavish Tp.			Veins comprised of amethyst, white quartz, barite, galena, zincblende, & chalcopyrite, also some sphalerite. Veins are found in fractures in granite & pegmatite. They vary in width from 10 to 17 cm.	Tanton, GSC 1931, Memoir 167, p. 162.

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS at CLAIMS	NAME at MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	Mazokama Bay Area	Mining claim TB4588 (east of Nipigon)			Amethyst found with calcite in veins of quartz and barite in a fracture zone in arenaceous tuff. Minor galena, sphalerite, chalcopyrite & pyrite are present.	Tanton, GSC 1931, Memoir 167, p. 183.
	Mazokama Bay Area	Mining claim TB6038 (east of Nipigon)			Composite vein of amethyst, white calcite, white quartz, & barite along with galena & sphalerite cements a shatter zone in pegmatitic granite-gneiss. Three parallel veins. 25-60 cm wide are interconnected by veinlets about 5 cm wide.	Tanton, GSC 1931, Memoir 167, p. 182.
	Whitfish Lake Area	West of Strange Tp.		Scripture's Vein Caldwell's Vein	Amethyst & white quartz comprise the vein material in faults cutting iron formation & overlying shales & diabase sill.	Tanton, GSC 1931, Memoir 167, p. 110.
	Crooks Tp.	Prince Bay		Prince's Mine	Vein more than 2 m wide has calcite with barite at centre flanked by quartz and amethyst.	Tanton, GSC 1931, Memoir 167, p. 193-4.

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	Gillies Tp.	Mining location T146	Patented Land		Veins of amethyst & white quartz, calcite. & some zincblende & pyrite. Vein up to 10 cm. wide.	Tanton, GSC 1931, Memoir 167, p. 134-5.
	Gillies Tp.	Mining location T95	Patented Land	Silver Creek Mine	Fissured & brecciated zone cemented with vein material of amethyst, calcite, white quartz, fluorite, galena, zincblende, pyrite, & argentite.	Tanton, GSC 1931, Memoir 167, p. 129.
	Hardwick Tp.	Mining location T173			Amethyst, white quartz & calcite vein in east facing cliff. Vein 125 cm wide.	Tanton, GSC 1931, Memoir 167, p. 110-11.
	Lismore Tp.	Mining location R80 & R81 (Sunset Lake)			Amethyst with well-developed crystal terminations, also white calcite, & white quartz in vein 60 cm wide.	Tanton, GSC 1931, Memoir 167, p. 114
	Lismore Tp.	Mining location R61 (SE of Silver Mountain)		Scripture's Vein	In centre of vein irregular developments & vug linings of white quartz & amethyst with well-terminated crystals. Vein material is white calcite, barite, green fluorite. Vein cuts grey taconite & overlying diabase & is from 60-100 cm wide.	Tanton, GSC 1931, Memoir 167, p. 114

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	Lybster Tp.	Mining locations R53-57		Silver Mountain Mines	Vein material of amethyst. calcite, barite, smoky & white quartz, fluorite zincblende, galena, pyrite, chalcopyrite, native silver, & argentite. Amethyst & calcite in walls of vugs are encrusted with pyrite. Most veins 5-8 cm in width.	Tanton, GSC 1931, Memoir 167, p. 115-117
	Lybster Tp.	Mining location R64 (Silver Mountain Area)	Patented Land		Large veins from 1 to 2.5 m wide contain amethyst, quartz, green fluorite, calcite & locally barite. Occasional metallic minerals include sphalerite. galena & pyrite. Veins cut iron formation.	Tanton, GSC 1931, Memoir 167, p. 118-19
	Lybster Tp.	Mining location R98	Patented Land	Palisades Mine	Amethyst, calcite, & white quartz compose the vein material with small amounts of galena, zincblende, & pyrite. The veins have a total width of 60 cm.	Tanton, GSC 1931, Memoir 167, p.121-2

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	Lybster Tp.	Mining location R110 (Silver Falls)	Patented Land		Composite vein composed of amethyst. quartz, white calcite, purple fluorite, barite, & some pink dolomite. Some galena, chalcopyrite, & pyrite also present.	Tanton, GSC 1931, Memoir 167, p. 121
	Lybster Tp.	Mining location R115	Patented Land		Vein of coarse-grained amethyst, white quartz, white calcite, & green fluorite, with local mineralization of galena & sphalerite. Vein is about 45 cm wide.	Tanton, GSC 1931, Memoir 167, p120
	Lybster Tp.	Mining location R135	Patented Land	Woodside's Vein	Network of veins through granite which are composed of amethyst, white calcite, white quartz, fluorite, galena, pyrite, & zincblende. Veins in a zone 350 cm wide.	Tanton, GSC 1931, Memoir 167, p.119-20
	MacGregor Tp.	Amethyst Harbour	Patented Land		Purple amethyst in clusters of several feet in diameter; crystals 1/4 inch to 5 inch (0.63 to 12.7 cm) long.	Traill, GSC 1970, Paper 69-45. p.463

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	MacGregor Tp.	Mining location 3A	Patented Land	Three A Mine	Veins of amethyst, white quartz, calcite, barite, zincblende, galena, pyrite, marcasite, & chalcopyrite in country rock of altered Keewatin lavas.	Tanton, GSC 1931, Memoir 167, p.158
	MacGregor Tp.	Mouth of MacKenzie River	Patented Land		Purple amethyst in clusters of several feet in diameter; crystals 1/4 inch to 5 inches (.63 to 12.7cm) long.	Traill, GSC 1970, Paper 69-45, p.463
	MacGregor Tp.	1/4 mile 1/2 km) west of mouth of MacKenzie River	Patented Land. Surface rights only		Specimens of amethyst are present in the National Mineral Collection.	Traill, GSC 1970, Paper 69-45, p. 464
	Marks Tp.	Lot 12 Con 1 (Echo Lake)			Beautiful crystals of amethyst reportedly taken, presumably, from a silver-bearing vein.	Tanton, GSC 1931, Memoir 167, p. 122
	Marks Tp.	Lot 4, Con. VI			Amethyst and quartz veinlets through granite.	Tanton, GSC 1931, Memoir 167, p. 122
	McIntyre Tp.	Within city limits of Port Arthur		Current River Veins	Veins of amethyst & quartz with disseminated galena & chalcopyrite. Veins up to 125 cm wide.	Tanton, GSC 1931, Memoir 167, p. 155

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	McIntyre Tp.	Mining location A		Emmon's Mine	Thick vein of amethyst showing with predominant white calcite plus some galena, mispickel, pyrite, & rarely chalcopyrite. Vein is 250 cm wide. Smaller 15 cm quartz veins are common.	Tanton, GSC 1931, Memoir 167, p. 150
	McIntyre Tp.	Mining Locations 8 & 9		Shuniah Mine	Amethyst & quartz in coarsely crystalline calcite with white fluorite & some galena, sphalerite, chalcopyrite & pyrite in middle of vein. Walls of vein lined with intimately associated quartz, pink & white calcite, green fluorite, sphalerite and galena. Native silver & argentite concentrated in sphalerite rich areas. Veins cement fissures & shatter zone in 20-foot (6m) wide fault zone.	Tanton, GSC 1931, Memoir 167, p.153-5
	McIntyre Tp.	Mining location 17		Osmun Vein	Composite vein of amethyst, white quartz, calcite, fluorite, a little galena. & chalcopyrite cutting through shale & cherty iron carbonate. The largest vein is 20 cm wide.	Tanton, GSC 1931, Memoir 167, p.151

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	McIntyre Tp.	Mining section 47			Veins of amethyst, calcite, & white quartz with some galena in country rock of cherty & shaly iron formation. The veins average about 5 cm in width.	Tanton, GSC 1931, Memoir 167, p.148
	McIntyre Tp.	Mining section 53			Series of veins of amethyst, quartz, calcite, barite, fluorite, sphalerite, and marcasite.	Tanton, GSC 1931, Memoir 167, p.151-2
	McTavish Tp.	Mineral lot A, S1/2	Patented for surface rights only		Minor amethyst in 30 cm wide quartz vein cutting biotite quartz rnonzonite.	McIlwaine, ODM P.721 and unpublished information
	McTavish Tp.	Mineral lot C	Patented Land	Enterprise Mine	Amethyst locally with galena, chalcopyrite, & barite in vein of calcite & white quartz. The largest vein has a width of 125 cm & is reported to pinch out at a depth of 55 m.	Tanton, GSC 1931, Memoir 167, p.168 McIlwaine, ODM, P.721
	McTavish Tp.	N1/2 Mineral lot C (1/4 mi. NNW of Enterprise Mine)	Patented Land		Amethyst found in a brecciated 5 cm vein along with chert fragments & galena.	McIlwaine, ODM, P.721 and unpublished information
	McTavish Tp.	N1/2 Mineral lot E	Patented Land		Minor amethyst occurring on joint faces in leucocratic biotite rnonzonite. Blocky character of rock exposed in quarry face.	McIlwaine, ODM, P.721 and unpublished information

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	McTavish Tp.	Mining location 1Z (Blende Lake)	Patented Land		Vein network cements 6 m wide fault zone. Larger vein of 60 cm width contains amethyst, white quartz, calcite & barite with some galena & sphalerite. Fault cuts Animikie sediments & overlying diabase.	Tanton, GSC 1931, Memoir 167, p.161
	McTavish Tp.	Section 8 Con VI (Silver Lake Area)			Vein of 30 cm width consists of amethyst, quartz. galena, sphalerite & some pyrite; other veins contain calcite, barite and fluorite as well.	Tanton, GSC 1931, Memoir 167, p.163
	McTavish Tp.	Mineral lot 2	Patented for surface rights only		Two outcrops in porphyritic biotite quartz monzonite both with pale amethyst. Northern location has 1 cm amethyst crystals in 2-4 cm wide vein. The southern occurrence of amethyst is minor.	McIlwaine, ODM, P.721 and unpublished information
	McTavish Tp.	Mineral lot 13			Minor amethyst & pyrite associated with 30 cm wide quartz vein cutting red dolomitic mudstone.	McIlwaine, ODM, P.721 and unpublished information
	McTavish Tp.	NW1/4, Section 2, Con 1	Patented Land		Amethyst & galena in vertical massive quartz veinlets over 40 cm wide cutting hematized leucocratic quartz monzonite.	McIlwaine, ODM, P.721 and unpublished information

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	McTavish Tp.	SW1/4, Section 3, Con. III			Minor amethyst occurs in several quartz veinlets in a biotite quartz monzonite host rock.	McIlwaine, ODM, P.720 and unpublished information
	McTavish Tp.	NW1/4, Section 4, Con. III	Patented for surface rights only		Amethyst crystals up to 1 cm occur in veinlets in a 10 m wide silicified zone.	McIlwaine, ODM, P.720 and unpublished information
	McTavish Tp.	SW1/4, Section 4, Con III			Small amounts of amethyst in quartz veins with galena mineralizations. Country rock cut by quartz veins is silicified red dolomitic mudstone. Individual veins up to 4 cm wide in 2 m wide area.	McIlwaine, ODM, P.720 and unpublished information
	McTavish Tp.	SW1/4, Section 5, Con. III			Minor amethyst & some chalcopyrite in 5 cm to 30 cm wide quartz veins cutting biotite quartz monzonite. Amethyst commonly hematite-coated in occurrence west of road.	McIlwaine, ODM, P.720 and unpublished information
	McTavish Tp.	SE1/4, Section 4, Con. IV	Patented Land	Detroit-Algoma Mine	Amethyst, pyrite & barite developed late in quartz-calcite veins carrying galena, sphalerite & chalcopyrite. Veins cement 4.5 m wide brecciated fault zone.	Tanton, GSC 1931, Memoir 167, p.164-165

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	McTavish Tp.	SW1/4, Section 4, Con. IV	Patented for surface rights only		Minor amethyst in veins cutting buff arenite of the Sibley Group. East of road 5 cm quartz vein also contains pyrite. West of road amethyst is associated with sphalerite & galena in vein of quartz, carbonate & brecciated sandstone.	McIlwaine, ODM, P.720 and unpublished information
	McTavish Tp.	NE1/4, Section 5, Con. IV			Amethyst, occasionally hematite coated, occurs in quartz veins cementing brecciated quartz monzonite. Chalcopyrite, galena & sphalerite are associated.	McIlwaine, ODM, p.720 and unpublished information
	McTavish Tp.	Section 5, Con. VII			Amethyst in vugs in 30 cm wide quartz vein cutting biotite quartz monzonite. Vein carries inclusions of pegmatite & also some galena.	McIlwaine, ODM, p.720-721
	McTavish Tp.	Section 1, Con. VIII			Amethyst in vuggy 25 cm wide quartz vein cutting hematized muscovite quartz monzonite. Vein pinches and swells.	McIlwaine, ODM, p.720 and unpublished information

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	Neebing Tp.	N1/2, Lot 17, Con. IV			Amethyst bearing quartz-calcite veins up to 60 cm wide cut Animikie iron formation. Locally the veins are well mineralized with galena, chalcopyrite and sphalerite.	Tanton, GSC 1931, Memoir 167, p.147
	Neebing Tp.	Lots 24 & 25, Con. V		Neepatyre Mine	Vugs & seams in coarsely crystalline calcite are lined with white quartz & amethyst. Galena & chalcopyrite occur sparsely disseminated in 9 m wide nearly solid mass of calcite.	Tanton, GSC 1931, Memoir 167, p.144-6
	O'Connor Tp.	Lot 1, Con. II		Empress Mine-Royal Vein	Composite amethyst bearing quartz-calcite vein with some sphalerite & galena occupies 1 m wide shatter zone in flat lying Animikie iron formation. Mineralized fissures respectively 35-55 cm & 10 cm wide.	Tanton, GSC 1931, Memoir 167, p.123-4

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	O'Connor Tp.	Mining location T145	Patented Land	Climax (or Keystone) Mine	Three 1-foot (0.3 m) wide composite veins in shale capped by diabase consist of amethyst, white quartz, calcite, fluorite, sphalerite, galena, pyrite & argentite. Individual veins are 7.5-15 cm wide & one vein occupies fault zone.	Tanton, GSC 1931, Memoir 167, p.127
	O'Connor Tp.	Mining location T140	Patented Land	West Beaver Mine	Two composite veins in shatter zones cutting Animikie shale contain calcite, quartz, amethyst. fluorite, sphalerite & some galena, pyrite & argentite. Rose quartz, pyrrhotite & chalcopyrite are found in addition in one of the veins.	Tanton, GSC 1931, Memoir 167, p.128
	O'Connor Tp.	Mining location T142	Patented Land		Composite 120 cm wide barite-quartz-calcite vein with locally amethyst, green & purple fluorite, pale yellow sphalerite & pyrite cutting shale & overlying diabase.	Tanton, GSC 1931, Memoir 167, p.131-2

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	Oliver Tp.	S1/2, Lot 5, Con. II			Composite 300 cm wide vein of amethyst, white calcite, white & yellow quartz. & some pyrite, galena, & marcasite cuts cherty iron formation.	Tanton, GSC 1931, Memoir 167, p.143
	Oliver Tp.	Lot 1, Con. V			Brecciated fault zone in amphibolite & diorite occupied by composite vein of amethyst, fluorite, calcite, quartz along with some galena & zincblende. The vein material occupies width of about 75 cm.	Tanton, GSC 1931, Memoir 167, p.143
	Paipoonge Tp.	Lot 20, Con. A & lots 20 & 21 Con.	Patented Land	Paresseux Rapids Vein	Series of veins through fissured greenalite-taconite. Individual veins have, from walls inward, fluorite, white quartz, calcite, amethyst & pyrite; sphalerite and galena are associated with fluorite. Veinlets are 1/2 to 10 cm wide.	Tanton, GSC 1931, Memoir 167, p.139
	Paipoonge Tp.	S1/2, Lot 26, Con. B	Patented Land. Surface rights only	Federal Mine (Copeland' Vein)	Composite vein cements fissures in fault zone. Amethyst, calcite, quartz. rose quartz, fluorite, barite, zincblende, galena, pyrite, marcasite & argentite constitute vein materials.	Tanton, GSC 1931, Memoir 167, p.138

COUNTY or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	Paipoonge Tp.	Lot 7, Con. C	Patented Land. Surface rights only	Victoria Mine	Composite vein cements 125 cm wide fracturezone in cherty iron formation. Vein minerals are calcite, amethyst, quartz, fluorite, galena, sphalerite & pyrite.	Tanton, GSC 1931, Memoir 167, p.134
	PaipoongeTp.	Lots 10 & 11, Con. C	Patented Land. Surface rights only.		Composite veins occupy parallel shatter zones in flat lying iron formation. Veins consist of coarsely crystalline, colourless. pale amethystine & rose quartz with some calcite & fluorite & locally galena and pyrite.	Tanton, GSC 1931, Memoir 167, p.134
	PaipoongeTp.	Lot 2, Con. D	Patented Land. Surface rights only.		Veinsof amethyst, calcite. & white quartz in a vertical fracture zone cutting black shales capped by diabase sill. Veins may be as wide as 10 cm.	Tanton GSC 1931, Memoir 167, p.133
	PaipoongeTp.	Lot 5, Con. D	Patented Land. Surface rights only.	Rothwell Mine	Ramifying veinlets of amethyst, white quartz & calcite in 60 cm wide fracture zone cutting flat-lying black shales.	Tanton. GSC 1931, Memoir 167, p.132

COUNTV or DISTRICT	AREA or TOWNSHIP	LOCATION	STATUS of CLAIMS	NAME of MINE	DESCRIPTIVE REMARKS	REFERENCE
Thunder Bay	Paipoonge Tp.	Lot 34, Con. II	Patented Land	Big Bear Vein	Vein minerals are amethyst, calcite, colourless quartz, fluorite, zincblende, galena, & pyrite. Composite vein occupies 60 cm wide fracture zone in black, flat-lying shales.	Tanton, GSC 1931, Memoir 167, p.137-8
	Paipoonge Tp.	Lot 19, Con. II	Patented Land	Parsons' or Lily of the Valley Mine	Composite veins of pale amethyst, quartz & calcite cement shatter zone in grey shale. Single veins are about 20-25 cm wide.	Tanton, GSC 1931, Memoir 167, p.138-9
	Scoble Tp.	Lot 10, Con. C		Rabbit Mountain Mine	Vein of amethyst, quartz, calcite, barite, fluorite. sphalerite, galena, pyrite, chalcopyrite, argentite & native silver. Veins cement 1 to 7 m wide brecciated zones along faults in the area.	Tanton, GSC 1931, Memoir 167, p.135-7
	Scoble Tp.	Mining Location T57		Rabbit Mountain Junior Mine	Vein of arnethyst, calcite, white quartz, fluorite, zincblende, chalcopyrite & pyrite in diabase.	Tanton, GSC 1931, Memoir 167, p.137
	Strange Tp.	Lot 5, Con. V		Star Mine	Vein of arnethyst, clear quartz, calcite, green fluorite, & some pyrite in 2 1/2-3 m wide fracture zone in flat-lying iron formation. Spectacular crystals of clear quartz up to 6 1/4 cm in diameter were found.	Tanton, GSC 1931, Memoir 167, p.113

GLOSSARY

Adit. A nearly horizontal passage by which a mine is entered or dewatered.

Agate. A banded silica found as nodules and amygdule fillings in basic lava flows.

Amazonite. An apple-green, bright green, or blue-green laminated variety of microcline, sometimes used as a gemstone.

Amorphous. Applied to rocks and minerals having no definite crystalline structure.

Amphibole. Rock-forming minerals of complex composition. Hydrous silicates, usually with aluminium, calcium, iron and magnesium.

Amygdule. A gas cavity in igneous rocks which is filled with such secondary minerals as zeolite, calcite or quartz.

Apatite. A mineral consisting of calcium phosphate.

Aplite. A light-coloured hypabyssal igneous rock characterized by a fine-grained texture consisting essentially of quartz, potassium feldspar, and acid plagioclase.

Arenite. A general name used for consolidated sedimentary rocks composed of sand-sized particles irrespective of composition.

Argentite. A dark lead-grey monoclinic mineral Ag_2S, a valuable ore of silver.

Argillite. A moderately metamorphosed shale.

Augite. A common mineral of the clinopyroxene group (Cu, Na) (Mg, Fe^{+2}, Al) (Si, $Al)_2O_6$.

Barite. Principal ore mineral of barium ($BaSO_4$).

Basal conglomerate. A coarse conglomerate usually found above an unconformity; the first material deposited after an erosional gap.

Basalt. A lava made up mainly of the minerals pyroxene or amphibole and feldspar, with or without olivine, of basic composition and dark colour.

Biotite. A black, dark brown or dark green mica.

Bloodstone. A semi-translucent and leek green or dark green variety of chalcedony speckled with red or brownish red spots of jasper resembling drops of blood.

Brazil twinning. Intergrowth of right-handed with left-handed quartz crystals.

Breccia. A fragmental material, the pieces of which are of angular shape, for example volcanic breccia, sedimentary breccia, fault breccia.

Cabochon. An unfaceted cut gemstone of domed, or convex form. The top is unfaceted and smoothly polished; the back, or base, is usually flat, or slightly convex, and often is unpolished. The girdle outline may be round, oval, square, or any other shape.

Calcite. A vein mineral and rock-forming mineral having the composition calcium carbonate ($CaCO_3$).

Carat. A unit of weight for pearls, diamonds, and other gems and formerly equal to 3 1/6 troy grains (205 mg). A carat-grain is one-fourth of a carat. The international metric carat (abbreviated MC) of 200 mg was made the standard in the United States (1913), as it was the standard in such countries as Great Britain, France, Germany, Holland, and Japan.

Carbonate. A chemical compound which, on being heated, yields the gas carbon dioxide (e.g. calcite, dolomite, siderite).

Carnelian. A translucent to semi-translucent blood red, flesh red, reddish with orange-red, reddish yellow, or brownish red variety of chalcedony, pale to deep in shade, containing iron impurities. It is used for seals and in the manufacture of signet rings.

Chalcedony. A semi-transparent white, blue, brown or black variety of quartz with a wax-like lustre.

Chalcopyrite. An ore mineral of copper ($CuFeS_2$).

Chert. An extremely fine-grained form of silica.

Chrysoprase. An apple-green or pale yellowish green variety of chalcedony containing nickel and valued as a gem.

Citrine. A transparent yellow or yellow-brown (sometimes red-orange or orange-brown) variety of crystalline quartz closely resembling topaz in colour. It can be produced by heating amethyst or dark smoky quartz. Syn: topaz quartz; false topaz; Bohemian topaz; quartz topaz; yellow quartz.

Cleavage. The breaking of a mineral along crystallographic planes of weakness.

Colloid. A finely divided substance with smaller than clay-sized particles that occurs in non-crystalline form.

Conchoidal. Said of a type of rock or mineral fracture that gives a smoothly curved surface. It is the characteristic habit of quartz and obsidian.

Conglomerate. Cemented rock containing rounded fragments corresponding in their grade sizes to gravel or pebbles.

Consolidation. Processes in which loose earthy materials become firm and coherent rock.

Corundum. Aluminium oxide (Al_2O_3) occurring as shapeless grains or rhombohedral crystals which may vary in colour. Ruby and sapphire are gem varieties. It has a hardness of 9.

Country rock. The rock enclosing or traversed by a mineral deposit or igneous intrusion.

Cryptocrystalline. A rock or crystal which is so fine-grained that the individual components or crystals cannot be recognized with an ordinary microscope.

Crystal. A body that is formed by the solidification of a chemical element, compound or a mixture having a regularly repeating atomic arrangement that may be outwardly expressed by planar surfaces.

Datolite. A greenish monoclinic mineral ($CaB SiO_4(OH)$) commonly occurs in cracks and cavities in diabase and basalt.

Dauphiné twinning. Intergrowth of two right-handed or two left-handed quartz crystals, one of which is rotated 180° along c-axis.

Detritus. Loose rock and mineral material that has been worn or removed by mechanical means that is by disintegration and abrasion.

Diabase dike. A tabular intrusion composed of labradorite and pyroxene and having an ophitic texture.

Dichroism. The property of showing different colours when a crystal is viewed in the direction of two different axes.

Diopside. A calcium magnesium pyroxene found in metamorphosed limestone.

Diorite. An igneous rock composed of hornblende and plagioclase and having a composition intermediate between that of syenite and that of gabbro.

Dispersion. The variation of velocity of light passing through a crystal.

Dolomite. Calcium magnesium carbonate $CaMg(CO_3)_2$.

Druse. A crust of small crystals lining the sides of acavity, usually the same minerals as those that constitute the enclosing rock.

Emerald. A brilliant or grass-green variety of beryl highly prized as a gemstone. The rich, full green colour is caused by the presence of chromium and may vary from light green to blue-green.

Fault. A surface or zone rock fracture along which there has been displacement.

Fissure. A fracture or a crack in rock along which there is a distinct separation.

Float. An isolated, displaced fragment of rock within another rock or on the surface.

Fluorescence. The emission of light of minerals exposed to ultraviolet light.

Fluorite. A transparent to translucent mineral, (CaF_2) having a hardness of 4. It occurs as a gangue mineral in veins, as crystalline cubes, and may be many different colours (often blue or purple).

Fluorspar. See Fluorite.

Flint. The homogeneous, dark green to black variety of chert.

Fracture. The manner of breaking of a mineral other than along planes of cleavage.

Gabbro. A coarse textured igneous rock having the same composition as basalt, but commonly intrusive forming dikes or sills.

Galena. The principal ore of lead (PbS).

Gel. A jellylike material formed by partial cohesion of collodial particles.

Gem. A term used for any stone that has beauty, durability, size, and rarity.

Geode. A hollow globular body found mostly in limestone beds and basalts.

Ghost crystal. See Phantom Crystal.

Glacial drift. Loose debris of sand and gravel transported and deposited by glaciers.

Gneiss. A rock containing bands rich in granular minerals that alternate with bands rich in platy or micaceous minerals.

Granite. A coarse textured igneous rock made up of quartz, one or more feldspars and one or more micas and/or hornblende; usually found in batholiths. It is an acid rock, with a high silica content.

Greywacke. A fine-grained variety of sandstone with fragments of rock and rock minerals (quartz + feldspar) resulting from rapid erosion and sedimentation.

Greenalite. An earthy or pale green iron mineral $(Fe^{+2}, Fe^{+3})_{5-6}$ $-Si_4O_{10}(OH)_8$. Associated with iron ores in Mesabi District.

Habit. The characteristic crystal form or combination of forms, including characteristic irregularities, of a mineral.

Hatchettolite (Ellsworthite, Betafite). A yellow, brown, greenish or black uranium mineral of the Pyrochlore group $(Ca, Na, U)_2(Nb, Ta)_2O_6(0,0H)$ (Satterly, 1956, p.20-22).

Hematite. A common iron mineral having a red colour (Fe_2O_3).

Hornblende. A variety of amphibole, dark green or black in colour.

Igneous rock. A rock formed by the crystallization of molten, or partially molten matter (Magma).

Index of refraction. In crystal optics, a number that expresses the ratio of the velocity of light in a vacuo to the velocity of light in a crystal.

Intrusion. A body of igneous rock that formed within surrounding rock.

Iridescence. The exhibition of colours in the interior or from the surface of a mineral caused by interference of light from layers of different refractive index.

Iron formation. A sedimentary rock having an unusually high iron content.

Isotope. One of two or more species of the same chemical element i.e. the same number of protons in the nucleus but differing from one another by having different atomic weights.

Jasper. A dense, cryptocrystalline, opaque (to slightly translucent) variety of chert (always quartz) associated with iron ores and containing iron-oxide impurities that give the rock various colours, characteristically red, although yellow, green, greyish blue, brown and black cherts have also been called jaspers. The term has been applied to any red chert or chalcedony irrespective of associated iron ore. Syn: jasperite; jaspis; jasperoid.

Leaching. The removal of soluble minerals by a percolating liquid.

Leucocratic. Light coloured igneous rock relatively poor in mafic minerals.

Lode. A mineral deposit consisting of a zone of veins.

Luminescence. The emission of light by a substance that has received energy or electromagnetic radiation of a different wavelength from an external stimulus.

Lustre. The reflection of a light from a mineral surface, described by its quality and intensity.

Magma. A hot mass of molten or partially molten rock constituents formed at high temperature within the earth.

Marcasite. A popular term used in the gemstone trade to designate any of several minerals with a metallic lustre, and also polished steel and white metal.

Metallogeny. The study of the genesis of mineral deposits, with emphasis on their relationship in space and time to regional petrography and tectonism.

Metamorphic rock. A rock which has formed from a pre-existing rock as a result of changes in temperature or pressure or both.

Migmatite. A rock formed of gneiss interbanded with granite.

Mineral. A homogeneous, crystalline, naturally occurring inorganic compound.

Mispickel (Arsenopyrite). A tin white to steel grey mineral (FeAsS); the principal ore of arsenic.

Monzonite. A group of plutonic rocks containing equal amounts of plagioclase and orthoclase feldspar and little or no quartz.

Mudstone. A sedimentary rock consisting of clay and silt with no laminations or other sedimentary structures.

Muscovite. Transparent white mica.

Native Silver. Silver found in nature uncombined with other elements.

Onyx. A variety of chalcedony that is like banded agate in consisting of alternating bands of different colours (such as white and black, black and red, white and red, white and brown) but unlike it in that the bands are always straight and parallel.

Orogeny. The cycle of events during which a mountain chain is formed.

Pegmatite. A very coarse-grained igneous rock with interlocking grains. Usually found as irregular dikes, lenses and veins, especially at margins of batholiths.

Peristerite. A gem variety of albite.

Phantom Crystal. A crystal (such as quartz, calcite, and fluorite) within which an earlier stage of crystallization or growth is outlined by dust, tiny inclusions or bubbles, e.g. serpentine, containing a ghost or phantom of original olivine.

Plutonic. Pertaining to igneous rocks formed at great depth.

Polarized Light. Light changed so that its vibrations occur in a single plane.

Porphyry. An igneous rock of any composition that contains conspicuous phenocrysts in a fine-grained groundmass.

Prism. Any crystal form having 3, 4, 6, 8, or 12 faces with parallel intersection edges, and open only at two ends.

Pyramid. An open crystal form consistingof 3, 4, 6, 8 or 12 nonparallel faces that meet at a point.

Pyrite. A sulphide of iron (FeS_2) nicknamed "Fool's gold".

Pyrrhotite. A weakly magnetic sulphide of iron ($Fe_{1-x}S$). Frequently contains nickel.

Quartz. A vein mineral and rock-forming mineral composed of silica (SiO_2).

Quartz-monzonite. A granitic rock containing approximately equal amounts of quartz, potassium feldspar, and plagioclase feldspar, and some 5-10 per cent ferromagnesian minerals.

Refraction. The deflection of a light or of an energy ray due to its passage from one medium to another of different optical densities, which changes its velocity.

Rhombohedron. A trigonal crystal form that is a parallelepiped whose six identical faces are rhombs.

Rock crystal. Transparent quartz, especially when colourless.

Rock forming. Those minerals that enter into the composition of a rock and determine its classification. The more important rock-forming minerals include quartz, feldspars, micas, amphiboles, pyroxenes, olivine, calcite and dolomite.

Rose quartz. A pink to rose-red and commonly massive variety of crystalline quartz often used as a gemstone or ornamental stone. The colour is perhaps due to titanium, and is destroyed or becomes paler on exposure to strong sunlight.

Sandstone. A compacted sand made up largely of quartz grains.

Schillerization. The play of colour due to the arrangements of minute inclusions in a crystal.

Selvage. A marginal zone of a rock mass, having some distinctive feature of fabric or composition; specifically the chilled border of an igneous mass (as of a dike or lava flow), usually characterized by a finer grain or sometimes a glassy texture, such as the glassy inner margins on the pillows in pillow lava.

Sericite. A white, fine-grained potassium mica occurring in small scales and flakes as an alteration product of various aluminosilicate minerals, having a silky lustre, and found in various metamorphic rocks (especially in schists and phyllites) or in the wall rocks, fault gouge, and vein fillings of many ore deposits. It is usually muscovite or very close to muscovite in composition, and may also include much illite.

Shale. A laminated sediment in which the constituent particles are predominantly clay-sized.

Shatter zone. An area of randomly fissured or cracked rock, may be filled with mineral veins.

Silicified zone. An area of rock that has been partially or largely replaced by silica.

Sill. A tabular mass of igneous rock occurring within and parallel to the structure of older rocks.

Slickenside. A polished, smoothly striated surface resulting from friction along a fault plane.

Smoky quartz. A smoky yellow, smoky brown or brownish grey and often transparent variety of crystalline quartz sometimes used as a semiprecious gemstone. It often contains inclusions of both liquid and gaseous carbon dioxide. The colour is probably caused by some organic compound.

Specific gravity. The ratio of the mass of a body to the mass of an equal volume of water at a specified temperature.

Sphalerite. An ore mineral of zinc. (ZnS).

Sphene. A yellowish or brownish mineral $CaTiSiO_5$. Occurs as an accessory mineral in granitic and calcium-rich metamorphic rocks.

Strike and dip. The strike is the direction that a structural surface takes as it intersects the horizontal. The dip, measured perpendicular to the strike is the angle of inclination of the structure to the horizontal.

Syenite. An igneous rock that, except for the absence of quartz, is similar to granite in both appearance and composition.

Taconite. A variety of iron formation made up largely of tiny rounded bodies of granules of iron-bearing minerals and chert in a groundmass of chert or carbonate.

Tectonism. A term for all movement of the crust produced by the earth's interior forces.

Tetrahedron. A crystal form which has four faces, each of which is a triangle.

Topaz. A white, orthorhombic mineral: ($Al_2SiO_4(F,OH)_2$). It occurs as a minor constituent in highly siliceous igneous rocks and in tin-bearing veins as translucent or transparent prismatic crystals and as masses, and also as rounded water-worn pebbles. Topaz has a hardness of 8 on Mohs scale.

Tuff. A rock made up of dust and fine rock fragments from explosive volcanic activity.

Tripolite. An incoherent, highly siliceous sedimentary rock composed of the shells of diatoms or of radiolaria or of finely disintegrated chert.

Vein. A thin sheetlike intrusion into a crevice.

Vesicle. A small cavity in a lava caused by the segregation of gas upon extrusion at the surface. When filled with later minerals a vesicle is called an amygdule.

Volatiles. Materials such as water and carbon dioxide in molten rock which are found as concentrated gases.

Vug. A small cavity in a vein or in rock usually lined with crystals of a different mineral compositive from the enclosing rock.

Zeolites. A generic term for a group of hydrous aluminous silicates of Na, Ca, Ba, Sr, and K characterized by their easy and reversible loss of water of hydration.

Zincblende. A brown or black (sometimes yellow or white) isometric mineral ((Zn, Fe) S) more commonly known as sphalerite.

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GUIDEBOOKS OF THIS SERIES

Geological Guidebook No. 1. Geology and Scenery; Rainy Lake and East to Lake Superior.

Geological Guidebook No. 2. Geology and Scenery; North Shore of Lake Superior.

Geological Guidebook No. 3. Geology and Scenery; Peterborough, Bancroft and Madoc Area.

Geological Guidebook No. 4. Geology and Scenery; North Shore of Lake Huron Region.

Geological Guidebook No. 5. Amethyst Deposits of Ontario.

Other guidebooks are planned. The Publications Office, Ministry of Natural Resources, Queen's Park, Toronto, will be pleased to put you on their notification list.

APPENDIX

Mineral and Lapidary Dealers*

Nipigon Trout Outfitters
R. R. No. 1, Hwy. 17
Nipigon, Ontario

Nick Dzuba
R. R. No. 1
Pass Lake, Ontario

The Rock Shop, on Hwy. 17 North,
708 Queen Street East
Sault Ste. Marie, Ontario

Castagne's Rocks and Minerals
Box 594
Thunder Bay, P7B 5G1
Ontario

March of Dimes Ability Centre
237 Cameron Street
Thunder Bay 'P', Ontario

E. Schwendinger Mining and Minerals
P.O. Box 944, Postal Station P
Thunder Bay, Ontario

Thunder Bay Amethyst Mining Co.
178 Margaret Street
Thunder Bay, Ontario

Turcott's Gift and Rock Shop
Fort Friendship, Hwy. 17
P.O. Box 300
Wawa, Ontario

Exotic Amethyst Rock and Gift Shop
R. R. No. 1, Hwy. 11-17
3 miles west of Nipigon River Bridge
Nipigon, Ontario

Dave's Amethyst Rock and Gem Shop
Crystal Beach Service Station
Hwy. 17 East, 14 miles from
Thunder Bay, Ontario

T. Galarneau
Little Bear Amethyst Quarry
Box 753
Nipigon, Ontario

Harry Gurney and Son
Esso Service and General Store
Hwy. 17 East, 25 miles from
Nipigon, Ontario.

Mineral and Lapidary Club*

Thunder Bay Lapidary Club
Mrs. L.L. Grant, Secretary
R.R. No. 1
Thunder Bay, Ontario

*For other listings in Ontario see "Rocks and Mineral Information 1975", published by the Ontario Division of Mines, Ministry of Natural Resources, Queen's Park, Toronto, Ontario.

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