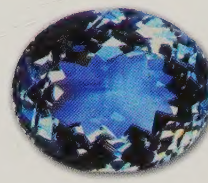
DK HANDBOOKS

GEMSTONES

CALLY HALL

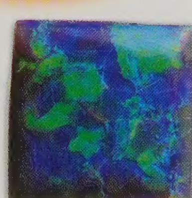
Rubellite

Azurite



Aquamarine

Pyrope



Precious Opal

Amethyst

DK HANDBOOKS
GEMSTONES

HANDBOOKS
GEMSTONES

CALLY HALL

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CONTENTS

AUTHOR'S INTRODUCTION

The mysterious appeal of gemstones, their exquisite colours, and the play of light within them, would alone have made them precious to many, but their rarity, hardness, and durability have made them doubly valuable. The natural beauty, strength, and resilience of gems have inspired beliefs in their supernatural origins and magical powers, and stones that have survived the centuries have gathered a wealth of history and romance around them.

THERE ARE OVER 3,000 different minerals, but only about 50 are commonly used as gemstones. Others are cut for collectors of the unusual, but are often not suitable for wear because they are too soft and easily scratched. In fact, the number of minerals regarded as gemstones constantly changes, as new sources and varieties are found and fashions change. Over 130 gem species, including some exceptionally rare stones, are described in this book, illustrating the very wide range of naturally occurring gemstones.

SORTING SAPPHIRES
Workers in Burma sort through sapphires collected from river sediment. When cut, they epitomize the allure of gemstones – beautiful, rare, and durable.

WHAT IS A GEMSTONE?

To be regarded as a gemstone, a mineral (or occasionally an organic material) must be beautiful, most importantly in its colour.

STAR SAPPHIRE (CABOCHON)

RIVER PEARL (UNCUT)

DIAMOND (BRILLIANT-CUT)

RUBY (STEP-CUT)

EMERALD (OCTAGONAL CABOCHON)

FIVE MAJOR GEMSTONES
These five stones are the most highly prized. All except pearl have a particular "cut" (shown in brackets) that brings out their best qualities.

A gemstone must also be durable – hard enough to survive constant use or handling without becoming scratched or damaged. Finally, it must be rare, because its very scarcity endows it with a greater market value.

The Science of Gemmology

Gems are scientifically fascinating, too. Gemmologists make a complete study of each stone, both as it is found in rocks and after it has been cut and polished. That is why the species entries in this book show the gem in its rough, natural state, perhaps still embedded in the host rock (or "matrix"), as well as after it has been cut, polished, or carved. Many entries also feature a micro-photograph which reveals the internal structure of the stone by magnifying it many times. In this world within a world the gemmologist may turn detective, being able to distinguish between two outwardly similar stones, or between a natural stone and a fake.

EMBLEMS OF POWER
The Cullinan I diamond (above), adorns the Royal Sceptre of the British Crown Jewels (right).

Kings and Commoners

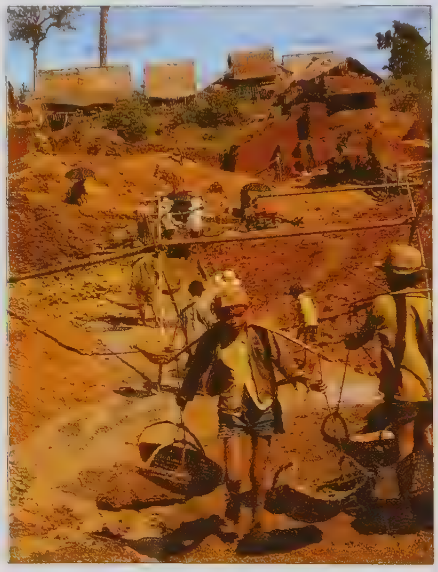
Throughout the ages, gemstones have been seen as representations of wealth and power. Symbols of supremacy, from crowns to richly decorated robes, have traditionally been adorned with jewels. But

PRIVATE COLLECTION
The Mathews collection in London comprises 4 boxes of unmounted gems from all around the world (above), and a group of Colombian emeralds (right). The scope of this collection is unique, but many fine examples of cut and uncut gemstones are on public display in museums.

gemstones are not just for the wealthy or the scientifically minded: they can be appreciated by anyone, from the amateur gem-spotter to the enthusiast who enjoys their beauty and history. For this reason, the *Gemstones Eyewitness Handbook* is not intended as a textbook, but as a general introduction and an initial guide to identification.

Collecting Gems

For many, the real satisfaction comes from actually owning gems. Most people cannot afford the more



Mining in Cambodia
In many parts of the world, traditional methods and equipment are still employed for the collection of gemstones.

expensive stones, but anybody can collect a few minerals that, even if not gem-quality, are still very attractive. You may even chance on a piece of amber on a beach, or come across a beautiful piece of jewellery in a local auction. No matter how modest your collection, it will give you hours of fascination and enjoyment.

A Box of Jewels
In the 18th century, jewelled trinkets like this decorative box were very fashionable. A large, citrine is in the centre, surrounded by amethyst, agates, amazonite, garnet, and pearls.

Fossicking in Australia
Fossicking (foraging) for sapphires and opals is still possible in parts of Australia, as long as you first obtain a permit from the authorities. River beds and streams are the best locations.

How This Book Works

THIS BOOK is divided into three parts: precious metals, cut stones, and organics. Cut stones are arranged by crystal structure into seven groups (cubic, tetragonal, hexagonal, trigonal, orthorhombic, monoclinic, and triclinic), but with a final section on amorphous gems. Within these sections, gem species are grouped with other species of a similar mineralogical type. The page below explains a typical entry.

What are Gemstones?

Gemstones are generally minerals that have been, or may be, fashioned to use for personal adornment. As a rule, they are beautiful, rare, and durable. Most are minerals: natural, inorganic materials with a fixed chemical composition and regular internal structure. A few gems, like amber and pearl, come from plants or animals, and are known as organics. Others, called synthetics, do not have a natural origin, but are made in laboratories. They have very similar physical properties to natural gems, and may be cut to imitate the real thing.

Precious Metals

The precious metals are gold, silver, and platinum. They are not true gemstones, but they are attractive and easily worked, often as settings for gems, and have their own intrinsic value. Platinum is the rarest and the most valuable.

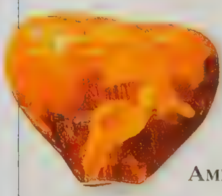
Gold Ring

Gold Nugget (Unworked)

Organics

Gem materials produced by living organisms are called "organic". Their sources are as diverse as shellfish (which produce pearls), polyps (whose skeletal remains form coral), and the fossilized resin of trees (which makes amber). Ivory, jet, and shell are also organics. These materials are not stones, and are not as durable as mineral gems. Instead of being cut in facets like mineral gems, they are usually polished or carved, or drilled and threaded as beads.

Amber Bead



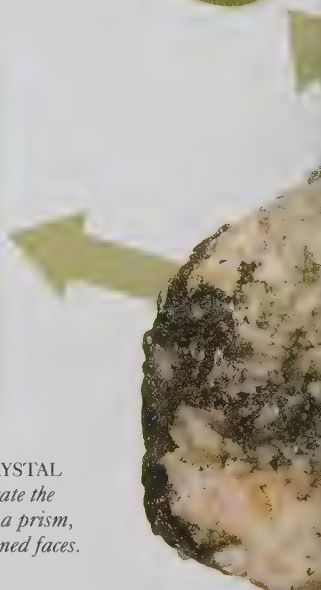
Amber Rough

Polished Stone

Crystals may be rounded and polished naturally (like this emerald pebble, rolled in a stream), or ground mechanically.

Natural Crystal

In its natural state the mineral may be a prism, with clearly defined faces.

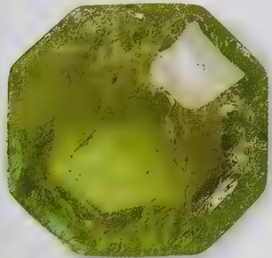


Cut Stones

Like the emerald shown here, almost all cut gems begin life in a crystalline form (see pp.18–19), embedded in a host rock known as the matrix. In this state, the stone is referred to as "rough". Many natural crystals are attractive enough to be displayed as they are. Others are faceted and polished to enhance their beauty (see pp.26–29), then set in a piece of jewellery or an ornament.

CABOCHON

A simple fashion for stones is to cut them en cabochon, *producing a domed, highly polished surface.*



FACETED STONE

Most gemstones are cut to give them a number of flat surfaces, called facets. The facets absorb and reflect light, to magical effect.

IMITATION EMERALD (GARNET ON GLASS)

IMITATIONS

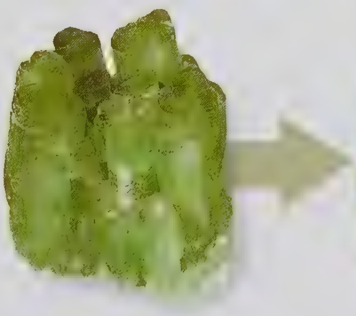
Gemstones have been imitated throughout the ages. Many lesser stones have been used, as well as glass paste and other man-made materials. Composite stones, like the red garnet on green glass (above), are made of more than one piece.

JEWELLERY

A piece of jewellery, usually one or several polished or faceted stones set in a mount of precious metal, is often the finished product.

SYNTHETICS

Man-made, synthetic stones (see pp.34–35) are similar in chemical composition and optical properties to their natural equivalents. In the flux method, crystals are grown, then faceted (right).

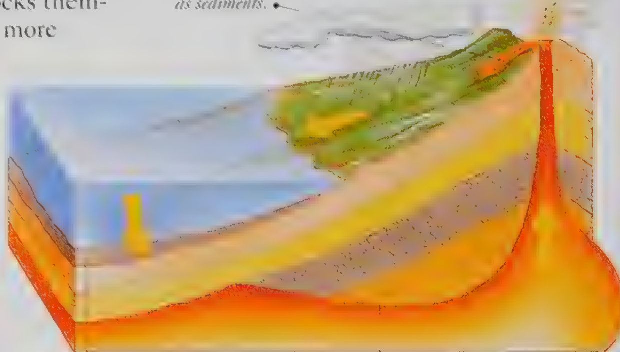


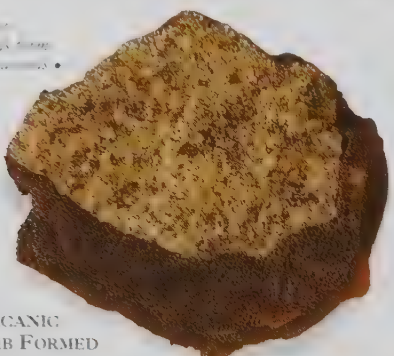
SYNTHETIC CRYSTALS

SYNTHETIC FACETED EMERALD

How Gemstones are Formed

Gemstones that have a mineral origin are found in rocks, or in gem gravels derived from these rocks. Rocks themselves are made up of one or more minerals, and may be divided into three main types. The formation of these three types – igneous, sedimentary, or metamorphic – is a continuous process, best described in terms of the rock cycle (shown right). Gem-quality minerals within these rocks may be easily accessible at the Earth's surface, or lie buried deep beneath it. Others, separated from their host rock by erosion, are carried by rivers to lakes or the sea.





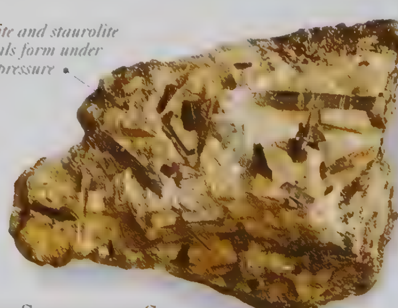
Volcanic Bomb Formed from Basaltic Lava

Igneous Rocks

Igneous rocks have solidified from molten rock, which comes from deep beneath the Earth's surface. Some, called "extrusive" igneous rocks, are thrown out from volcanoes as lava, volcanic bombs (see left), or ash. "Intrusive" igneous rocks are those that solidify beneath the surface. Essentially, the slower a rock cools and solidifies, the larger the crystals – and therefore the gemstones – formed within it. Many large gemstone crystals form in a kind of intrusive igneous rock known as pegmatite.

Metamorphic Rocks

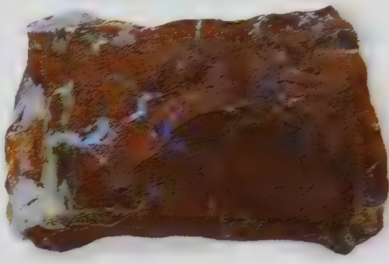
Metamorphic rocks are either igneous or sedimentary rocks that have been changed by heat and pressure within the Earth to form new rocks with new minerals. As this happens, gemstones can grow within them. Garnets, for example, form in rocks called mica schists, which were once mudstones and clays. Marble, formed from limestone that has been subjected to intense pressure and high temperatures, may contain rubies.



Kyanite-Staurolite Schist

Sedimentary Rocks

Sedimentary rocks are formed by the accumulation of rock fragments produced by weathering. In time, these fragments settle down and harden into rock once more. Sedimentary rocks are usually laid down in layers, and these may be shown as a feature in decorative stones. Most Australian opal occurs in sedimentary rocks; turquoise occurs mainly as veins in sedimentary rocks such as shale; halite and gypsum *are* sedimentary rocks.



Australian Opal in Sedimentary Rock

Organic Gems

Organic gems come from plants and animals. Natural pearls form around foreign bodies that have made their way inside the shells of marine or freshwater shellfish. Cultured pearls are produced artificially in large fisheries, many in the shallow waters off the shores of Japan and China. Shells treated as gems may come from animals as diverse as snails and turtles, living in the ocean, in fresh water, or on land. Coral is made up of the skeletons of tiny marine animals called coral polyps. Bone, or ivory from the teeth or tusks of mammals, may come from recently living animals or from fossils thousands of years old. Amber is fossilized tree resin, collected from soft sediments or the sea. Jet is fossilized wood, found in some sedimentary rocks.

Treasure from the Sea

The action of sea water has given this piece of amber (fossilized tree resin), washed up on a beach in Norfolk, England, a pitted and worn surface.

Modern Diamond Mine in Botswana

Some gemstones are so valuable that large-scale mining, in which tonnes of rock may be extracted to collect tiny amounts of gemstone, are still viable.

Alluvial Mining for Sapphires

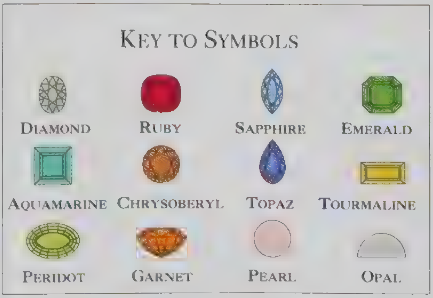
Small-scale mining with traditional methods and equipment, such as this in Sierra Leone, is still common in many under-developed countries.

WHERE GEMSTONES ARE FOUND

SOME GEM MINERALS, such as quartz and garnet, are found worldwide. Others, like diamonds and emeralds, are rarer, due to the more unusual geological conditions necessary for their formation. Even when a mineral is found worldwide, only a minute proportion may be of gem quality. The main gem localities of the world are therefore those where gem-quality material occurs in sufficient quantity to make production economic.

DIAMONDS OF AFRICA

The kimberlite rocks of southern Africa are mined in a modern, large-scale way, producing vast quantities of diamonds for both industrial and gem use.



TWELVE KEY GEMS

The 12 varieties of gemstone shown on this map represent some of the world's best-known gems. All are popular and highly prized, but some are far rarer than others.

Pearls in Japan

The shallow coastal waters of the Japanese islands offer ideal conditions for farming pearl oysters. Pearls are organic gems, and therefore independent of geological conditions.

World Distribution

This map shows the main localities for 12 key gems. Each gem may of course occur in other places, but probably not in sufficient quantities to make its extraction economic. Some sites, although historically important, may now be worked out.

Rubies in Burma

The rich mineral deposits of Mogok in Burma have yielded some of the world's finest rubies, although extraction is by traditional methods. Sapphires are also mined here.

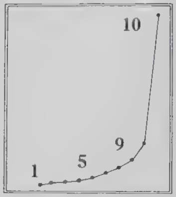
Physical Properties

THE PHYSICAL PROPERTIES of gemstones, their hardness, their specific gravity or density, and the way they break or "cleave", depend on chemical bonding and the atomic structure within the stone. For example, diamond is the hardest natural material known, and graphite is one of the softest, yet both are made of the same element, carbon. It is the way in which the carbon atoms are bonded together in diamond that gives it a greater hardness and resilience.

TESTERS
The point of each of these testing pencils is one of Mohs' minerals.

Hardness

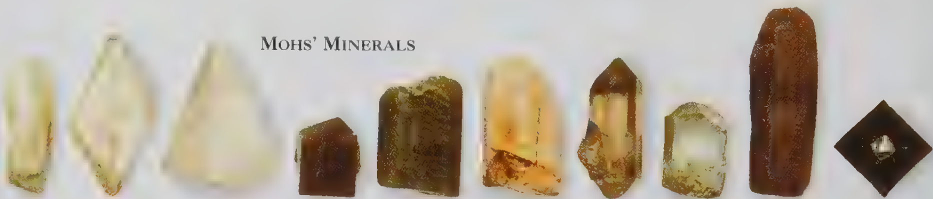
One of the key qualities of a gemstone, hardness may be measured by how well a stone resists scratching. Every stone can be tested and classified using the Mohs' scale of hardness (below), which gives every mineral a figure from one to ten. Intervals between numbers on the scale are not equal, most obviously between nine and ten (see the Knoop scale, right). Hardness testing is destructive, however, and should only be used on a gemstone if other tests fail.



KNOOP SCALE
This scale shows the indentation caused by a diamond point when it meets the surface of a mineral. The 10 stages correspond to Mohs' points.

MOHS' SCALE OF HARDNESS
The Mohs' scale was devised by the German mineralogist Friedrich Mohs as a means of classifying the relative hardness of minerals. He took ten common minerals and put them in order of "scratchability": each one will scratch those below it on the scale, but will be scratched by those above it.

MOHS' MINERALS



1 TALC 2 GYPSUM 3 CALCITE 4 FLUORITE 5 APATITE 6 ORTHOCLASE 7 QUARTZ 8 TOPAZ 9 CORUNDUM 10 DIAMOND

Specific Gravity

The specific gravity (SG) of a gem is an indication of its density. It is calculated by comparing the stone's weight with the weight of an equal volume of water. The greater a stone's specific gravity, the heavier it will feel. For example, a small cube of pyrite, with an SG of 5.2, will feel heavier than a larger piece of fluorite with an SG of 3.18; and a ruby (SG 4.00) will feel heavier than an emerald (SG 2.71) of similar size.

FLUORITE

PYRITE

RELATIVE WEIGHTS
The smaller piece of pyrite (SG 5.2) feels heavier than the fluorite (SG 3.18), because it is more dense.

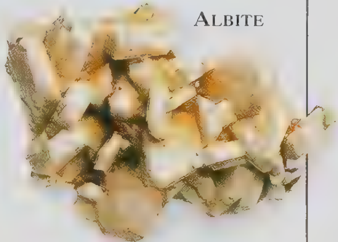
CLEAVAGE AND FRACTURE

Gemstones may break in two ways: they either cleave or they fracture. Which way they break depends on the internal atomic structure of the stone. Gems that cleave tend to break along planes of weak atomic bonding (cleavage planes). These planes are usually parallel, perpendicular, or diagonal to the crystal faces (as both planes and faces are directly related to the stone's atomic structure). A gemstone may have one or more directions of cleavage, which may be defined as perfect (almost perfectly smooth), distinct, or indistinct (examples are shown right). Gems with perfect cleavage include diamond, fluorite, spodumene, topaz, and calcite.

When a gemstone breaks along a surface that is *not* related to its internal atomic structure, it is said to fracture. Fracture surfaces are generally uneven, and each type has its own descriptive name, shown in the examples below and right.

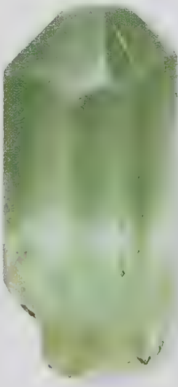
BARYTE

◁ PERFECT CLEAVAGE
Fragile baryte has three directions of easy cleavage, giving smooth surfaces.



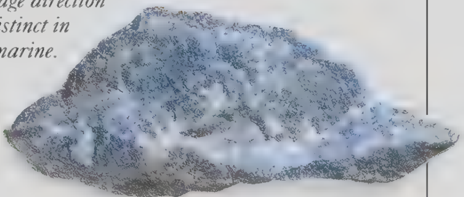
ALBITE

Δ DISTINCT CLEAVAGE
Although not perfectly smooth, albite's cleavage surfaces can be clearly seen.



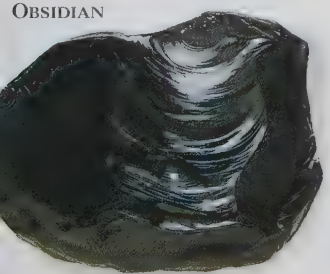
AQUAMARINE

◁ INDISTINCT CLEAVAGE
Cleavage direction is indistinct in aquamarine.



DUMORTIERITE

Δ UNEVEN FRACTURE
An uneven fracture surface is typical of fine-grained or massive gems like dumortierite.

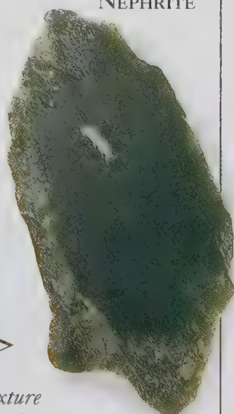


OBSIDIAN

Δ CONCHOIDAL FRACTURE
The type most commonly found in gemstones, the name refers to the shell-like fracture surface.

GOLD

HACKLY FRACTURE Δ
Rough, uneven fracture surface, seen on the right of this gold specimen.



NEPHRITE

SPLINTERY ▷ FRACTURE
Interlocking texture causes splintery fracture.

Crystal Shapes

Most mineral gemstones are crystalline, with their atoms arranged in regular and symmetrical patterns, like a lattice; a few are amorphous, with no or only a weak crystal structure. Crystalline minerals may consist of a single crystal, or of many in a group. Polycrystalline minerals are made up of many, usually small, crystals; in cryptocrystalline minerals the crystals are too small to see without the aid of a microscope.

Crystalline minerals are made up of a number of flat surfaces called faces; the orientation of these faces defines the overall shape, which is known as the "habit". Some minerals have a single, characteristic habit, such as pyramidal or prismatic; others may have several. A lump of crystalline mineral without a definite habit is called massive. Amorphous gemstones, like obsidian and tektites, have an irregular shape. Examples of common habits are shown right.

Twinning

Natural crystals are seldom perfect. Their growth is influenced by external factors such as temperature, pressure, space, and the medium in which they grow. One irregularity that may occur is known as "twinning" – when the internal structure of the crystal is repeated. Twins grow together in a number of different ways.

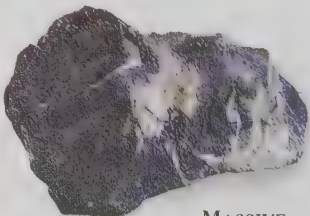
Twinned Amethyst

Amorphous

Pyramidal

Acicular (Needle-like)

Prismatic



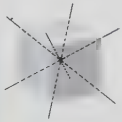
Massive

Dendritic

Crystal Systems

Crystals are classified into seven different systems, according to the "minimum symmetry" of their faces. This depends on a crystal's "axes of symmetry" – imaginary lines (shown in black in the artworks on this page) around which a crystal may rotate and still show identical aspects. The number of times the same aspect may be seen – in one 360-degree rotation around an axis – defines that axis as two-fold, three-fold, etc., up to six.

Pyrite

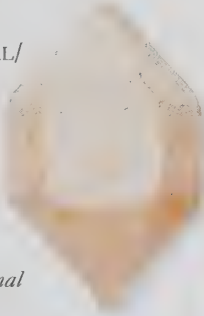


Cubic

Crystals in the cubic system (also known as the isometric system) have the highest symmetry, e.g. cubes, octahedra, and pentagonal dodecahedra. The minimum symmetry is four three-fold axes.

Hexagonal/Trigonal

These systems (thought by some to be one system) share the same axis of symmetry. Hexagonal crystals have six-fold symmetry; trigonal crystals three-fold.



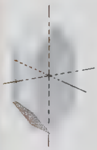
Milky Quartz

Tetragonal

This system is defined by one four-fold axis. Typical crystal shapes include four-sided prisms and pyramids, trapezohedra, and eight-sided pyramids.

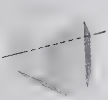
Zircon

Topaz



Orthorhombic

The minimum symmetry of this system is three two-fold axes. Typical crystal shapes are rhombic prisms and pyramids with basal pinacoids, and rhombic double pyramids.



Monoclinic

The monoclinic system has a minimum symmetry of one two-fold axis. Prisms with basal pinacoids are common crystal shapes found in this system.

Brazilianite

Triclinic

Triclinic crystals have no axis of symmetry, so gemstones within this system are the least symmetrical.

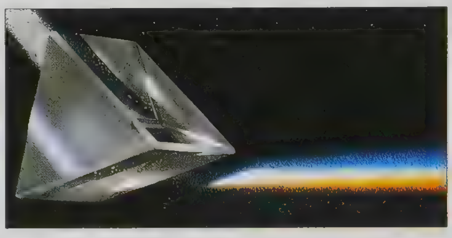
Axinite

OPTICAL PROPERTIES

COLOUR IS THE MOST OBVIOUS visual feature of a gem, but in fact it is just one of many optical properties, all of which are dependent upon light. The individual crystalline structure of a gemstone (see pp.18–19), interacts with light in a unique way, and determines the optical properties of each gem species. Effects produced by light passing *through* a gem are described here; those produced by the *reflection* of light are described on pages 22–23.

WHAT MAKES COLOUR?

The colour of a gem depends largely on the way it absorbs light. White light is made up of the colours of the rainbow (spectral colours), and when it strikes a gem some spectral colours are "preferentially absorbed". Those that are not absorbed, pass through or are reflected back, giving the gem its colour. Each gem in fact has a unique colour "fingerprint" (known as its absorption spectrum), but this is only visible when viewed with a spectroscope (see p.38). To the naked eye, many gems look the same colour.

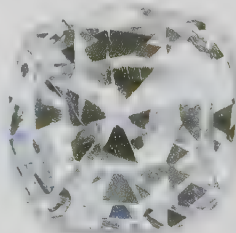


SPLITTING LIGHT THROUGH A PRISM
Splitting white light into its spectral colours is called dispersion, and gives gems their internal fire.

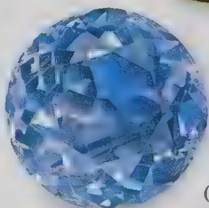
ALLOCHROMATIC GEMS

Allochromatic ("other-coloured") gems are coloured by trace elements or other impurities that are not an essential part of their chemical composition. Corundum, for example, is colourless when pure, but impurities in it (usually a metal oxide) create the red stones we know as rubies, blue, green, and yellow sapphires, and orange-pink padparadscha. Allochromatic gems are often susceptible to colour enhancement or change.

RUBY (RED CORUNDUM)



PURE CORUNDUM

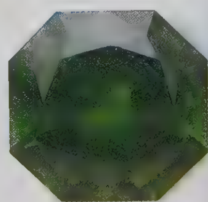


SAPPHIRE (BLUE CORUNDUM)

IDIOCHROMATIC GEMS

The colour of idiochromatic ("self-coloured") gems comes from elements that are an essential part of their chemical composition. Thus idiochromatic gems generally have only one colour, or show only a narrow range of colours. Peridot, for example, is always green, because the colour is derived from one of its essential constituents, iron.

PERIDOT



PERIDOT

Parti-coloured Gems

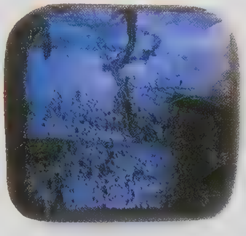
A crystal that consists of different-coloured parts is called parti-coloured. It may be made up of two colours (bicoloured), three (tricoloured), or more. The colour may be distributed unevenly within the crystal, or in zones associated with growth. The many different varieties of tourmaline probably show the best examples of parti-colouring, exhibiting as many as 15 different colours or shades within a single crystal.

bicoloured crystals can make attractive gemstones; junctions of colour zones may be distinct (as here) or gradual

WATERMELON TOURMALINE

Pleochroic Gems

Gems that appear one colour from one direction, but exhibit one or more other shades or colours when viewed from different directions, are known as pleochroic. Amorphous or cubic stones show one colour only; tetragonal, hexagonal, or trigonal stones show two colours (dichroic); orthorhombic, monoclinic, or triclinic stones may show three colours (trichroic).



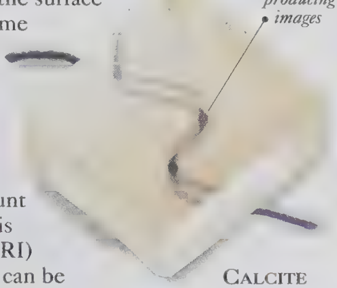
IOLITE (BLUE ASPECT)

iolite is strongly pleochroic: colourless from one direction; blue when rotated 90 degrees

IOLITE (COLOURLESS ASPECT)

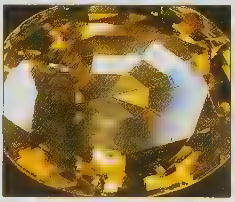
Refractive Index (RI)

When a ray of light meets the surface of a polished gemstone, some light is reflected, but most passes in. Because the gem has a different optical density from air, the light slows down and is bent from its original path (refracted). The amount of refraction within a gem is called its refractive index (RI) and, with the DR (below), can be used to help identify the stone.



calcite is highly birefringent, producing double images

CALCITE



SEEING DOUBLE
Zircon's back facets look doubled, due to strong double refraction (DR).

Birefringence (DR)

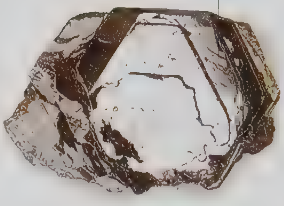
When viewed through a refractometer (far right), cubic minerals like spinel are singly refractive, showing a single shadow edge; doubly refractive minerals like tourmaline split light rays in two, producing two shadow edges. The difference between the two gives the "birefringence" (DR).

SPINEL

TOURMALINE

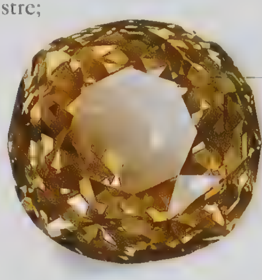
Lustre

The overall appearance of a gemstone, its "lustre", is determined by the way light is reflected from its surface. This is related to the degree of surface polish, which is generally greater the harder the stone is. Gemmologists use a variety of terms to describe lustre and its degree of intensity. "Splendent" means that the stone reflects light like a mirror; but if little light is reflected, the lustre may be described as "earthy" or "dull". Stones with a lustre comparable to diamond are described as "adamantine", and are the most desirable. In fact, most transparent, faceted gems have a glass-like, "vitreous" lustre; the precious metals have a "metallic" lustre; and organic gems show a range, from "resinous" to "pearly" and "waxy". Some gemstone species vary in their lustre: garnets, for example, range from the resinous hessonite garnet to the adamantine lustre of demantoid garnet. Rough lazulite and howlite have a dull, earthy lustre, which is vitreous after polishing.



hematite crystals, like pyrite and the precious metals, display metallic lustre

METALLIC LUSTRE

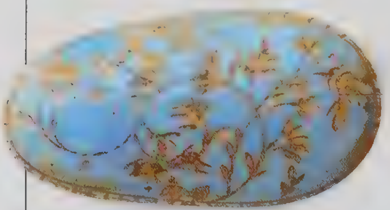


hard and highly polished, the look of a diamond defines adamantine lustre

ADAMANTINE LUSTRE

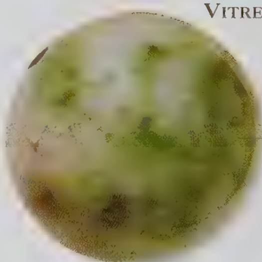
the glass-like lustre of this ruby is the most common for cut stones

VITREOUS LUSTRE



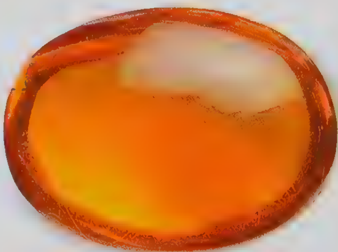
waxy lustre is most commonly associated with turquoise

WAXY LUSTRE



the greasy lustre of this polished imperial jadeite is comparatively rare

GREASY LUSTRE



organic gems, like this amber bead, may occur in a range of lustres, depending on the nature of the material

RESINOUS LUSTRE

satin spar gypsum is commonly cited to describe silky lustre

SILKY LUSTRE

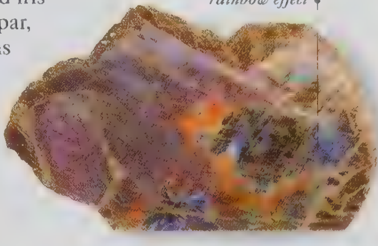
INTERFERENCE

Interference is an optical property caused by the reflection of light off structures within a gemstone. This internal reflection gives a play of colour. In some stones it will produce the full range of the spectral colours; in others just one colour may predominate. In opal, interference occurs because of the structure of the stone itself – spheres arranged in regular three-dimensional patterns. This produces the rainbow effect called iridescence, also shown by a number of other gems such as hematite, labradorite, and iris quartz. In moonstone feldspar, interference at the junctions of its internal layers (thin, alternating layers of different types of feldspar) produces a shimmering effect just below the surface of the stone, known as adularescence, opalescence, or a schiller (sheen).

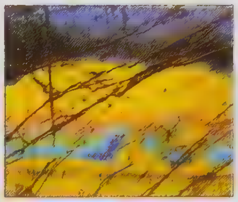
moonstone feldspar exhibits a bluish white shimmer or sheen

ADULARESCENCE

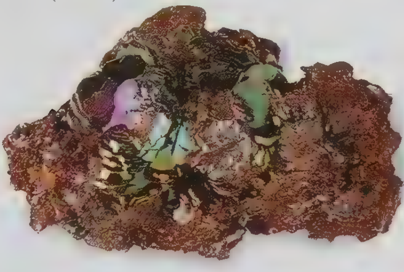
light reflected from labradorite gives a rainbow effect



IRIDESCENCE

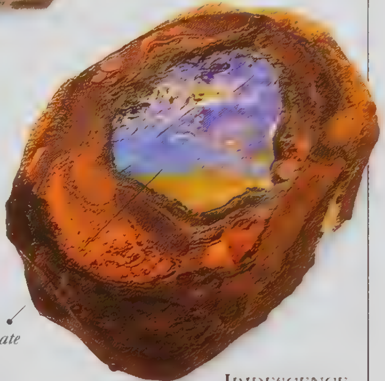


LIGHT LAYERS
Iridescence appears at layers within labradorite.



hematite shows a play of colour

IRIDESCENCE



blue and green may predominate within opal

IRIDESCENCE

CAT'S-EYES AND STARS

When a gemstone is cut *en cabochon* (with a domed, polished surface), light reflecting from the stone's internal features, such as cavities, or fibrous or needle-like inclusions (see pp.24–25), may create a cat's-eye effect (chatoyancy) or star stones (asterism). One set of parallel fibres gives rise to the cat's-eye effect; two sets of fibres produce a four-rayed star, three sets of fibres a six-rayed star, and so on.

reflection from acicular (needle-like) rutile crystals gives a six-rayed star

SAPPHIRE STAR STONE

parallel fibres within the stone produce the cat's-eye "flash"

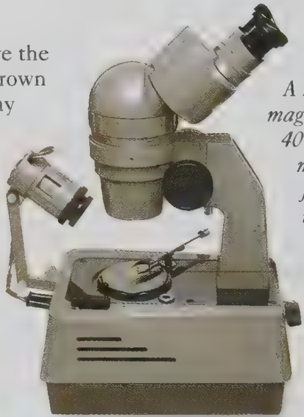
CHRYSOBERYL CAT'S-EYE

Natural Inclusions

Inclusions are internal features of gems. They may be solids, liquids, or gases that the crystal enclosed as it grew, or cleavages, cracks, and fractures that filled (or partly filled) after the host material finished growing. Although usually regarded as flaws, inclusions today are often seen as adding interest to a stone. They can also be invaluable in identifying a gem, because some are peculiar to a particular species, while others occur only in a particular locality.

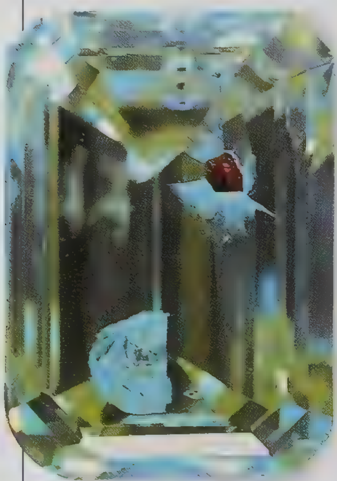
Formation of Inclusions

Solid inclusions have usually formed before the host stone – the crystals of the host have grown around them and enclosed them. They may be distinct crystals or amorphous masses. Solids and liquid inclusions formed at the same time as the host are aligned to its atomic structure. For instance, the stars in star rubies and sapphires are caused by needle-like crystals of rutile, which formed parallel to the crystal faces at the same time as the host corundum crystals. Cavities filled or fractures healed after the formation of the host give inclusions that resemble feathers, insect wings, or fingerprints.



Microscope
A microscope that magnifies between 10 and 40 times is one of the most useful instruments for examing inclusions in gemstones.

Diamond with Garnet
Solid inclusions may be the same gem type as the host, or different – like the garnet in this diamond.

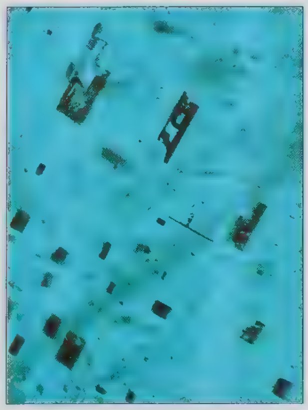


Peridot "Water Lily" (Magnified 30 times)
Inclusions that look like water lily leaves are a typical feature of peridot from Arizona, USA. They consist of a central chromite crystal surrounded by liquid droplets.

MOONSTONE "CENTIPEDES"
These insect-like inclusions (magnified 35 times) are a common feature of moonstone. In fact they are parallel cracks caused by strain.

INSECT IN AMBER
Insects are sometimes found trapped in amber, caught by the sticky resin as it was exuded. Insects have been added to some imitation amber to create a natural effect.

RUTILE NEEDLES
This carved rock crystal perfume bottle contains inclusions of needle-like rutile crystals. Tourmaline and gold are also found in rock crystal.



ALMANDINE GARNET (ABOVE)
Magnified 45 times, the grey patch on the left is a rounded apatite inclusion. The bright interference colours to the right are due to a zircon crystal.

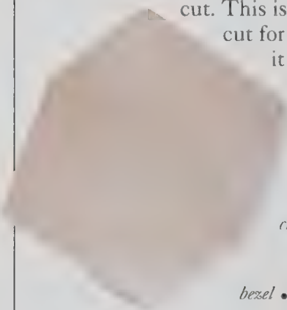
EMERALD (LEFT)
Rectangular cavities with tails (magnified 40 times) are sometimes found in natural Indian emeralds.

FACETING

THE MOST USUAL METHOD of fashioning a gem is to cut the surface into a number of flat faces, known as facets. This gives the stone its final shape, or "cut". The craftsman, or lapidary, who cuts the stone aims to show its best features, taking into account its colour, clarity, and weight. He may, however, have to compromise to retain weight and therefore value. The blue diagrams on the opposite page show the most popular cuts, and are used throughout the book.

HOW A STONE IS FACETED

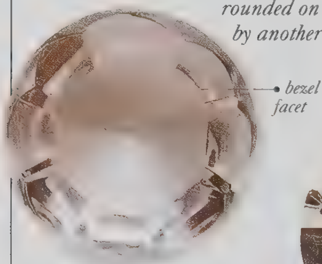
There are several stages in the cutting of a gemstone, each of which may be carried out by a different expert. In our example, a rough diamond crystal is fashioned into a brilliant-cut. This is the most popular cut for this stone because it maximizes the gem's naturally strong light dispersion. However, because each stone is a different shape, or has imperfections within it, or because retaining the weight is of paramount importance, the cut in its ideal form (the "make") may not be possible. Nevertheless, the essential aim is to make the diamond bright and "sparkling", showing flashes of colour called fire. To this end, the size, number, and angles of the facets are mathematically calculated. The rough crystal is sawn or cleaved to obtain a basic workable piece, then turned on a lathe against another diamond to give it a round shape. The facets are then cut and polished in stages, and the stone is given a final polish before mounting.



1. ROUGH
A rough diamond crystal is selected for faceting.

2. CUT
The top is cut off, and the stone rounded on a lathe by another diamond.

3. GRIND
The central facet – the flat table – is ground first, then the bezel facets.



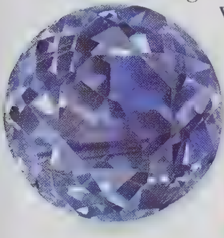
4. TOP AND BOTTOM
More facets are put on in groups and in sequence: the star facets and upper girdle facets on the crown; then the lower girdle facets and the culet on the pavilion (the underside).

5. FINISHING
A "brillianteer" then adds a further 24 facets above the girdle and 16 below.

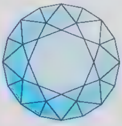
6. MOUNTING
After a final polish, the stone is mounted in precious metal.

BRILLIANT-CUTS

The brilliant-cut is the most popular for diamonds, and for many other stones, particularly colourless ones. It ensures that maximum light is reflected out through the front, giving brightness and fire. Variations in the outline give the oval, the pear-shaped pendeloque, and the boat-shaped marquise or navette.



BRILLIANT-CUT SAPPHIRE



ROUND

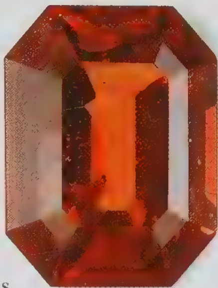
OVAL

RINGS OF FIRE

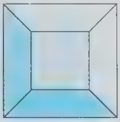
These gold rings from the house of Cartier are set with diamonds, sapphires, rubies, and emeralds, in a mixture of cuts from brilliant to fancy.

STEP-CUTS

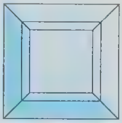
The step-cut (or trap-cut) shows coloured stones to advantage, having a rectangular or square table facet and girdle, with parallel rectangular facets. The corners of fragile gems may be removed, making octagonal stones – as, for example, in most emeralds.



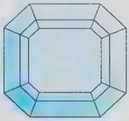
OCTAGONAL STEP-CUT SPESSARTINE



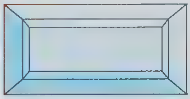
TABLE



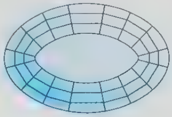
SQUARE



OCTAGONAL



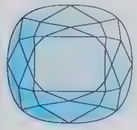
BAGUETTE



OVAL

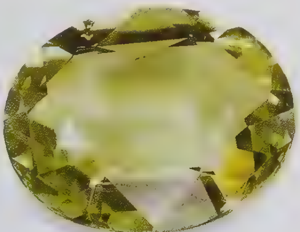
MIXED-CUTS

Mixed-cut stones are usually rounded in outline, with the crowns (above the girdle) cut as brilliants, and the pavilions (below the girdle) step-cut. Sapphires, rubies, and most transparent coloured stones are cut in this style.



CUSHION

MIXED



MIXED-CUT PERIDOT

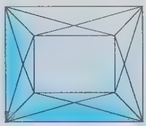
FANCY-CUTS

These have several possible outlines, such as triangular, kite-shaped, lozenge-shaped, pentagonal, or hexagonal. The cut may be used for rare gems, or to make the most of a flawed or irregularly shaped gem.

FANCY-CUT HELIODORE

PENDELOQUE

MARQUISE



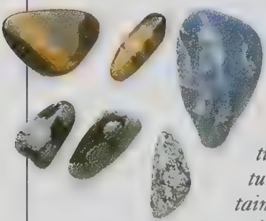
SCISSORS

POLISHING, CARVING, AND ENGRAVING

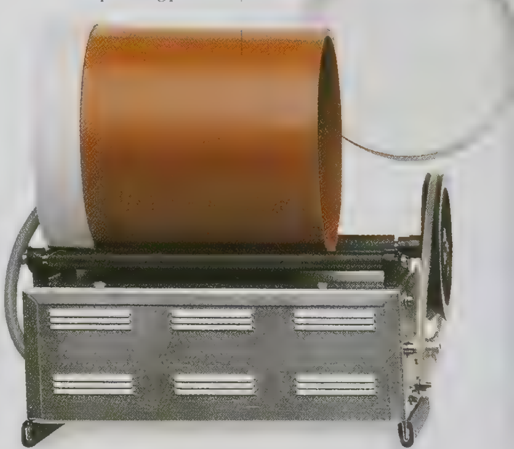
PRECIOUS METALS AND GEMS – usually massive, microcrystalline stones and organics – can be worked by polishing, carving, or engraving. Polishing is the oldest form of fashioning. Carving produces three-dimensional objects by cutting them from a larger mass of material. Engraved images are made by scratching out lines or holes, or by cutting away to leave a raised image. Carving and engraving require tools harder than the material being worked.

POLISHING

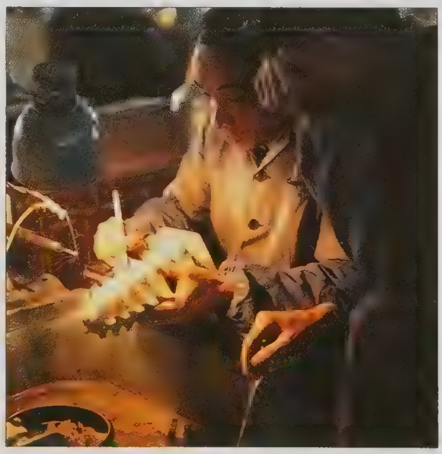
The shine given to the surface of a stone – either by rubbing it with grit or powder, or against another stone – is its polish. Dark-coloured gemstones and those that are translucent or opaque, for instance opal and turquoise, are often polished rather than faceted, as are organic gems. They may be polished as beads or as flat pieces to be used in inlay work, or cut *en cabochon* with a smooth, rounded surface and usually a highly polished domed top and flat base.



PEBBLE POLISHER
Gem fragments of similar hardness may be turned into attractive pebbles (left) by tumbling in a drum containing abrasive grits and polishing powders (right).



MOTOR-DRIVEN TUMBLING DRUM FOR POLISHING



CARVING

Carving usually refers to the cutting of decorative objects from a larger mass. Stones as hard as 7 on the Mohs' scale were carved in Ancient Egypt, Babylonia, and China. Impure corundum (emery) was used for carving and engraving in India; nowadays a hand-held chisel or turning machine is used. Popular stones for carving include serpentine, Blue John, malachite, azurite, rhodonite, and rhodochrosite.

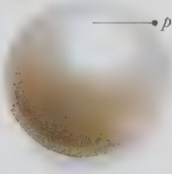
CHINESE CARVING
Carving of gemstones in China dates back to the Neolithic period. The most prized material was imported nephrite jade, and decorative objects like this model pagoda are still made.

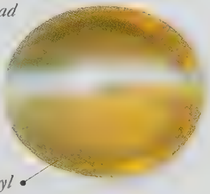
Engraving

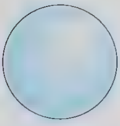
Engraving usually refers to the decoration of the surface of a gemstone by the excavation (scratching out) of lines, holes, or trenches with a sharp instrument, known as a graver or turin. Of all engraved objects, cameos and intaglios are perhaps the most popular. A cameo is a design (often a human profile) in flat relief, around which the background has been cut away. In an intaglio it is the subject, not the background, that is cut away, creating a negative image that may be used as a seal in clay or wax. Intaglios were particularly popular with the Ancient Greeks and Romans, and are still prized by collectors.

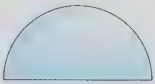
Gold Engraving

The surface of gold and other precious metals used in jewellery may be decorated with intricate patterns, using a hand-held chisel called a graver.







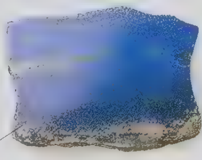


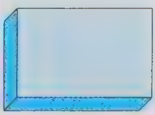
Bead

Spherical gems such as pearls may be pierced and threaded as beads on necklaces.

Cabochon

This simple cut is used to display colours and optical effects in opaque and translucent stones.





Carving

The cameo symbol used in this book is intended to denote both carvings and engravings.

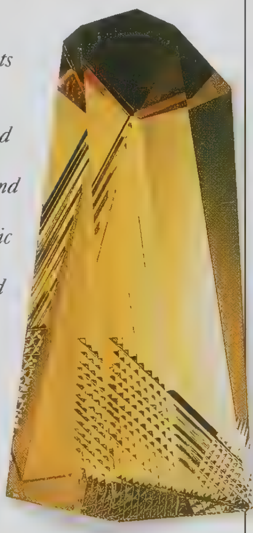
Polished Stone

Decorative stones given a flat, polished surface may be used in ornaments and jewellery.

Engraved gemstones gained prominence in Europe in the Renaissance period. During the Elizabethan period in Britain cameo portraits were often given as gifts, particularly among the nobility. All through the ages, layered stones have been used for cameos or intaglios, with onyx and sardonyx particularly popular. Other gems suitable for engraving include rock crystal, amethyst, citrine, beryl, peridot, garnet, lapis lazuli, and hematite, as well as organic materials such as ivory and jet.

Modern Designs

This citrine prism, with its clean, architectural lines and exquisite engraving, demonstrates the flair and craftmanship of modern designers. Its maker, Bernd Munsteiner, uses conventional cuts to create classic modern jewels akin to pieces of sculpture. Bernd Munsteiner is one of many artists working in Idar-Oberstein in Germany. Together with Hong Kong, Idar-Oberstein is considered to be one of the most important centres for carving and engraving gemstones today.



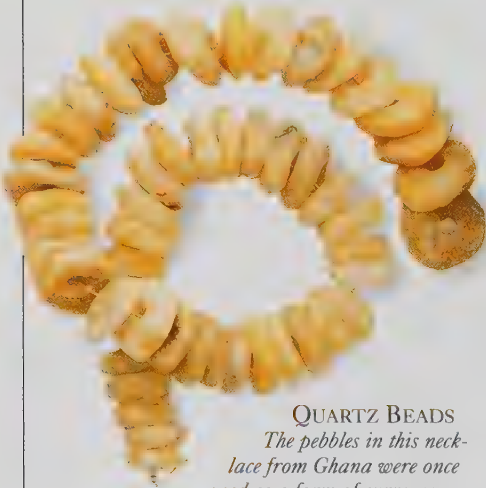
Engraved Citrine

GEMS THROUGH THE AGES

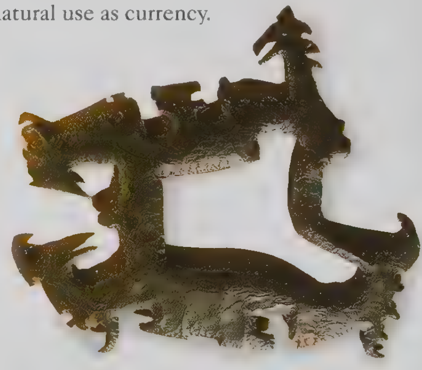
PEOPLE EVERYWHERE, throughout history, have followed a natural instinct to collect things of beauty and value, and have used whatever gems they found locally – from shells to sapphires – to adorn themselves. Today, the whole range of the world's gems is available to those who can afford them. There are more gem-producing areas than ever before, new stones are on the market, and jewellery designs continue to evolve. But the inherent attraction of gems – their beauty, durability, and rarity – remains the same.

FIRST USES

Gem materials were probably first used as much for their durability as their beauty. But beauty was not ignored, even then. For example, the Stone Age obsidian axe below has been wrought to be attractive as well as practical, and ancient civilizations did fashion gems purely for adornment. Although most were primitive in design, some were highly intricate, with painted surfaces. Down the ages, gems have also been offered as prestigious gifts, and their portability and intrinsic value gave them a natural use as currency.



QUARTZ BEADS
The pebbles in this necklace from Ghana were once used as a form of currency.



OBSIDIAN AXE
A natural volcanic glass, obsidian could be fashioned into a razor-sharp tool or weapon.

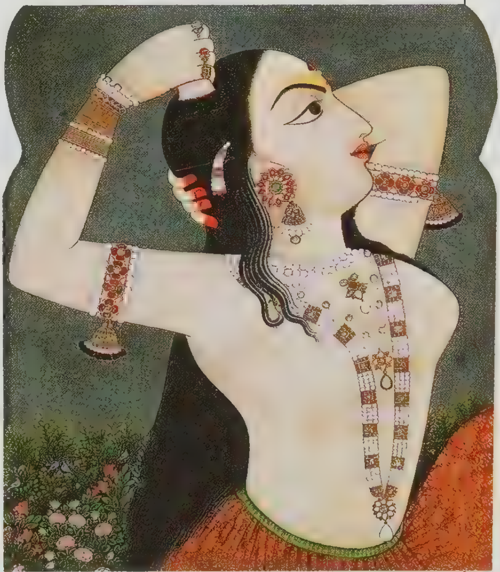
EARLY COLLECTORS

The earliest collectors found gems with no more equipment than a stick or shovel, a basket, and a sharp eye. Similar Stone Age tools found in the Mogok area of Burma show that rubies have been mined there for thousands of years – and the same methods of panning the stream with wicker baskets are used today. Evidence of more organized early mining – for example, abandoned mines and waste dumps – is found in the Urals of Russia, on the shores of the Mediterranean, in Cornwall, England, and in many other places worldwide.

EMERALD IN LIMESTONE
Emerald has been sought after for many thousands of years, the earliest known mines dating back to Egypt, 2000BC.

Ancient Jewellery

Very little jewellery made before the 18th century survives. The best examples are probably those of Ancient Egypt, much of it gold set with gems such as turquoise, lapis lazuli, and carnelian. It shows the great skill of the Egyptian goldsmiths: the gold refined, annealed, and soldered; the gems fashioned – probably using silica sand, a technique also known to the Ancient Chinese. The Romans went on to develop the polished stone rather than the setting. The art of the goldsmith and lapidary survived in the Dark Ages, though in medieval times gothic style was functional – mainly buckles, clasps, and rings.



Clothed in Jewels
Civilizations through the ages have used jewellery for adornment. This late 18th-century miniature shows an Indian woman clothed in richly jewelled necklaces, earrings, bracelets, and amulets.

Merman
In this typical 16th-century pendant, a pearl forms the torso, with diamonds and rubies set in gold around it.

Gem-encrusted Modern Brooch
Jewellery has passed through many styles, from baroque in the 16th century and floral themes in the 17th, to art deco and beyond in the 20th.

Up to the Present

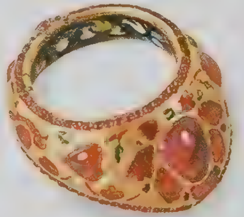
With the discovery of the Americas in the 15th century, European trade in gemstones expanded, and 16th- and 17th-century jewellers could use gems from all over the world. With the rise of an affluent merchant class, jewellery became more widely owned, and diamonds first became fashionable. In the 20th century, an increase in demand for affordable gems, and the scarcity of the most valuable, will doubtless continue the trend to use more varied gem species in jewellery.

History and Folklore

There are numerous myths and legends associated with gems. Some tell of cursed stones; others of stones with special powers of healing, or that protect or give good luck to the wearer. Some of the largest known diamonds have legends associated with them that have been told and re-told over centuries, and many now lost are surrounded by tales of intrigue and murder. Some mines are thought to be cursed – probably a rumour spread by the mine-owners to keep unwanted prospectors away. In Burma, for instance, where all gemstones belonged to the monarch, the belief that anyone who took a stone from a mine would be cursed may have been deliberately cultivated to curb losses of a valuable national asset.

Death Mask
This Aztec funeral mask adorned with turquoise may have speeded entry to the next world.

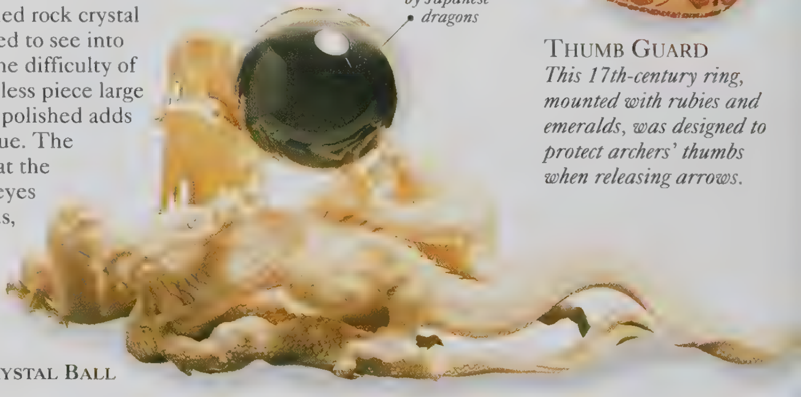
Peruvian God
This 12th-century ceremonial knife from Peru is made from gold adorned with turquoise. The handle has been formed into the image of a divinity.



Thumb Guard
This 17th-century ring, mounted with rubies and emeralds, was designed to protect archers' thumbs when releasing arrows.

Crystal Gazing

Since Greek and Roman times, balls of polished rock crystal have been used to see into the future. The difficulty of finding a flawless piece large enough to be polished adds to the mystique. The mystic gazes at the ball, lets the eyes go out of focus, and then interprets the misty "image".



Crystal Ball

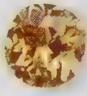
Birthstones

Certain gems have traditionally been associated with different months of the year, and are thought lucky or important for people born under their "influence". This probably stems from the ancient belief that gems came from the heavens. Many cultures associate gems with the signs of the zodiac, and others with the months of the year, but the selection varies from country to country, perhaps influenced by availability of gems, local traditions, or fashions. The custom of wearing birthstone jewellery started in 18th-century Poland, and has since spread throughout the world. The most popular selection today is shown right.

January (Garnet)

February (Amethyst)

March (Aquamarine)

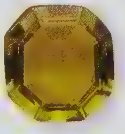


April (Diamond)

May (Emerald)

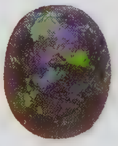
June (Pearl)

July (Ruby)



August (Peridot)

September (Sapphire)



October (Opal)

November (Topaz)

December (Turquoise)

Signs of the Zodiac

This rock crystal is shaped with 12 pentagonal faces, each engraved with one of the signs of the zodiac.

Crystal Healing

Belief in the healing properties of gems has a very long history, as the rituals of medicine men in ancient tribes attest. Crystal healers today believe that each gem has the power to influence the health and well-being of a specific part of the body. The light reflected off stones placed on vital nerve points is thought to be absorbed by the body, supplying it with healing energy.

Rock Crystal

Prized for their beauty and clarity, rock crystals are often chosen for use in crystal healing.

Crystal Pendant

Gems worn close to the skin are believed to heal or protect.

SYNTHETIC GEMSTONES

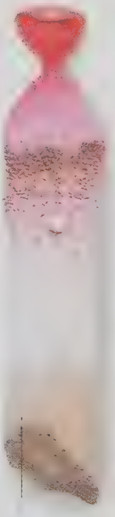
SYNTHETIC GEMSTONES are made in laboratories or factories, not in rocks. They have virtually the same chemical composition and crystal structure as natural gemstones, so their optical and physical properties are very similar. However, they can usually be identified by the differences in their inclusions. Many gems have been synthesized in the laboratory, but only a few are produced commercially – generally for industrial and scientific purposes.

MAKING A SYNTHETIC

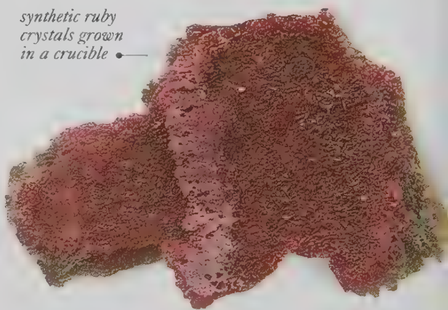
Man has tried to replicate gemstones for thousands of years, but it was not until the late 1800s that any substantial success was achieved. In 1877 French chemist Edmond Frémy grew the first gem-quality crystals of reasonable size (see bottom right), and then around 1900 August Verneuil devised his technique to manufacture ruby. With a few modifications, the Verneuil "flame-fusion" method is still in use today. The powdered ingredients are dropped into a furnace and melt as they fall through a flame hotter than 2,000°C (3,630°F), fusing into liquid drops. These drip on to a pedestal and crystallize. As the pedestal is withdrawn, a long, cylindrical crystal, which is known as a boule, forms.

FLUX-MELT SYNTHETIC EMERALD

FLUX-MELT TECHNIQUE
Pioneered by the French chemist Edmond Frémy, the flux-melt technique is still used to make emeralds. The powdered ingredients are melted and fused in a solvent (flux) in a crucible. The material must be kept at a very high temperature for months, before being left to cool very slowly.



FLAME-FUSION CORUNDUM
Synthetic corundum manufactured by flame-fusion grows as a single mass called a "boule". It has the same inner structure as a natural crystal and can be cut to shape.

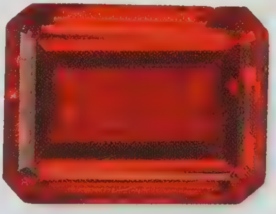


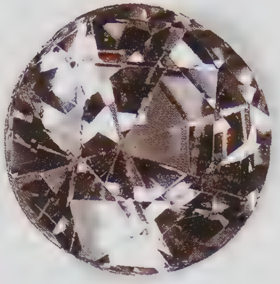
EDMOND FRÉMY
The first to grow emerald crystals of a reasonable size, French chemist Edmond Frémy went on to grow ruby crystals by melting aluminium oxide and chromium in a crucible.

CORUNDUM BOULES

Shapes and Colours

Because of the way they are made, synthetic gems may show subtle differences in shape and colour that help to distinguish them from their natural counterparts. For instance, corundum produced by flame-fusion has curved growth lines, rather than straight ones, because the ingredients have not mixed together fully. Some synthetic gems may also suffer from uneven colour distribution. Flame-fusion spinel is manufactured to imitate gems such as ruby, sapphire, aquamarine, blue zircon, tourmaline, peridot, and chrysoberyl.



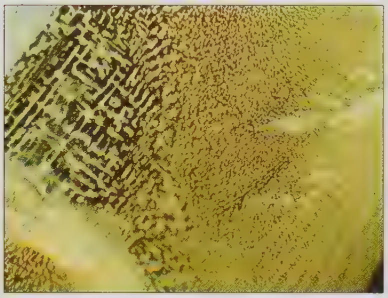


SYNTHETIC SPINEL
Synthetic spinel (above), coloured red, may make a better imitation gem than flame-fusion ruby (left).

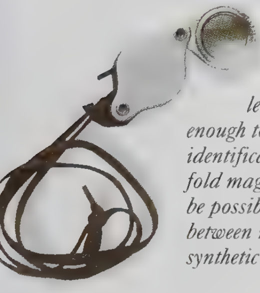
Distinctive Inclusions

Synthetic gems have different inclusions from natural gems, so often the best way to tell them apart is to examine them with a loupe (below) or a microscope. Synthetic inclusions may be typical of a process, or of a synthetic gem species. For instance, in Verneuil rubies, gas bubbles have well-defined outlines; in flux-melt emeralds (right), characteristic "veil" and "feather" patterns form.

GILSON FLUX-MELT EMERALD



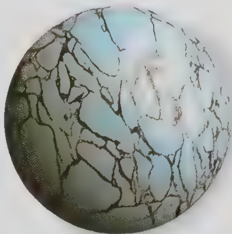
GILSON EMERALD INCLUSIONS
Synthetic emeralds from the French manufacturer, Gilson, have characteristic veil-like inclusions. The gems are made from poor-quality material by a flux-melt method.



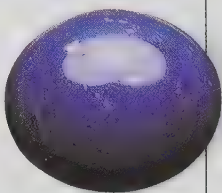
LOUPE
This hand-held lens is powerful enough to assist in gem identification. With its ten-fold magnification it may be possible to distinguish between natural and synthetic inclusions.

Gilson Gems

Lapis lazuli, turquoise, and coral produced by the French manufacturer, Gilson, are similar to their natural counterparts, but are not true synthetics because their optical and physical properties differ from the natural gems. Gilson lapis lazuli, for example, is more porous and has a lower specific gravity.



GILSON TURQUOISE



GILSON LAPIS LAZULI

GILSON CORAL

Imitation and Enhancement

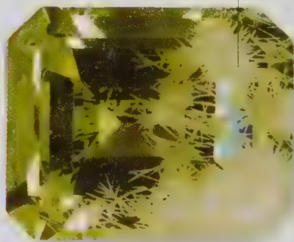
Imitation gems have the appearance of their natural counterparts, but their physical properties are different. They are made to deceive. Man-made materials, such as glass and synthetic spinel, have been used to imitate many different gems, but natural stones can also be modified to resemble more valuable gems. It is possible to enhance authentic gemstones by hiding cracks and flaws, or by heat-treating or irradiating to improve their colour.

Glass Imitations

Glass has been used for centuries to imitate gemstones. It can be made either transparent or opaque, in almost any colour, and, like many gems, has a vitreous lustre. At first sight, therefore, it may easily be mistaken for the real thing. However, it can usually be detected by its warmer feel, and by the evidence of wear and tear that results from its greater softness. Chipped facets and internal swirls and bubbles are common. In addition, unlike most of the gems it imitates, glass is singly refractive.

Glass "Ruby"

glass can be made to imitate almost any transparent gem

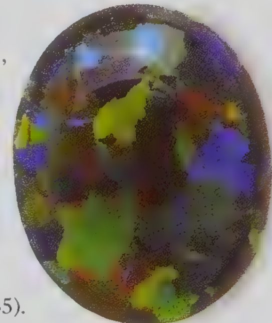


glass imitations often contain pronounced inclusions

Snowflake Inclusion in Glass

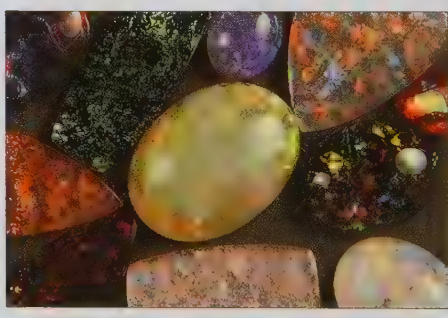
Opal Imitations

Gemmologists call the flashes of colour in opal its "play of colour", or iridescence. It is caused by the interference of light from the minute spheres of silica gel that make up the gem. This structure is imitated to great effect in opals made by the French manufacturer, Gilson, although the difference can be seen in the mosaic-like margins of the patches of colour (see p.135). There are various other opal imitations, including stones made of polystyrene latex, or of different pieces assembled as one. In an opal "doublet" (two pieces) the top is natural precious opal, but the base is common (potch) opal, glass, or chalcedony. A "triplet" (three pieces) has an additional protective dome of rock crystal.



Gilson Opal

Polystyrene Latex "Opal"

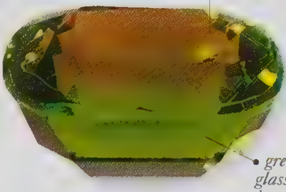


Slocum Stones

The American John Slocum developed imitation opals with a convincing play of colour, but they lack the silky, flat colour patches of genuine opal, and the structure looks crumpled when magnified.

Garnet-topped Doublet

One of the most common "composite" stones (stones made of more than one piece) is the garnet-topped doublet, or GTD. A thin section of natural garnet is cemented to a coloured glass base, which gives the GTD its apparent colour. The deception is most easily seen at the junction of the two layers, which may be obvious.

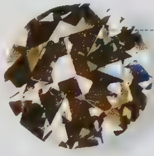


Garnet-topped Doublet

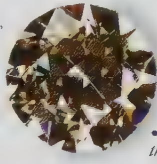
GTD JUNCTION
Changes in colour and lustre are visible where garnet and glass meet.

Diamond Imitations

Many natural materials have been used to imitate diamond, but zircon is the most convincing. Synthetic imitations are popular, but each has its faults (right). Imitations can usually be detected by testing the heat conductivity of the stone.



Yttrium Aluminium Garnet (YAG)



Cubic Zirconia

Strontium Titanate

Heat Treatment

Heating may enhance or change the colour or clarity of some gems. Techniques range from throwing gems in a fire to "cook", to use of sophisticated equipment. The outcome is certain for some gems (like aquamarine, changing from green to blue), but less so for others.

Brown Zircon Heated to Blue

Irradiation

Gems may change colour if exposed to radiation. This may come from radioactive elements within the Earth's crust, or from artificial sources. Natural radiation may take millions of years to have an effect, while artificial irradiation may take only a few hours to change a gem's colour. In some cases a gem will revert to its original colour, or may fade with time. Many changes can be reversed or modified by heat treatment.

Irradiated, Heat-treated Topaz

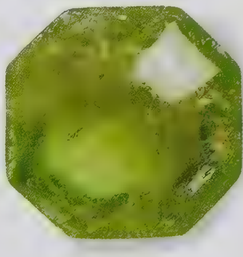
Staining

Stains, dyes, or chemicals can alter the appearance of a gem, coating just the surface, or changing the whole specimen. For staining to be effective, a stone must be porous or contain cracks and flaws through which the colour can enter. Porous white howlite, for example, can be stained to imitate turquoise.

Stained Howlite

Oiling

Oils may enhance a gem's colour and disguise fissures and blemishes. It is common to oil emeralds in order to fill their natural cracks and flaws.

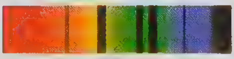


Oiled Emerald

COLOUR KEY

WHEN IDENTIFYING a gemstone, a gemmologist will want to hold it, feel it, and examine it from all angles. This is done to assess the appearance of the stone: the lustre, the colour, and any other features. A hand-held loupe (see p.35) may be used to search for scratches and flaws on the surface which may give an indication of hardness, while a search inside the stone may reveal characteristic inclusions. These features may be unique to one gem, but further tests may be necessary to identify synthetic or imitation stones. From this initial examination, however, the gemmologist should know which tests to perform.

RUBY



ALMANDINE GARNET

RED GLASS

SPECTROSCOPE
Many gems appear the same colour, but can be distinguished when viewed with a spectroscope (above). This reveals an absorption spectrum (left) that is unique to each gemstone (see p.21).

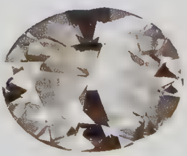
HOW THE COLOUR KEY WORKS

This key puts all gems into one of seven colour categories, though colour varieties within some species may appear (or be listed, if not pictured in the book itself) in more than one. Each colour category is divided into three sections: gems that are always that colour, gems usually that colour, and gems sometimes that colour.

COLOURLESS GEMSTONES

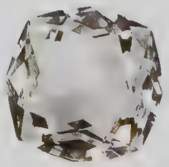
ALWAYS COLOURLESS

HAMBERGITE *115*
Perfect cleavage, large birefringence



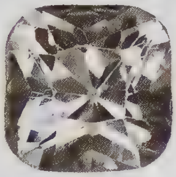
PHENAKITE *98*
Silvery look if well cut

ALBITE *130*
Vitreous to pearly lustre



GOSHENITE *77*
Spiky inclusions common

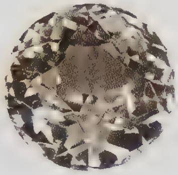
BERYLLONITE *118*
Lacks fire, soft, brittle



ROCK CRYSTAL *81*
Vitreous lustre, transparent

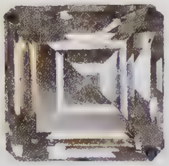
PETALITE *129*
Vitreous lustre, transparent

DATOLITE *129*
Tinge of yellow, green, or white



ACHROITE *102*
Extremely rare

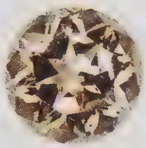
USUALLY COLOURLESS



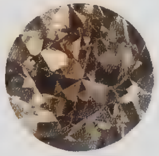
SCHEELITE *70*
Quite soft, good fire, uncommon

CELESTINE *105*
Soft, cut for collectors only

DIAMOND *54*
Adamantine lustre, good fire

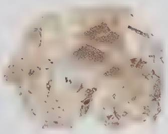


DANBURITE *110*
Yellow/pink tinge, bright, lacks fire

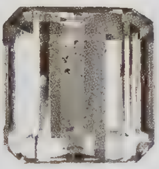


CERUSSITE *105*
Adamantine lustre, high density, soft

SOMETIMES COLOURLESS



DOLOMITE *99*
Soft, vitreous to pearly lustre



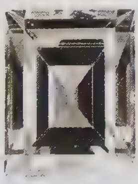
EUCLASE *129*
Rare, black mineral inclusions

MOONSTONE *123*
Opalescence, blue or white sheen

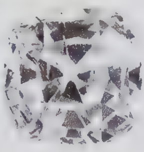
COLOURLESS ORTHOCLASE *122*
Three good cleavages

SCAPOLITE *71*
Rare, vitreous lustre

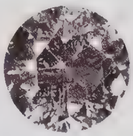
FLUORITE *66*
Soft, lacks fire, hematite inclusions



ZIRCON *72*
Adamantine lustre, good fire



SAPPHIRE *96*
Rare, high density, extremely hard



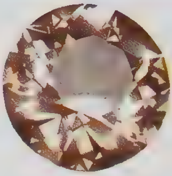
APATITE *79*
Fairly soft

OTHER GEMS

ENSTATITE *111*
GROSSULAR *61*
TOPAZ *106*

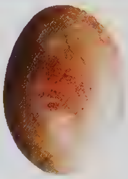
RED OR PINK

ALWAYS RED OR PINK


ROSE QUARTZ *83*
Cloudy, distinctive pinkish colour


KUNZITE *120*
Strongly pleochroic, good cleavage


MORGANITE *78*
Distinctive colour, hard


THULITE *116*
Distinctive colour mix, massive


PINK GROSSULAR *60*
Distinctive colour, fine-grained, opaque


TUGTUPITE *74*
Opaque, may be mottled, massive


RHODOCHROSITE *100*
Fine-grained, banded; also clear faceted stones


RHODONITE *132*
Black veins in massive material


RED BERYL *78*
Extremely rare, seldom cut


RUBY *94*
Distinctive red colour, hard

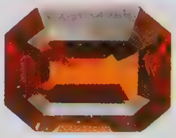

ALMANDINE *59*
Distinctive colour, high lustre


PYROPE *58*
Distinctive colour, inclusions rare

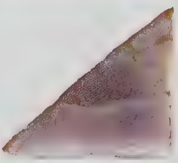

RUBELLITE *101*
Pleochroic, cat's-eye cabochons

USUALLY RED OR PINK


TAAFFEITE *80*
Extremely rare, fairly hard


SPESSARTINE *58*
Lace-like inclusions, rare at gem-quality

SOMETIMES RED OR PINK

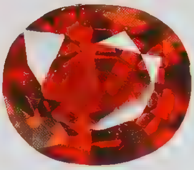

JADEITE *124*
Dimpled surface when polished


TOPAZ *106*
Distinctive colour, hard, high density

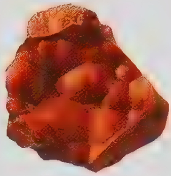

WATERMELON TOURMALINE *103*
Distinctive colours


SAPPHIRE *97*
High density, hard, pleochroic

CORAL *142*
Grain on surface, soft, may fade



SPINEL *64*
Hard, singly refractive



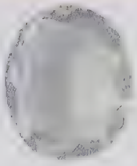
JASPER *92*
Distinctive colour, opaque

OTHER GEMS

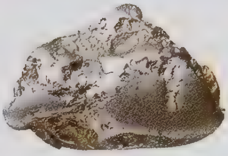
ZIRCON *73*
RUTILE *71*
SMITHSONITE *99*
SCAPOLITE *71*
GARNET-TOPPED DOUBLET *61*

WHITE OR SILVER

ALWAYS WHITE OR SILVER

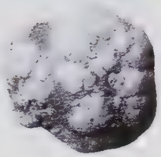


MILKY QUARTZ *85*
Distinctive milky white colour



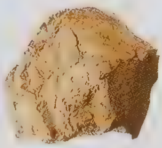
PLATINUM *52*
Metallic lustre, high density, opaque

SILVER *50*
Metallic lustre, soft, opaque



HOWLITE *128*
Very soft, chalky, opaque

IVORY *146*
Soft, growth lines on surface



MEERSCHAUM *119*
Chalky, opaque, fine-grained, soft

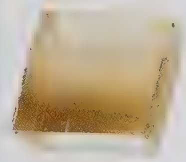
GYPSUM *128*
Silky to vitreous lustre, soft

USUALLY WHITE OR SILVER

PEARL *138*
Pearly lustre, very soft

SHELL *144*
Iridescent, very soft

SOMETIMES WHITE OR SILVER



CALCITE *98*
Soft, large birefringence

SERPENTINE *127*
Vitreous to greasy lustre, translucent

NEPHRITE *125*
Tough interlocking structure

OTHER GEMS

AGATE *88*
CORAL *142*
OPAL *134*
MOONSTONE *123*

Yellow to Brown Gemstones

Always Yellow–Brown

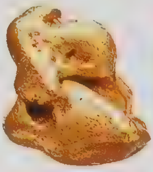
Anglesite *114*
High density, fragile, good fire

Citrine *83*
Distinctive colour

Brazilianite *118*
Fragile, brittle, fairly soft, rare

Sinhalite *114*
Pleochroic, large birefringence

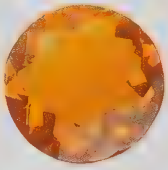
Heliodor *77*
Pleochroic, hard, pastel shades



Gold *48*
Distinctive colour, soft

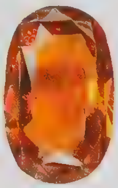
Padparadscha *95*
Distinctive orange-pink colour, hard

Carnelian *93*
Translucent, reddish brown



Fire Opal *134*
Low density, transparent

Sardonyx *90*
Distinctive white bands



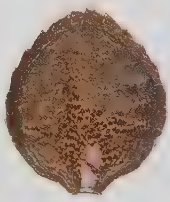
Hessonite *60*
Granular inclusions

Sunstone *130*
Bright metallic inclusions

Hypersthene *112*
Reddish iridescence, fairly soft

Dravite *102*
Pleochroic, showing two shades of body colour

Cassiterite *70*
High density, good fire



Tortoiseshell *144*
Distinctive mottling on surface

Smoky Quartz *84*
Distinctive greyish brown colour

Epidote *121*
Strongly pleochroic, fragile, rarely cut

Other Gems

Topazolite *107*
Pyrite *63*

Usually Yellow–Brown

Amblygonite *132*
Vitreous to pearly lustre

Yellow Orthoclase *122*
Fragile, cat's-eyes

Vesuvianite *74*
Pleochroic, vitreous to adamantine lustre

Sphalerite *63*
Good fire, metallic to vitreous lustre

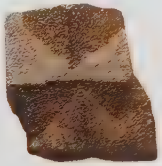
Titanite *121*
Very good fire, pleochroic

Amber *148*
Very soft, resinous lustre

Aventurine Quartz *85*
Platy inclusions

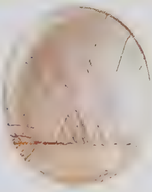
Axinite *133*
Pleochroic, easily chipped

Enstatite *111*
Fragile, distinctive absorption spectrum



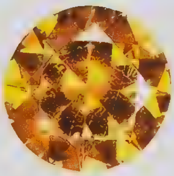
Staurolite *117*
Opaque, twinned crystals cross-shaped

Sometimes Yellow–Brown



Rutile *71*
Good fire, needle-like inclusions

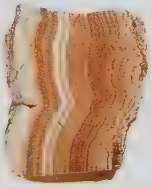
Prehnite *115*
Usually cloudy and translucent



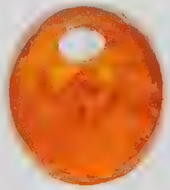
Scheelite *70*
Fairly soft, good fire

Chatoyant Quartz *86*
Fibrous structure

Moss Agate *89*
Translucent, moss-like pattern



Aragonite *104*
Very soft, micro-crystalline



Spessartine *58*
Hard, lace-like inclusions

Baryte *104*
High density, very soft

Chrysoberyl *108*
Hard, strongly pleochroic

Other Gems

Diamond *54*
Demantoid *62*
Fluorite *66*
Zircon *72*
Apatite *79*
Sapphire *96*
Tourmaline *101*
Topaz *106*
Kornerupine *113*

GREEN GEMSTONES

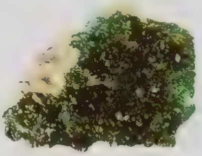
ALWAYS GREEN

CHRYSOCOLLA *126*
Distinctive colour, opaque, very soft

EMERALD *75*
Distinctive colour, seldom flawless

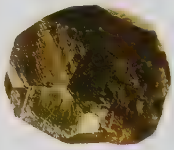
PERIDOT *113*
Distinctive oily green colour

HIDDENITE [illegible]
Distinctive colour, pl[illegible]

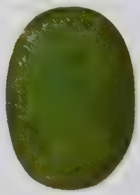


DIOPTASE *99*
Distinctive colour, large birefringence

BLOODSTONE *93*
Opaque, red spots

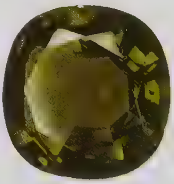


UVAROVITE *59*
Distinctive colour, crystals fragile



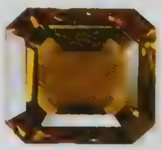
PRASE *92*
Translucent, dark green colour

MALACHITE *126*
Characteristic bands of colour, soft



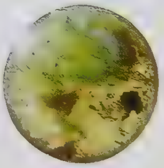
MOLDAVITE *137*
Glassy, inclusions of bubbles and swirls

ALEXANDRITE *108*
Colour changes, pleochroic, high density

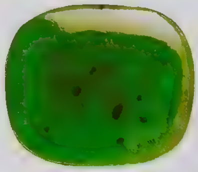


ANDALUSITE *110*
Very strong pleochroism

USUALLY GREEN

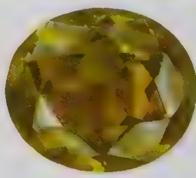


SERPENTINE *127*
Vitreous to greasy lustre, fairly soft

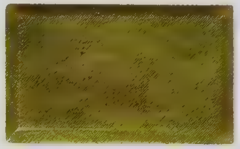


JADEITE *124*
Fine-grained, may be dimpled

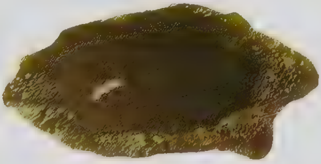
DIOPSIDE *119*
Large birefringence



DEMANTOID *62*
Asbestos inclusions, adamantine lustre



AVENTURINE QUARTZ *85*
Platy inclusions, vitreous lustre



NEPHRITE *125*
Tough interlocking structure, greasy to pearly lustre

OTHER GEMS

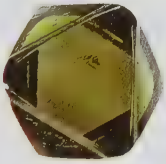
PREHNITE *115*

SOMETIMES GREEN

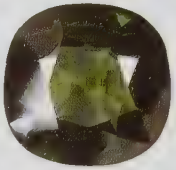
MICROCLINE *123*
Distinctive blue-green colour

AGATE *88*
Translucent, distinct banding

WATERMELON TOURMALINE *103*
Bicoloured



DIAMOND *56*
Hardest natural substance, good fire

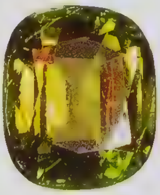


SAPPHIRE *96*
High density, hard, pleochroic

APATITE *79*
Distinctive absorption spectrum

ZIRCON *72*
Good fire, adamantine to resinous lustre

GROSSULAR GARNET *61*
Vitreous lustre



GARNET-TOPPED DOUBLET *61*
Two parts joined

ENSTATITE *111*
Distinctive absorption spectrum

KORNERUPINE *113*
Strongly pleochroic, rare as gem-quality

SPHALERITE *63*
Very soft, good fire, high density

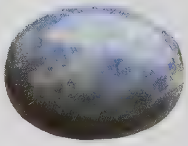
OTHER GEMS

FLUORITE *66*
KYANITE *133*
TOURMALINE *103*
SMITHSONITE *99*
EUCLASE *129*

BLUE OR VIOLET GEMSTONES

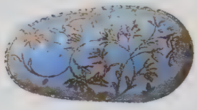
ALWAYS BLUE OR VIOLET

AQUAMARINE *76*
Tubular inclusions, pleochroic



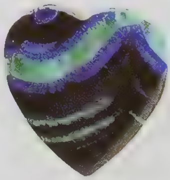
LAZULITE *128*
Often mottled

HAUYNE *68*
Small stones, rarely cut

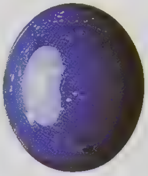


TURQUOISE *131*
Distinctive colour, fragile

INDICOLITE *101*
Strongly pleochroic

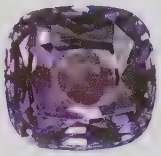


AZURITE *126*
Distinctive colour, fragile, soft



LAPIS LAZULI *69*
Distinctive blue, pyrite inclusions

SODALITE *68*
Distinctive blue colour

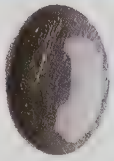


ZOISITE *116*
Strongly pleochroic

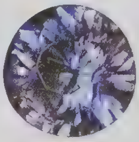
AMETHYST *82*
Tiger-stripe inclusions

USUALLY BLUE OR VIOLET

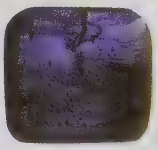
SILLIMANITE *111*
Distinctly pleochroic, good cleavage



DUMORTIERITE *117*
Usually massive, distinctive colour



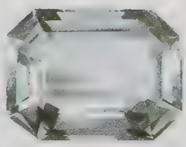
BENITOITE *80*
Good fire, birefringence



IOLITE *112*
Strongly pleochroic

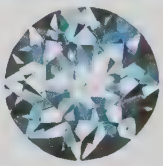
KYANITE *133*
Pleochroic, brittle, flaky

SOMETIMES BLUE OR VIOLET



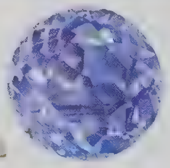
FLUORITE *66*
Lacks fire, soft, good cleavages

TOPAZ *106*
Pleochroic, hard, tear-like inclusions



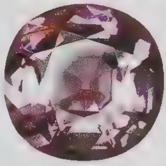
ZIRCON *72*
Good fire, adamantine to resinous lustre

SMITHSONITE *99*
Distinctive blue colour



SAPPHIRE *95*
High density, hard, pleochroic

Scapolite *71*
Cat's-eyes, fibrous inclusions



Spinel *64*
Hard, singly refractive

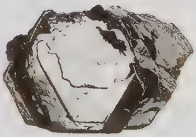
Axinite *133*
Pleochroic, brittle

Other Gems

Apatite *79*
Agate (stained) *88*
Howlite (stained) *128*
Diamond *54*
Euclase *129*
Chrysoberyl *108*
Garnet-topped Doublet *61*

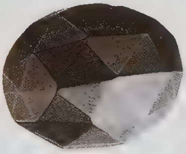
Black Gemstones

Always Black



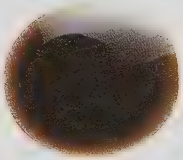
Hematite *100*
Metallic lustre, opaque, iridescent

Schorl *103*
Opaque, vitreous lustre



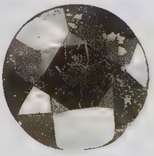
Jet *140*
Very soft, coal-like smell when warm

Usually Black

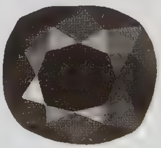


Obsidian *136*
Glassy, fairly hard, bubble-like inclusions

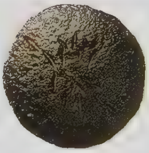
Sometimes Black



Melanite *62*
Adamantine to vitreous lustre



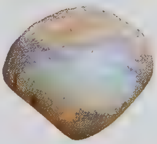
Diamond *54*
Adamantine lustre, hard



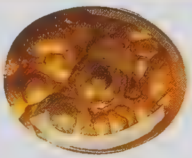
Tektite *137*
Glassy, cracks on surface

Coral *142*
Sensitive to heat, soft

Iridescent Gemstones

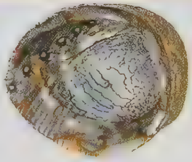


Opal *134*
Iridescent colours, may dry and crack



Fire Agate *87*
Iridescence resembles oily rings of colour

Labradorite *130*
Iridescence on dark body colour



Mother-of-Pearl *145*
Blue and purple iridescence on surface

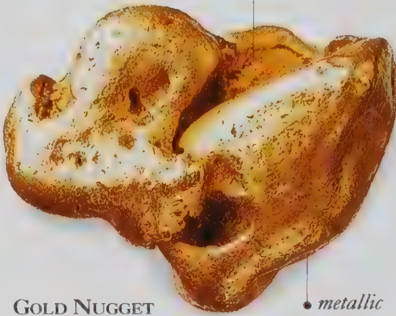
Crystal structure	Composition	Hardness
Cubic	Gold	2½

Gold

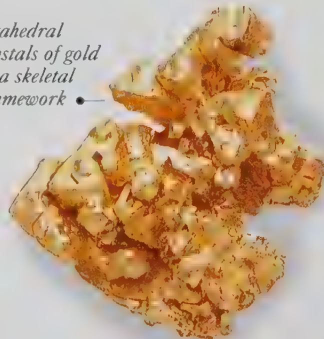
The colour of gold depends upon the amount and type of impurities it contains. Native gold is typically golden yellow, but in order to vary its colour and increase its hardness for use in jewellery, gold may be alloyed to other metals. Silver, platinum, nickel, or zinc may be added to give a pale or white gold. Copper is added for red or pink gold; iron for a tinge of blue. Gold purity is defined by the proportion of pure gold metal present, and this is expressed as its carat (ct) value. The purity of gold used in jewellery varies from 9 carat (37½ per cent or more pure gold), through 14, 18, and 22 carat, to 24 carat, which is pure gold. In many countries, gold is "hallmarked" to indicate its degree of purity.

• **Occurrence** Gold is found in igneous rocks and in associated quartz veins, often in small quantities invisible to the naked eye. It is also concentrated in secondary "placer" deposits – as nuggets or grains in river sands and gravels. Gold may still be extracted from placer deposits by the traditional panning method, but modern commercial mining involves large earth-moving machinery and concentrated acids for processing the ore. The main gold-bearing rocks occur in Africa, California and Alaska (USA), Canada, the former USSR, South America, and Australia.

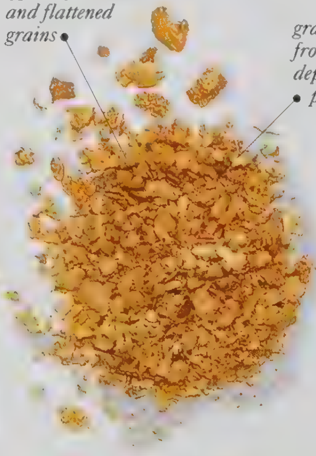
• **Remark** Gold has been used for coins, decoration, and jewellery for thousands of years. It is attractive, easily worked, and wears well.



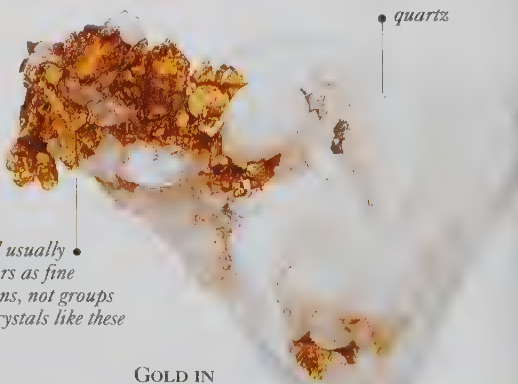
Gold Nugget



Crystallized Gold Nugget



Gold Grains



Gold in Quartz Matrix

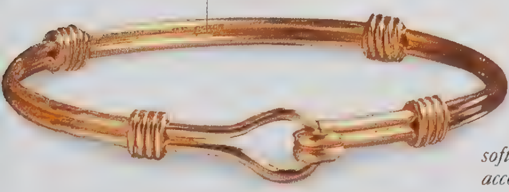
SG	RI	DR	Lustre
19.30	None	None	Metallic

TIE-PIN
This unusual piece of jewellery features a gold nugget set into a gold tie-pin.

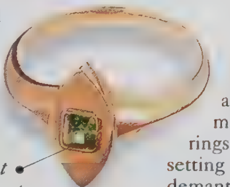
GOLD, DIAMONDS, AND PEARLS
This gold neckpiece is set with pink pearls and clusters of diamonds. Gold is a popular setting for precious stones as it is both easy to fashion and hard-wearing, being resistant to acids and tarnishing.

GOLD BANGLE
This flexible bracelet is made from 18-carat red and yellow gold.

GOLD MOULD
This ivy leaf motif set was made by casting 18-carat gold in a wax mould.



GOLD BANGLE
The hallmark that shows the purity of worked gold is just visible on this delicate bangle. In this case, it indicates the gold is 18 carat.



GOLD RING
Gold is a popular and resilient material for finger rings. Here it is the setting for a green demantoid garnet.

Crystal structure	Composition	Hardness
Cubic	Silver	2½

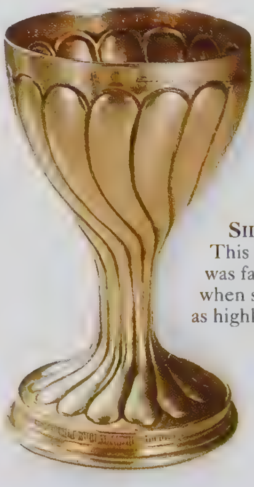
SILVER

Silver usually occurs in massive form as nuggets or grains, although it may also be found in wiry, dendritic (tree-like) aggregates. When newly mined or recently polished, it has a characteristic bright, silver-white colour and metallic lustre. However, on exposure to oxygen in the air a black layer of silver oxide readily forms, tarnishing the surface. Because of this, and the fact that it is too soft to be used in most jewellery in its pure form, silver is often alloyed with other metals, or given a covering layer of gold. Electrum, an alloy of gold and silver in use since the time of the Ancient Greeks, contains 20–25 per cent silver. Sterling silver contains 92½ per cent or more pure silver (and usually some copper), and Britannia silver has a silver content of 95 per cent or more. Both alloys are used as standards to define silver content.

• **OCCURRENCE** Most silver is a by-product of lead mining, and is often associated with copper. The main silver mining areas of the world are South America, the USA, Australia, and the former USSR. The greatest single producer of silver is probably Mexico, where silver has been mined from about AD1500 to the present day. The finest native silver, which occurs naturally in the shape of twisted wire, is from Kongsberg, Norway.

DENDRITIC SILVER CRYSTALS

POLISHED SLICE OF SILVER AND COPPER ORE



SILVER WINE CUP
This part-gilt silver cup was fashioned in 1493, when silver was valued as highly as gold.

NATIVE SILVER FROM KONGSBERG, NORWAY

SG	RI	DR	Lustre
10.50	None	None	Metallic

Tower Brooches
These modern silver brooches, made by British silversmith, V. Ambery-Smith, have additional decoration in red and yellow gold.

Silver Bracelet
This sterling silver bracelet also features 18-carat gold thread.

Silver Dish
Fashioned in 1973, this dish features a leaf motif border made from oxidized silver.

Watch Case
Because of its softness, silver is extremely popular for fine metalwork, as seen in this 18th century watch.

Modern Uses
Silver is prized for ornamental items, such as these key rings. Today it is also used in the electronics and photographic industries.

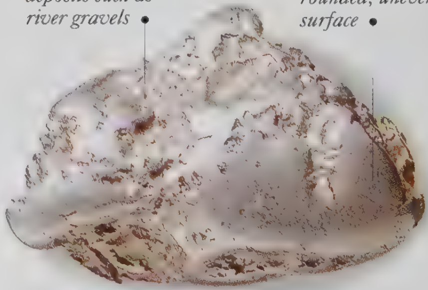
Crystal structure Cubic	Composition Platinum	Hardness 4

PLATINUM

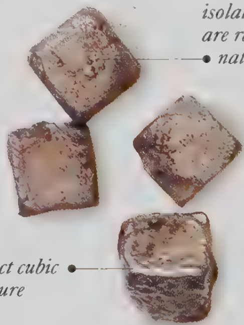
Platinum has been used for thousands of years, but it was not recognized as a chemical element until 1735. Of the three precious metals – gold, silver, and platinum – it is the rarest and the most valuable. Chemically inert and resistant to corrosion, platinum does not tarnish when exposed to the atmosphere, unlike silver. It is silvery grey, grey-white, or white in colour, opaque, and has a metallic lustre. It is slightly more dense than pure gold and about twice as dense as silver. Early jewellers had difficulty achieving the 1,773°C (3,223°F) needed to melt platinum: it was not until the 1920s that the technology was developed sufficiently to work this precious metal.

• **OCCURRENCE** Platinum forms in igneous rocks, usually as ores in which the grains of platinum are often too minute to be seen with the naked eye. It may also occur in secondary "placer" deposits in river sands and gravels, and glacial deposits – usually as grains, more rarely as nuggets. The main occurrences of platinum have been in South Africa, Canada (Sudbury), the USA (Alaska), Russia (the River Perm and other rivers running down from the Urals), Australia, Colombia, and Peru.

• **REMARK** Although nuggets had been set in rings before 1920, most platinum jewellery dates from after this time. Soft and easy to work, platinum is often fashioned into quite intricate designs.

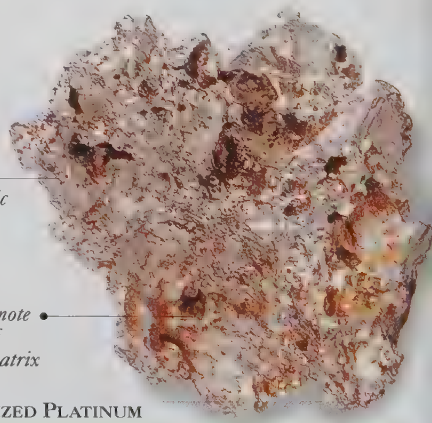


PLATINUM NUGGET



ISOLATED CRYSTALS

PLATINUM GRAINS



CRYSTALLIZED PLATINUM

SG 21.40	RI None	DR None	Lustre Metallic

RING AND EARRING SUITE
This modern suite is set with square-cut precious stones in all the colours of the rainbow.

FILIGREE NECKLACE
Like gold and silver, platinum is quite a soft material, making it ideal for the sort of intricate working seen in this necklace. Unlike silver, platinum does not tarnish when exposed to the atmosphere.

NECKLACE WITH DIAMONDS
Platinum is a perfect, if very expensive, setting for cut diamonds, as the colours complement each other well.

MODERN BROOCH
Platinum is a popular and stylish material for modern jewellery.

AQUAMARINE RING
Platinum provides a cool setting for this ice-blue pendeloque-cut aquamarine and its twenty diamonds.

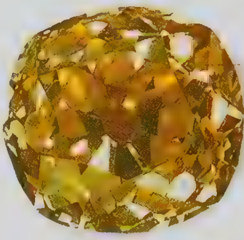
Crystal structure Cubic	Composition Carbon	Hardness 10

DIAMOND

Diamond is the hardest mineral on Earth, and this, combined with its exceptional lustre and brilliant fire, has made it the most highly prized of all gems. Pure, colourless diamond is the most popular, but other varieties – from yellow and brown to green, blue, pink, red, grey, and black – are also found, depending on the impurities present. Because of the uniform arrangement of their constituent carbon atoms, diamond crystals are well-formed – usually octahedral with rounded edges and slightly convex faces. Their perfect cleavage facilitates the early stages of fashioning (see p.26), but they can only be polished by other diamonds.

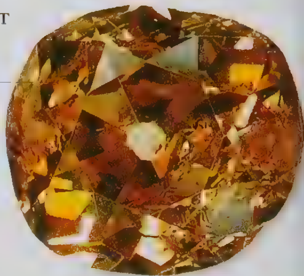
• **OCCURRENCE** Diamond forms at high temperatures and pressures 80km (50 miles) or more underground. When India and later Brazil were the main producers, most diamond came from secondary sources, such as river gravels. However, since the discovery of diamond in kimberlite rock in South Africa (around 1870), its extraction has involved processing vast quantities of rock. Australia is the main producer today; other localities include Ghana, Sierra Leone, Zaire, Botswana, Namibia, the former USSR, the USA, and Brazil.

• **REMARK** Diamonds are graded by colour, cut, clarity, and carat (weight) – the four c's.



coloured diamonds, such as this yellowish green variety, are known as "fancy"

BRILLIANT-CUT



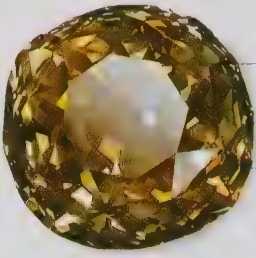
most diamonds are faceted as a brilliant-cut, which brings out their natural fire

BRILLIANT-CUT

pale pink stone

brilliant-cut reflects as much light as possible out through front of stone

BRILLIANT-CUT

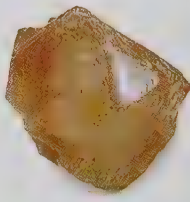


subtle grey-green colour

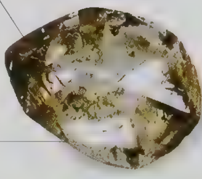
minimum light leakage through back facets

BRILLIANT-CUT

pink-red variety



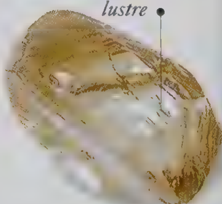
diamonds may be transparent to opaque



green and black inclusions

rounded edges

typical convex surfaces

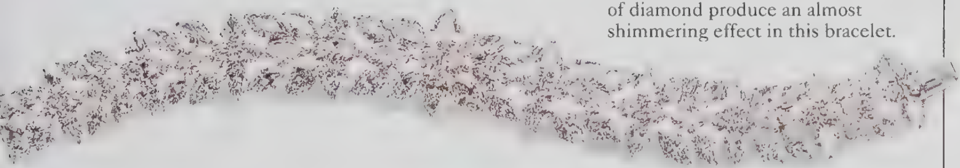


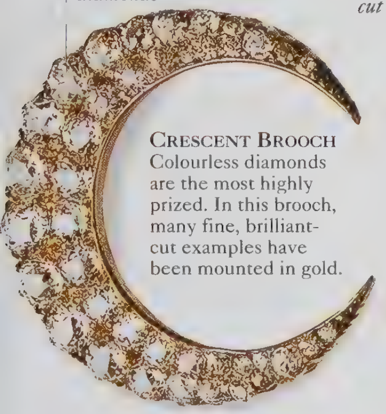
adamantine lustre

FIVE UNPOLISHED DIAMOND CRYSTALS

SG 3.52	RI 2.42	DR None	Lustre Adamantine

LEAF DESIGN BRACELET
The extraordinary fire and lustre of diamond produce an almost shimmering effect in this bracelet.





colourless, brilliant-cut diamonds

CRESCENT BROOCH
Colourless diamonds are the most highly prized. In this brooch, many fine, brilliant-cut examples have been mounted in gold.

round, brilliant-cut diamonds

platinum ring

marquise-cut diamonds

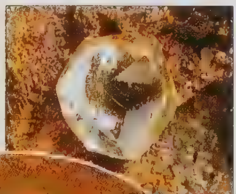
diamond-studded earring

CLUSTER RING AND EARRINGS
Diamonds are popular for all jewellery, from the simplest to the most sophisticated, because of their hardness, superb lustre, and spectacular fire.

sugar-like surface texture

cubic habit uncommon

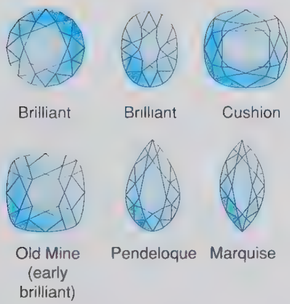
DIAMOND CRYSTALS



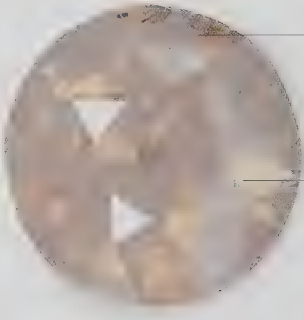
rough diamond with convex crystal faces

conglomerate of pebbles and mineral grains

DIAMOND IN CONGLOMERATE MATRIX

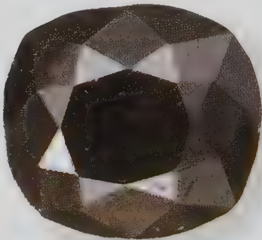


Crystal structure	Composition	Hardness
Cubic	Carbon	10



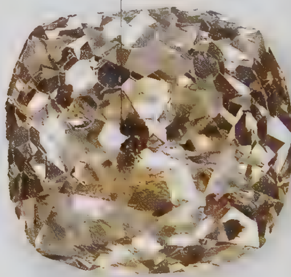
BRILLIANT-CUT

Inclusions in this diamond cause asterism in the form of a double six-rayed star.



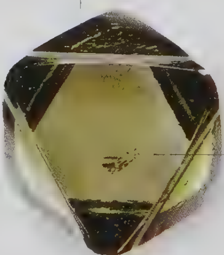
BRILLIANT-CUT BORT DIAMOND

BRILLIANT-CUT



BRILLIANT-CUT

DIAMOND CRYSTAL

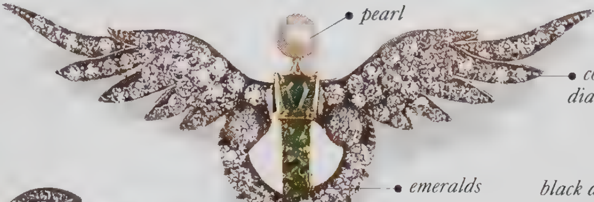


FANCY DIAMOND CRYSTAL

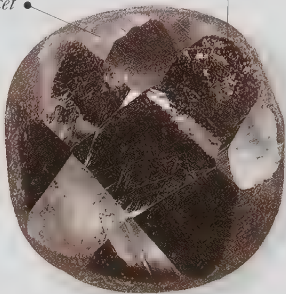
DIAMOND IN KIMBERLITE

SG	RI	DR	Lustre
3.52	2.42	None	Adamantine

DIAMOND BROOCH
Diamonds and emeralds set in gold make up this bird-shaped brooch, with pearls top and bottom.

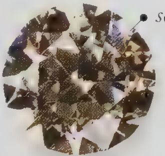



BUTTERFLY BROOCH
This glittering brooch, set with more than 150 diamonds, shows examples of round, square, drop, pendeloque, and fancy cuts.



FACETED BORT DIAMOND

YAG



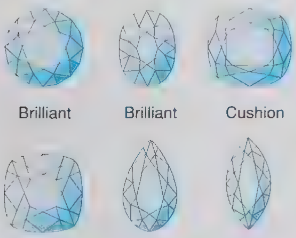
GLASS

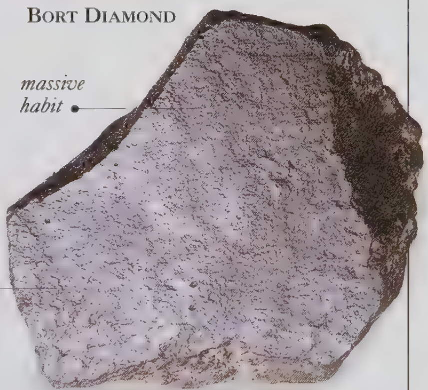
CUBIC ZIRCONIA

STRONTIUM TITANATE

CRYSTALLIZED BORT DIAMOND

DIAMOND IMITATIONS
Diamonds may be imitated by any colourless stone, by glass, and by man-made gems like YAG (yttrium aluminium garnet). None is an exact copy (see above).





CARBONADO DIAMOND ROUGH

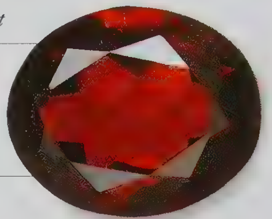
Crystal structure Cubic	Composition Magnesium aluminium silicate	Hardness 7¼

Pyrope (Garnet)

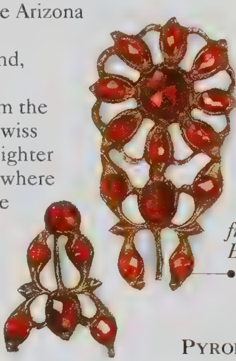
The blood-red colour of pyrope is due to its iron and chromium content. It rarely has inclusions, but when present they are rounded crystals or have irregular outlines. As with all garnets, pyrope has no cleavage, and fracture is subconchoidal to uneven.

• **Occurrence** Pyrope is found in volcanic rock and alluvial deposits, and may, along with certain other minerals, indicate the presence of diamond-bearing rocks. Localities include Arizona (USA), South Africa, Argentina, Australia, Brazil, Burma, Scotland, Switzerland, and Tanzania.

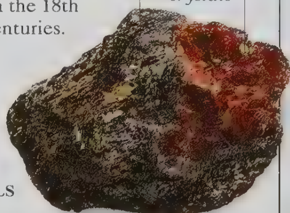
• **Remark** Pyrope comes from the Greek *pyropos*, meaning fiery. Swiss and South African pyropes are lighter red than stones from Bohemia, where pyrope jewellery has been made for over 500 years.



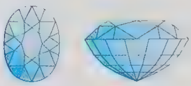
Oval Brilliant



Bohemian Earrings Perfectly transparent, clear, uniformly coloured crystals like these were popular for jewellery in the 18th and 19th centuries.



Pyrope Crystals in Matrix



SG 3.80	RI 1.72–1.76	DR None	Lustre Vitreous

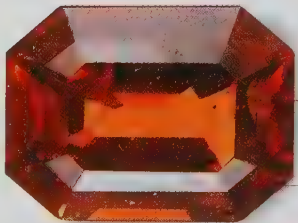
Crystal structure Cubic	Composition Manganese aluminium silicate	Hardness 7

Spessartine (Garnet)

Gem-quality spessartine is uncommon. It is bright orange when pure, but an increase in the iron content makes the stone darker orange to red. Inclusions are lace- or feather-like.

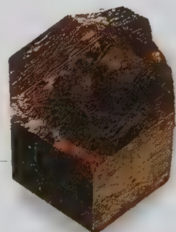
• **Occurrence** Spessartine occurs in granitic pegmatites and alluvial deposits. It is found in Sri Lanka, Madagascar, Brazil, Sweden, Australia, Burma, and the USA; also Germany and Italy, but crystals there are too small to facet.

• **Remark** Spessartine is named after the Spessart district of Bavaria, Germany. It can be confused with hessonite garnet or yellow topaz, but on close examination of inclusions it is distinguishable.

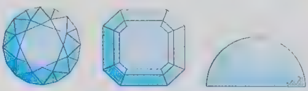


Octagonal Step-cut

Cabochon



Spessartine Crystal



SG 4.16	RI 1.79–1.81	DR None	Lustre Vitreous

Crystal structure Cubic	Composition Iron aluminium silicate	Hardness 7½

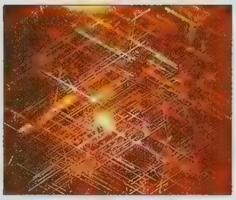
ALMANDINE (GARNET)

Almandine is generally darker red than pyrope and may appear black, although pinkish red specimens are found. It is usually opaque or subtranslucent, but the rare transparent stones have high lustre. Although dense, almandine is brittle and facet edges chip. Many stones show characteristic inclusions, and four-rayed stars may be seen when the stones are cut *en cabochon*. The darker almandines are frequently cut as cabochons or used as abrasives in garnet paper. The underside of dark almandine is often hollowed out to let more light filter through the stone.

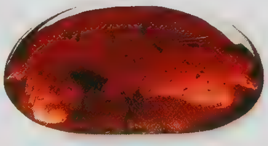
• **OCCURRENCE** Almandine is found in metamorphic rocks, such as garnet mica schist, and less frequently in granitic pegmatites. It has a worldwide occurrence.

• **REMARK** Slices of garnet have been used in windows in churches and temples, and legend has it that Noah suspended garnet in the ark in order to disperse light. Garnet was once said to cure melancholy and to warm the heart.

ROUND BRILLIANT-CUT



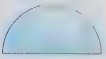
Needle-like crystals of rutile or hornblende are typical inclusions in almandine.



CABOCHON

DROP EARRINGS The pale pinkish red almandine garnets of this 18th-century pair of earrings have been faceted in the rose-cut, and set in gold.

ALMANDINE CRYSTALS IN MATRIX



Cabochon

Mixed

SG 4.00	RI 1.76–1.83	DR None	Lustre Vitreous

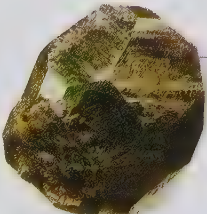
Crystal structure Cubic	Composition Calcium chromium silicate	Hardness 7½

UVAROVITE (GARNET)

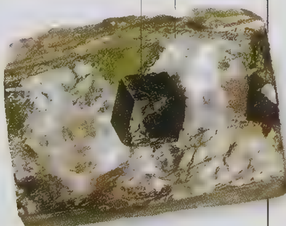
The attractive, bright green colour of uvarovite is due to the presence of chromium. The crystals are very fragile, with subconchoidal to uneven fracture.

• **OCCURRENCE** Uvarovite occurs in serpentine rocks. The best clear crystals are found in the Urals in Russia, lining cavities or rock fissures. Other sources are Finland, Turkey, and Italy.

Brilliant



UVAROVITE CRYSTAL



UVAROVITE CRYSTALS IN MATRIX

SG 3.77	RI 1.86–1.87	DR None	Lustre Vitreous

Crystal structure Cubic	Composition Calcium aluminium silicate	Hardness 7¼

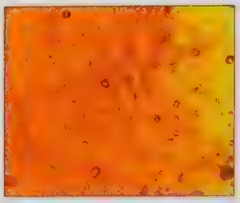
Hessonite (Grossular Garnet)

Grossular garnets occur in a very wide range of colours, from colourless right through to black, but derive their name from the first specimen ever found, a distinctive gooseberry-green colour (see opposite). The orange-brown colour of hessonite grossular garnet is due to manganese and iron inclusions.

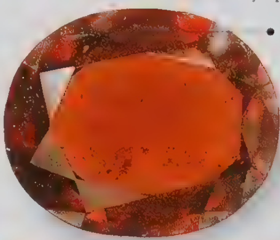
• **OCCURRENCE** The best hessonite garnets are found in Sri Lanka in metamorphic rocks, or gem gravels and sands. In Madagascar hessonite is often referred to as cinnamon stone. Other localities include Brazil, Canada, and Siberia (Russia), as well as Maine, California, and New Hampshire in the USA.

• **REMARK** Both the Ancient Greeks and Romans made cameos, intaglios, and cabochons from hessonite, and faceted stones for jewellery.

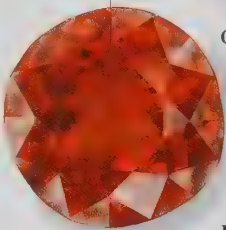
OVAL MIXED-CUT



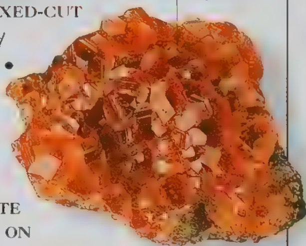
Hessonite garnet has swirls of inclusions, giving it a treacly appearance.



OVAL MIXED-CUT

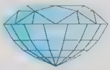


ROUND MIXED-CUT



HESSONITE CRYSTALS ON MATRIX

Brilliant



Mixed

SG 3.65	RI 1.73–1.75	DR None	Lustre Vitreous to resinous

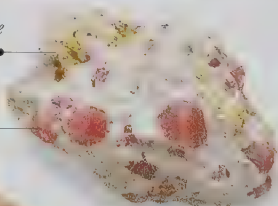
Crystal structure Cubic	Composition Calcium aluminium silicate	Hardness 7

Pink Grossular (Garnet)

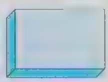
Pure grossular garnet is colourless, but impurities incorporated during its formation cause a wide range of colours. This pink variety results from the presence of iron.

• **OCCURRENCE** Pink grossular is found in Mexico, usually as a massive form in metamorphic rocks. Crystals are rare. It also occurs in South Africa.

• **REMARK** Pinkish grossular from Mexico may be known as rosolite.



CRYSTALS IN MATRIX



Polished

GROSSULAR GARNET POLISHED SLAB

SG 3.49	RI 1.69–1.73	DR None	Lustre Vitreous

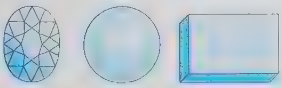
Crystal structure Cubic	Composition Calcium aluminium silicate	Hardness 7

Green Grossular (Garnet)

There are two varieties of green grossular: one is found as transparent crystals, the other is massive. Massive green grossular from South Africa is called Transvaal jade, after its main locality and because it resembles jade. It may contain black specks of the mineral magnetite. Since the 1960s a transparent, green grossular garnet, named tsavorite, has been mined in Kenya. Massive green grossular is used as a decorative stone; tsavorite is faceted as a gem.

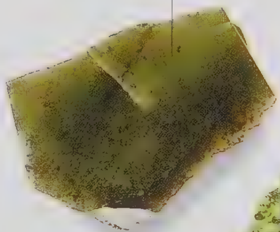
• **Occurrence** Found in Canada, Sri Lanka, Pakistan, the former USSR, Tanzania, South Africa, and the USA. Kenya is the main source for tsavorite.

• **Remark** The name "grossular" is derived from the botanical name of the gooseberry, *R. grossularia*. Massive grossular garnet of a gooseberry-green colour was first discovered in the former USSR. Since then it has also been found in Hungary and Italy.

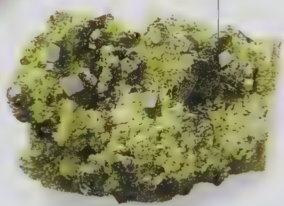


Brilliant-cut

Bead Necklace Polished massive green grossular beads have a speckly appearance due to magnetite inclusions.



Massive Polished Slab



Green Grossular Crystals in Matrix

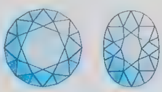
SG 3.49	RI 1.69–1.73	DR None	Lustre Vitreous

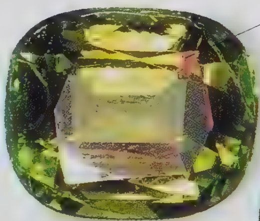
Crystal structure Variable	Composition Variable	Hardness Variable

Garnet-topped Doublet

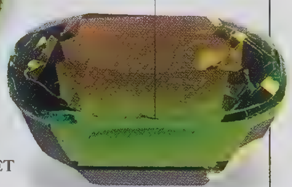
A doublet is a stone made of two separate pieces cemented together to create the appearance of a precious stone. Glass topped by red almandine garnet is the most common form, with green glass used to imitate emerald, blue to imitate sapphire. Once joined, the stone is faceted and polished.

• **Remark** These stones were very popular in Britain and the rest of Europe in the Victorian era.





Cushion-cut Doublet



Almandine Garnet on Glass Base

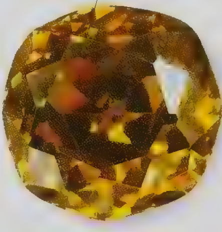
SG Variable	RI Variable	DR None	Lustre Variable

Crystal structure Cubic	Composition Calcium iron silicate	Hardness 6½

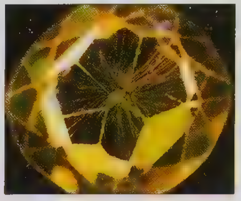
ANDRADITE GARNET

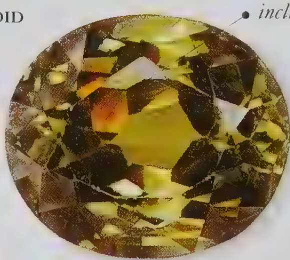
Garnets containing titanium and manganese are grouped as andradite garnet. The most valuable is demantoid, whose emerald-green colour is due to the presence of chromium. It has a higher dispersion than diamond and can be recognized by the characteristic "horsetails", which are fine, hair-like inclusions of asbestos. Topazolite, the yellow variety of andradite garnet, varies from pale to dark yellow. Only small crystals are found. Melanite is a generally black form, but can also be dark red.

• OCCURRENCE The best demantoid is found in the Urals in Russia, and is associated with gold-bearing sands and metamorphic rocks. Other localities include northern Italy, Zaire, and Kenya. Topazolite crystals are found in the Swiss and Italian Alps in metamorphic rocks. Melanite is found in metamorphic rocks and volcanic lavas; fine crystals are found on the island of Elba (Italy), and in France and Germany.



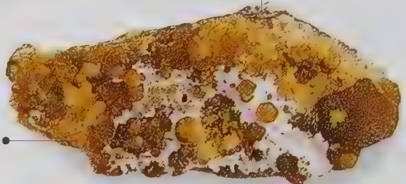
BRILLIANT-CUT DEMANTOID


Demantoid garnet has inclusions of fine, hair-like asbestos fibres, known as "horsetails".

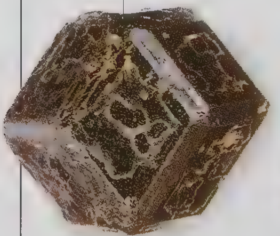


MIXED-CUT DEMANTOID

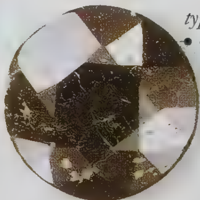
BRILLIANT-CUT DEMANTOID



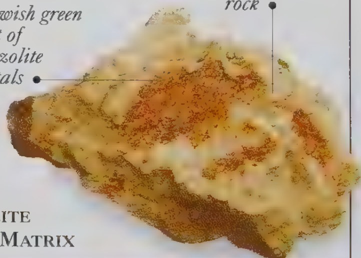
DEMANTOID GARNET CRYSTALS IN MATRIX



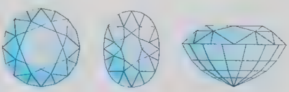
MELANITE CRYSTAL



BRILLIANT-CUT MELANITE



TOPAZOLITE CRYSTALS IN MATRIX


Brilliant   Brilliant   Mixed

SG 3.85	RI 1.85–1.89	DR None	Lustre Vitreous to adamantine

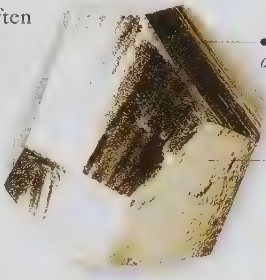
Crystal structure Cubic	Composition Iron sulphide	Hardness 6

PYRITE

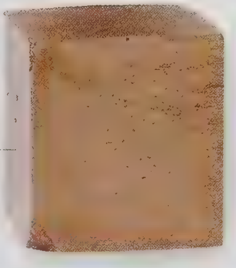
With its brassy yellow colour, pyrite is often mistaken for gold (hence its other name, fool's gold). It occurs as cubes, or as "pyritohedra", which have twelve faces, each with five edges. Pyrite has been used in jewellery for thousands of years, and examples from the ancient civilizations of the Greeks, Romans, and Incas have been found. Today it is used mainly in costume jewellery, but is brittle and requires careful cutting.

• **OCCURRENCE** Pyrite is found worldwide in igneous, metamorphic, and sedimentary rocks. Fine specimens come from Spain, Mexico, Peru, Italy, and France.

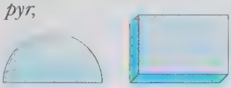
• **REMARK** The name comes from the Greek word *pyr*, meaning fire, since sparks are caused if pyrite is struck with a hammer.



PYRITE CRYSTAL



PYRITE CRYSTAL



Cabochon Polished

SG 4.90	RI None	DR None	Lustre Metallic

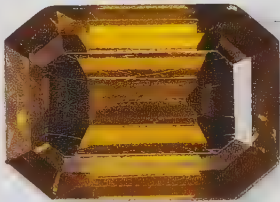
Crystal structure Cubic	Composition Zinc sulphide	Hardness 3½

SPHALERITE

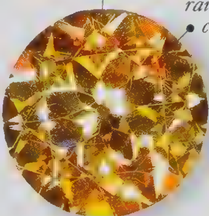
Sphalerite, also known as blende, is an important ore of zinc. It is usually very dark brown to black in colour, but, occasionally, transparent yellowish brown or green stones are found that can be faceted. Since sphalerite is soft and has perfect cleavage, it is not suitable for jewellery, and is faceted for museums and collectors only.

• **OCCURRENCE** Sphalerite crystals are usually pseudo-octahedral in shape, forming in hydrothermal veins with other minerals, such as galena, quartz, pyrite, and calcite. Transparent, cuttable stones are found in Santander (Spain) and Mexico.

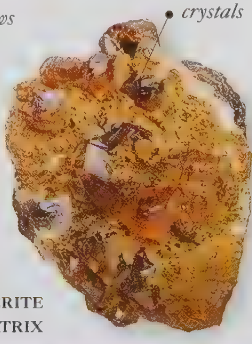
• **REMARK** In the past, sphalerite has often been confused with galena (lead sulphide), to which it is similar.



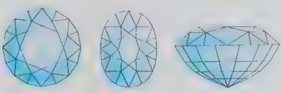
OCTAGONAL STEP-CUT



BRILLIANT-CUT



SPHALERITE CRYSTALS IN MATRIX



Brilliant Brilliant Mixed

SG 4.09	RI 2.36–2.37	DR None	Lustre Metallic to vitreous

Crystal structure Cubic	Composition Magnesium aluminium oxide	Hardness 8

SPINEL

Spinel is found in a wide range of colours due to the presence of various impurities, and is transparent to almost opaque. Red spinel coloured by chromium and iron is the most popular, although for many years it was thought to be a variety of ruby. The orange-yellow or orange-red variety is called rubicelle (a diminutive of the French word for ruby). Blue spinel is coloured by iron, and less commonly by cobalt. Occasionally, inclusions of crystals such as magnetite or apatite may occur, and some Sri Lankan spinels may include zircon crystals surrounded by brown haloes. Star stones are rare, but when cut *en cabochon* may show 4-rayed or 6-rayed stars.

• **OCCURRENCE** Spinel occurs in granites and metamorphic rocks, and is often found in association with corundum. Octahedral crystals and waterworn pebbles in a wide range of colours are found in the gem gravels of Burma, Sri Lanka, and Madagascar. Other localities include Afghanistan, Pakistan, Brazil, Australia, Sweden, Italy, Turkey, the former USSR, and the USA.

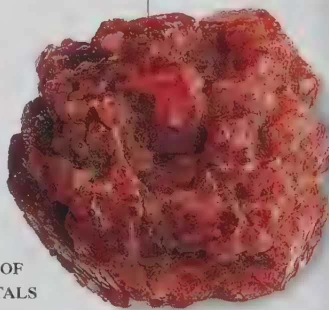
• **REMARK** Synthetic spinel has been manufactured since 1910. It has been used to imitate diamond, or coloured to imitate stones such as aquamarine and zircon. Blue synthetic spinel, coloured by cobalt, has been used to imitate sapphire. The name may derive from the Latin word *spina*, meaning little thorn, referring to the sharp points on some crystals.

OCTAGONAL MIXED-CUT

OVAL BRILLIANT-CUT

OCTAGONAL STEP-CUT

CRYSTALS AND FRAGMENTS



AGGREGATE OF SPINEL CRYSTALS

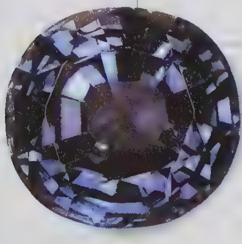
SG 3.60	RI 1.71–1.73	DR None	Lustre Vitreous

STAR-STONE CABOCHON

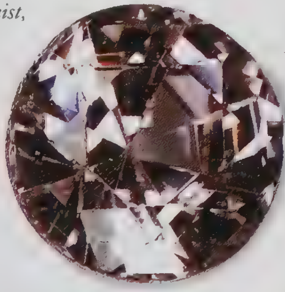
CUSHION MIXED-CUT

CUSHION MIXED-CUT

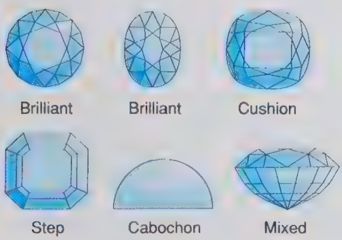
OCTAGONAL STEP-CUT

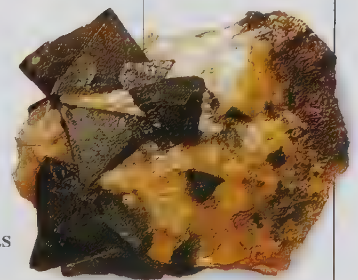


MIXED-CUT GAHNOSPINEL



BRILLIANT-CUT SYNTHETIC SPINEL





SPINEL CRYSTALS IN MATRIX

Crystal structure Cubic	Composition Calcium fluoride	Hardness 4

FLUORITE

Formerly called fluorspar, fluorite has limited use as a gemstone because it is relatively soft and therefore easily scratched. However, the wide range of colours (including yellow, blue, pink, purple, and green), the frequent incidence of more than one colour in a single specimen, and zoning or patchy distribution of colour, make it an interesting stone. Despite its fragility and perfect octahedral cleavage, stones may be faceted (usually for collectors), and can be polished very brightly. Cabochons of fluorite have been capped with rock crystal (see p.81) to protect them from scratching.

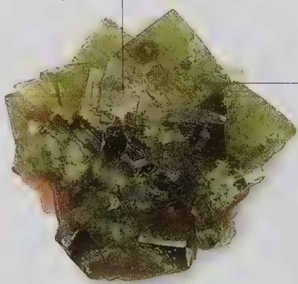
• **OCCURRENCE** Localities include Canada, the USA (where some of the largest crystals are found), South Africa, Thailand, Peru, Mexico, China, Poland, Hungary, Czechoslovakia, Norway, England, and Germany. Pink octahedral crystals are found in Switzerland. A purple and yellow banded variety called Blue John occurs in Derbyshire (England).

• **REMARK** The Ancient Egyptians used fluorite in statues and to carve scarabs, and the Chinese have used it in carvings for more than 300 years. In the 18th century, fluorite was powdered in water to relieve the symptoms associated with kidney disease.

OCTAGONAL STEP-CUT

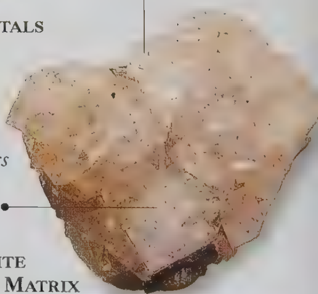
FLUORITE CRYSTALS IN MATRIX

OCTAGONAL STEP-CUT



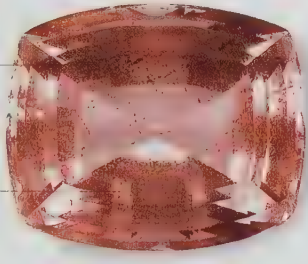
FLUORITE CRYSTALS IN MATRIX

CUSHION FANCY-CUT

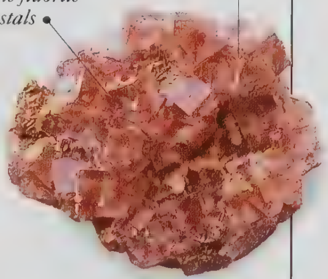


FLUORITE CRYSTALS IN MATRIX

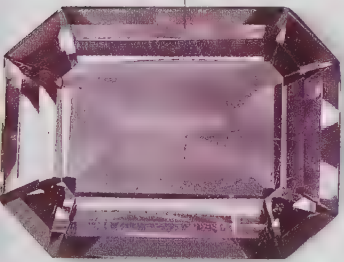
SG 3.18	RI 1.43	DR None	Lustre Vitreous



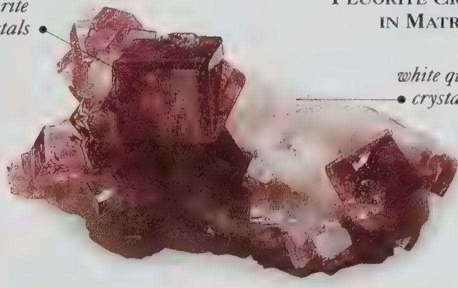
CUSHION STEP-CUT



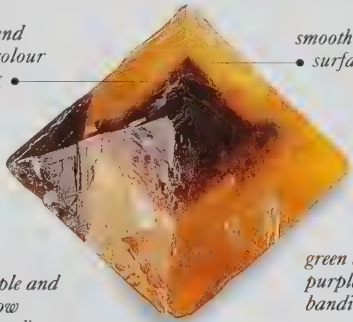
FLUORITE CRYSTALS IN MATRIX



OCTAGONAL STEP-CUT



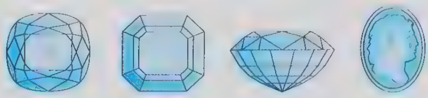
FLUORITE CRYSTALS INTERGROWN WITH QUARTZ



CLEAVED FLUORITE CRYSTAL

FLUORITE ROUGH

BLUE JOHN VASE
This attractive banded variety of fluorite has been carved since Roman times. The Ancient Romans believed that drinking alcohol from a cup made of Blue John would allow the drinker to imbibe without becoming drunk.



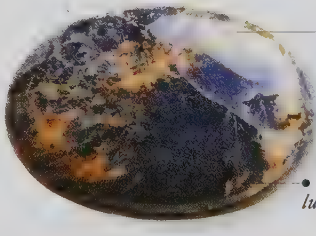
Crystal structure	Composition	Hardness
Cubic	Sodium aluminium silicate	5½

SODALITE

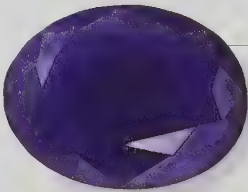
Sodalite, whose name reflects its sodium content, is found in all shades of blue, and is a major constituent of the rock lapis lazuli (opposite), so the two are easily confused. However, unlike lapis lazuli, sodalite very rarely contains brassy pyrite specks, and has a lower specific gravity. Sodalite may contain white streaks of the mineral calcite, and can be carved for use in jewellery.

• **OCCURRENCE** Sodalite is usually found as masses in igneous rocks. Crystals are very rare, but twelve-sided crystals have been found in the lavas of the volcano Vesuvius in Italy, although they are too small to be used in jewellery. Other localities include Brazil, Canada, India, Namibia, and the USA.

• **REMARK** The most important commercial source of sodalite is Bancroft in Ontario (Canada). It was discovered during a royal visit by Princess Margaret of England. For this reason, sodalite from Bancroft is sometimes called Princess Blue.

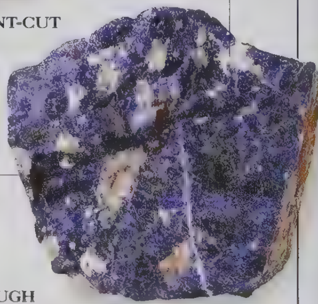


CABOCHON



OVAL BRILLIANT-CUT

POLISHED SODALITE



SODALITE ROUGH

Cabochon

Cameo

SG	RI	DR	Lustre
2.27	1.48 (mean)	None	Vitreous to greasy

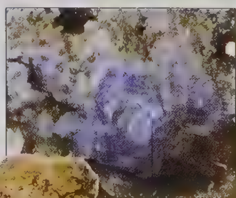
Crystal structure	Composition	Hardness
Cubic	Complex silicate	6

HAUYNE

Hauyne forms part of lapis lazuli (opposite). Intergrown with other minerals, it is seldom found as individual crystals. Hauyne has perfect cleavage, making cutting difficult, so it is faceted primarily for collectors.

• **OCCURRENCE** Hauyne is found as small, rounded grains in volcanic rocks. Ancient volcanoes of Germany and Morocco are the best-known sources.

BRILLIANT-CUT



HAUYNE CRYSTALS IN MATRIX

Brilliant

SG	RI	DR	Lustre
2.40	1.50 (mean)	None	Vitreous to greasy

Crystal structure Various	Composition Rock containing lazurite and other minerals	Hardness 5½

LAPIS LAZULI

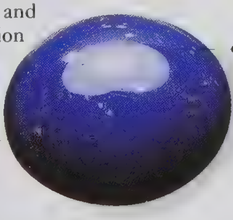
Lapis lazuli is a blue rock made up of several different minerals, including lazurite, sodalite, hauyne, calcite, and pyrite. The composition and colour of lapis lazuli varies, but it is the intense dark blue, with minor patches of white calcite and brassy yellow pyrite, that is considered to be the best quality.

• **OCCURRENCE** Lapis lazuli is usually found as boulders or within limestones. The best-quality lapis lazuli is from Afghanistan, and has been used in many famous pieces, including the mask of Tutankhamun. Argentinian lapis lazuli is also of a high quality. A pale blue variety occurs in the former USSR and in Chile. Lapis lazuli from the USA is a darker shade of blue; Canadian specimens are lighter blue.

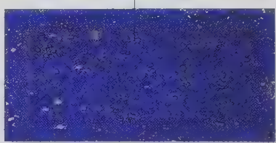
• **REMARK** Lapis lazuli has been worn in the belief that it will protect the wearer from evil. It has been imitated by stained jasper, and by paste with inclusions of copper. Imitation lapis lazuli is also produced by Pierre Gilson in France, and has a very similar composition to natural lapis lazuli.

BEAD NECKLACE
Specks of pyrite and streaks of calcite are visible in these lapis lazuli beads.

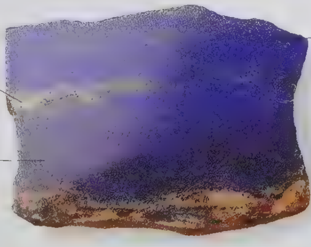
BUDDHA CARVING
This carving is made from the highest quality lapis lazuli from Afghanistan.



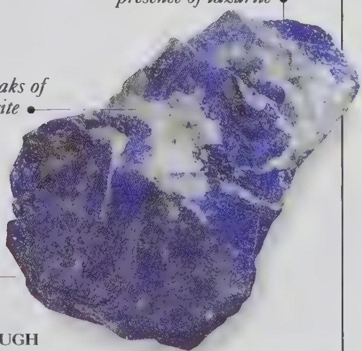
GILSON IMITATION CABOCHON



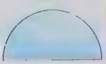
GILSON IMITATION SLAB



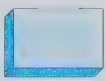
POLISHED LAPIS LAZULI SLAB



LAPIS LAZULI ROUGH


Cabochon


Cameo


Polished

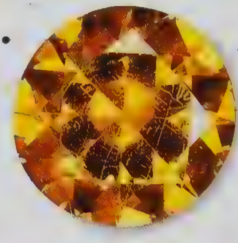
SG 2.80	RI 1.50 (mean)	DR None	Lustre Vitreous to greasy

Crystal structure Tetragonal	Composition Calcium tungstate	Hardness 5

SCHEELITE

Scheelite is quite soft and is therefore faceted only for collectors of the unusual. It has high dispersion and good fire, and varies in colour from a pale yellowish white to brown. Colourless synthetic scheelite is used to imitate diamond, but can be distinguished by its birefringence. It may also be coloured by trace metals in order to imitate other gemstones.

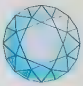
• OCCURRENCE Scheelite is found in pegmatites and metamorphic rocks. Very large crystals over 0.5kg (1lb) have been collected in Brazil, but, generally, larger crystals are not sufficiently transparent to be faceted. Other localities include Australia, Italy, Switzerland, Sri Lanka, Finland, France, and England.

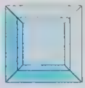


BRILLIANT-CUT

SQUARE STEP-CUT

SCHEELITE CRYSTALS IN MATRIX


Brilliant


Step


Mixed

SG 6.10	RI 1.92–1.93	DR 0.017	Lustre Vitreous to adamantine

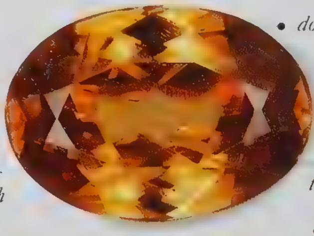
Crystal structure Tetragonal	Composition Tin oxide	Hardness 6½

CASSITERITE

Cassiterite is the principal ore of tin. It is usually recovered from mines as black opaque grains, which are of little use in jewellery. Crystals are generally short, stubby prisms. Occasionally, rare, transparent, reddish brown crystals with adamantine lustre are found, and faceted for collectors. They could be confused with diamond, brown zircon, and sphene, but for the higher specific gravity and distinct dichroism.

• OCCURRENCE Cassiterite occurs in pegmatites and can be washed into alluvial deposits. Localities include the Malay Peninsula, England, Germany, Australia, Bolivia, Mexico, and Namibia.

• REMARK The name "cassiterite" comes from the Greek word, *kassiteros*, meaning tin.



OVAL BRILLIANT-CUT

ROUND BRILLIANT-CUT

CASSITERITE CRYSTALS IN MATRIX


Brilliant


Mixed

SG 6.95	RI 2.00–2.10	DR 0.100	Lustre Adamantine

Crystal structure Tetragonal	Composition Complex silicate	Hardness 6

Scapolite

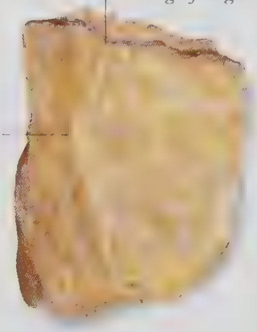
Also called wernerite after the German geologist, A.G. Werner, scapolite ranges in colour from pink, purple, blue, yellow, and grey, to colourless. These colours reflect the variation in composition, from sodium-rich to calcium-rich. Crystals are found as prisms that resemble sticks, giving rise to the name "scapolite", derived from the Greek words *scapos*, meaning rod, and *lithos*, meaning stone.

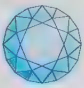
• **OCCURRENCE** Scapolite is found as crystals in pegmatites and metamorphic rocks like mica schist and gneiss. It also occurs in massive form. Localities include Brazil, Burma, Canada, Kenya, and Madagascar.

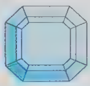
• **REMARK** A cat's-eye effect can be seen in some pink and purple stones. Scapolite may easily be confused with amblygonite, chrysoberyl, and golden beryl.

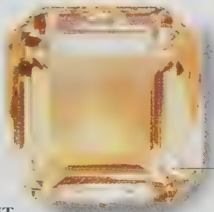
MIXED-CUT

CABOCHON




Brilliant


Step



STEP-CUT

MASSIVE SCAPOLITE

SG 2.70	RI 1.54–1.58	DR 0.020	Lustre Vitreous

Crystal structure Tetragonal	Composition Titanium oxide	Hardness 6

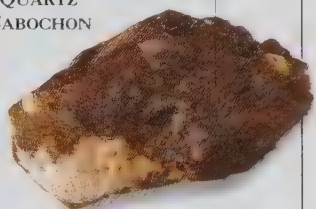
Rutile

Natural rutile has many times the fire shown by diamond, but it is masked by the red, brown, or black body colour. The black material has been used in mourning jewellery, but rutile is most usually seen as rich, reddish brown, needle-like inclusions within quartz, or within other stones, where the rutile crystals create a star effect by reflecting light.

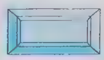
• **OCCURRENCE** Igneous and metamorphic rocks and alluvial deposits in Australia, Brazil, the USA, Italy, Mexico, and Norway.

QUARTZ CABOCHON

POLISHED QUARTZ



RUTILE ROUGH


Baguette


Mixed

SG 4.25	RI 2.62–2.90	DR 0.287	Lustre Vitreous to metallic

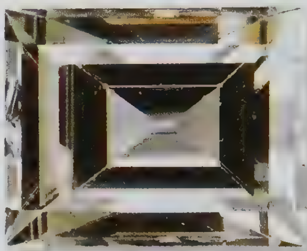
Crystal structure	Composition	Hardness
Tetragonal	Zirconium silicate	7½

ZIRCON

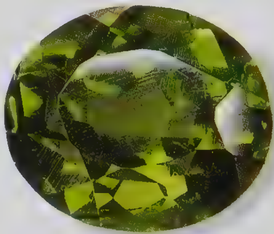
Zircon is most famous for its colourless stones, which closely resemble diamonds and have been used both intentionally and mistakenly in their place. Although colourless when pure, impurities will produce yellow, orange, blue, red, brown, and green varieties. Brown stones from Thailand, Vietnam, and Kampuchea are usually heat-treated to change them into the colourless or blue stones popular in jewellery. Blue stones that revert to brown will regain the blue if reheated. Blue zircon reheated in the presence of oxygen will change to golden-yellow. Zircon may be distinguished from diamond by its double refraction and by wear and tear on its facet edges. It has been imitated by both colourless glass and synthetic spinel. Some zircon contains radioactive thorium and uranium, which eventually break down the crystal structure. Decayed stones are known as "low" zircon, with a "metamict" structure; undamaged material is "high" zircon.

• **OCCURRENCE** Gem-quality crystals are usually found as pebbles in alluvial deposits. Sri Lanka has been a source of gem material for over 2,000 years; other localities include Burma, Thailand, Cambodia, Vietnam, Kampuchea, Australia, Brazil, Nigeria, Tanzania, and France.

• **REMARK** Zircon was believed to provide the wearer with wisdom, honour, and riches, and loss of lustre was said to warn of danger. The name is from the Arabic *zargun*, which derives from the Persian for "gold colour".

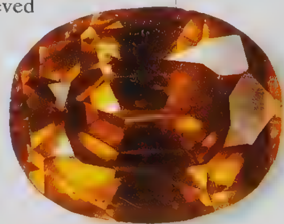


RECTANGULAR STEP-CUT

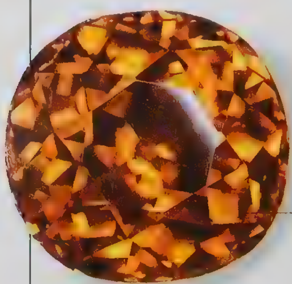


OVAL BRILLIANT-CUT

GREEN "METAMICT" PEBBLE



OVAL MIXED-CUT

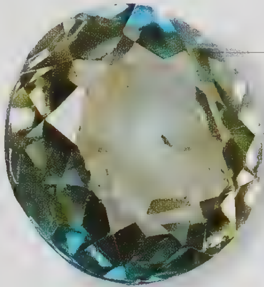


CUSHION BRILLIANT-CUT

CRYSTALS IN MATRIX

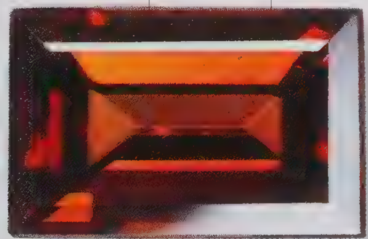
SG	RI	DR	Lustre
4.69	1.93–1.98	0.059	Resinous to adamantine

ROUND BRILLIANT-CUT



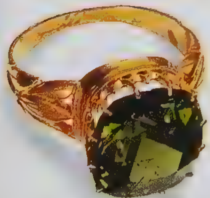
ROUND BRILLIANT-CUT

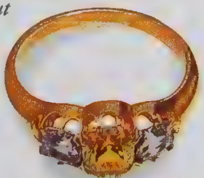
WATERWORN PEBBLES



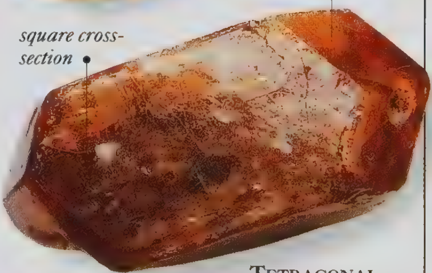
RECTANGULAR STEP-CUT

CUSHION BRILLIANT-CUT

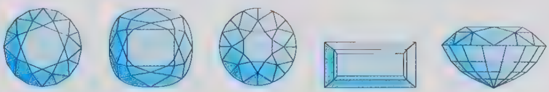




ZIRCON FINGER RINGS
Its adamantine lustre, strong birefringence, hardness, and vast colour range make zircon an attractive stone when set in a ring. Unfortunately, cut stones are somewhat brittle and are susceptible to damage if not treated with care.



TETRAGONAL ZIRCON CRYSTAL



Crystal structure Tetragonal	Composition Calcium aluminium silicate	Hardness 6½

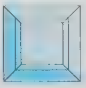
VESUVIANITE

This mineral was first discovered on the Italian volcano, Vesuvius, as small, perfect crystals. Also called idocrase, it may be red, yellow, green, brown, or purple. It is seldom used in jewellery, but it may be cut for collectors. Crystals are usually thick prisms with a square cross-section.

• **OCCURRENCE** There are several varieties: californite from California (USA) is green; rare, blue cyprine is found in Norway; yellowish green xanthite is from New York (USA); green wiluite crystals are from the former USSR. Other localities include Austria, Canada, Italy, and Switzerland.

• **REMARK** Vesuvianite may be confused with demantoid garnet, diopside, epidote, smoky quartz, tourmaline, zircon, and peridot.

Brilliant



Step

Mixed

CALIFORNITE CABOCHON

CUSHION-CUT

VESUVIANITE CRYSTAL

VESUVIANITE CRYSTALS

SG 3.40	RI 1.70–1.75	DR 0.005	Lustre Vitreous to adamantine

Crystal structure Tetragonal	Composition Sodium aluminium beryllium silicate	Hardness 6

TUGTUPITE

Tugtupite was first discovered in 1960 in Greenland, where it is carved for jewellery. Colours include dark red to bright pink, and shades of orange. It may look mottled. When it is placed in the dark, the paler parts of the rock fade to white, but exposure to light restores the colour.

• **OCCURRENCE** Tugtupite is found as massive opaque material in pegmatite veins. It also occurs in northern Russia.

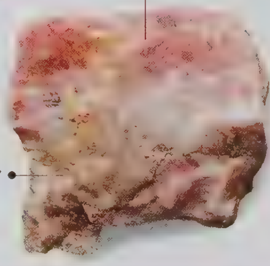
• **REMARK** The name derives from its occurrence in Tugtup, Greenland, and means reindeer stone.

Cabochon

Cameo

Polished

POLISHED STONE



TUGTUPITE ROUGH

SG 2.40	RI 1.49–1.50	DR 0.006	Lustre Vitreous

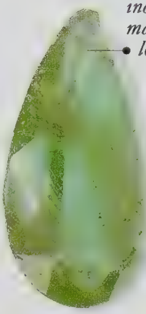
Crystal structure Hexagonal	Composition Beryllium aluminium silicate	Hardness 7½

EMERALD (BERYL)

Emerald derives its beautiful green colour from the presence of chromium and vanadium. Emeralds are rarely flawless, so stones are often oiled to fill and disguise cracks, hide flaws, and enhance colour. To minimize the loss of material, the step-cut (or "emerald-cut", as it is known) is commonly used, but ancient engravings are known, and cameos, intaglios, and beads can make the best of a flawed stone.

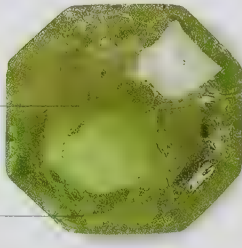
• **OCCURRENCE** Found in granites, pegmatites, and schists, as well as alluvial deposits, the finest emeralds are from Colombia. Other sources are Austria, India, Australia, Brazil, South Africa, Egypt, the USA, Norway, Pakistan, and Zimbabwe.

• **REMARK** Most emeralds used in historical jewellery would have been from Cleopatra's mines in Egypt, which now yield only poor-quality emeralds.

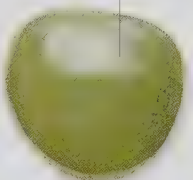


PENDELOQUE

Tremolite inclusions may be found in emeralds as short rods or long fibres.

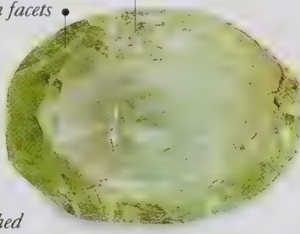


OCTAGONAL CABOCHON



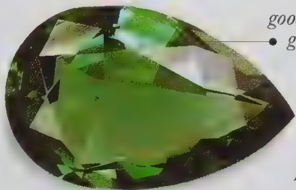
POLISHED PEBBLE

Synthetic emeralds have characteristic veil or wisp-like, liquid-filled inclusions.

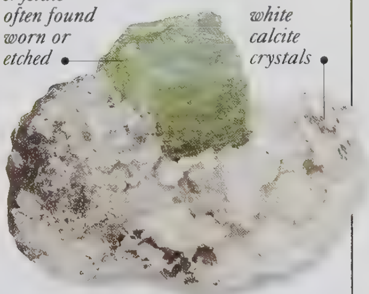


MIXED-CUT

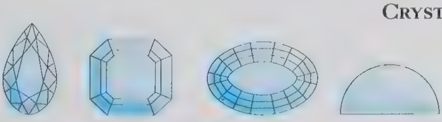
HEXAGONAL CRYSTAL



SYNTHETIC PENDELOQUE



CRYSTAL IN MATRIX



Pendeloque Step Step Cabochon

SG 2.71	RI 1.57–1.58	DR 0.006	Lustre Vitreous

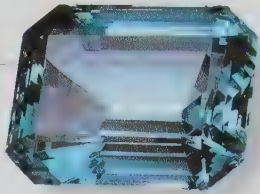
Crystal structure	Composition	Hardness
Hexagonal	Beryllium aluminium silicate	7½

AQUAMARINE (BERYL)

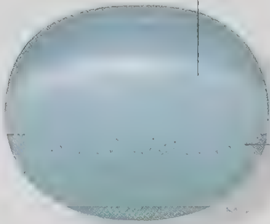
In the 19th century the preferred colour for aquamarine was sea-green, and indeed the name itself means sea water. Today the most valued colours are sky-blue and dark blue. Aquamarine is dichroic, appearing blue or colourless as the stone is viewed from different angles. Gem-quality aquamarine is found as hexagonal crystals, which may be up to 1m (39in) long and flawless, with striations along the length of the crystal. Aquamarine is often cut with the table facet parallel to the length of the crystal in order to emphasize the deepest coloration.

• **OCCURRENCE** The best of the gem-quality aquamarine is found in Brazil, where it occurs in pegmatites and alluvial deposits of gravel, locally called *cascalho*. Other localities include the Urals (Russia), Afghanistan, Pakistan, India, and, more recently exploited, Nigeria. A dark blue variety occurs in Madagascar.

• **REMARK** Almost all aquamarine in the market has been heat-treated to enhance its colour. Care must be taken not to overheat the stones, as they may become colourless.



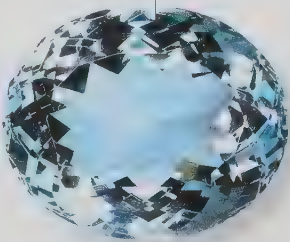
OCTAGONAL STEP-CUT



CABOCHON

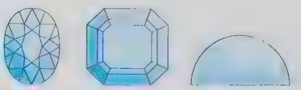
OCTAGONAL STEP-CUT

OCTAGONAL STEP-CUT



BRILLIANT-CUT

AQUAMARINE CRYSTALS



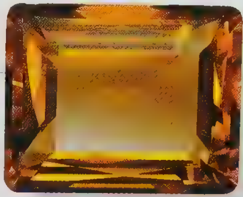
SG	RI	DR	Lustre
2.69	1.57–1.58	0.006	Vitreous

Crystal structure Hexagonal	Composition Beryllium aluminium silicate	Hardness $7\frac{1}{2}$

Heliodor (Beryl)

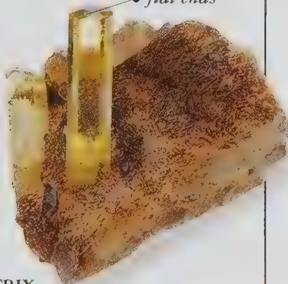
Heliodor, a yellow or golden yellow form of beryl, has always been linked with the Sun. Gem-quality specimens are occasionally found, but more usually inclusions of fine, slender tubes are present, which are visible to the naked eye.

• **OCCURRENCE** Heliodor is found associated with aquamarine in granitic pegmatites. The best-quality stones are found in the Urals (Russia). Brazilian heliodor is often a pale yellow and is step-cut to give depth of colour. Heliodor from Madagascar is a finer colour. Other localities include the Ukraine, Namibia, and the USA.

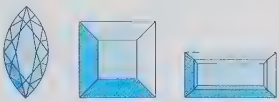


Scissors-cut

Fancy-cut



Heliodor Crystals in Matrix



Marquise Table Baguette

SG 2.80	RI 1.57–1.58	DR 0.005	Lustre Vitreous

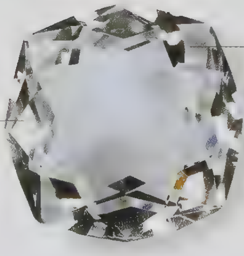
Crystal structure Hexagonal	Composition Beryllium aluminium silicate	Hardness $7\frac{1}{2}$

Goshenite (Beryl)

Goshenite is the pure, colourless variety of beryl. It has been used to imitate diamond or emerald, by placing silver or green-coloured metal foil behind a cut goshenite gemstone, then placing the stone in a closed setting so that the foil cannot be detected.

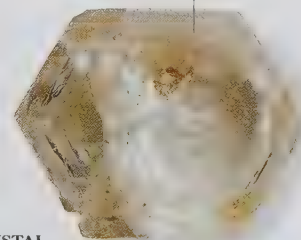
• **OCCURRENCE** Goshenite is named after Goshen, Massachusetts, in the USA, where it was first found. Present localities include Canada, Brazil, and the former USSR.

• **REMARK** Pale and colourless beryl was once used for the lenses in spectacles, thus the German word for spectacles, *brille*, may have been derived from the word "beryl".

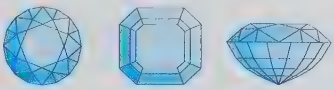


Fancy-cut

Brilliant-cut



Tabular Crystal



Brilliant Step Mixed

SG 2.80	RI 1.58–1.59	DR 0.008	Lustre Vitreous

Crystal structure Hexagonal	Composition Beryllium aluminium silicate	Hardness 7½

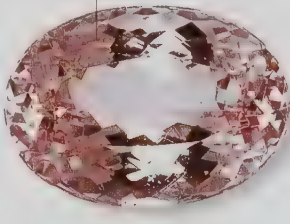
MORGANITE (BERYL)

Coloured by manganese impurities, the pink, rose, peach, and violet varieties of beryl are called morganite, after the American banker and gem enthusiast, J. Pierpoint Morgan. Morganite tends to occur as short and stubby (tabular) prisms, and is dichroic, showing either two shades of the body colour, or one shade and colourless.

• **OCCURRENCE** The first morganite to be described was a pale rose-coloured specimen from California (USA), where it occurred with tourmaline. Some of the finest morganite is from Madagascar; Brazil produces pure pink crystals, as well as some containing aquamarine and morganite in the same crystal. Other localities include Elba (Italy), Mozambique, Namibia, Zimbabwe, and (recently discovered) Pakistan.

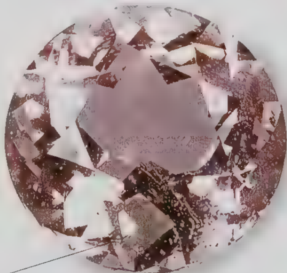
• **REMARK** Stones with a yellow or orange tinge may be heat-treated for a purer pink.

OVAL MIXED-CUT

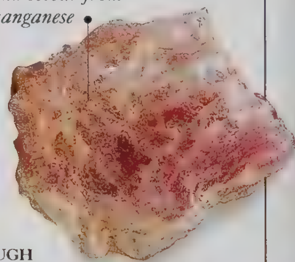


BRILLIANT-CUT

DROP-SHAPED CUT

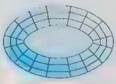


ROUND BRILLIANT-CUT



MORGANITE ROUGH


Brilliant


Step

SG 2.80	RI 1.58–1.59	DR 0.008	Lustre Vitreous

Crystal structure Hexagonal	Composition Beryllium aluminium silicate	Hardness 7½

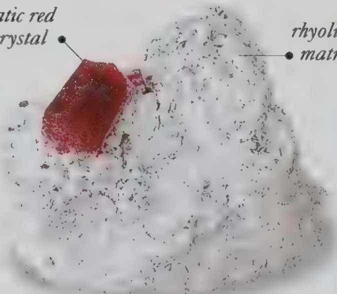
RED BERYL

Very rare, and seldom seen as a cut stone, red beryl nonetheless has an unusually intense colour, due to the presence of manganese.

• **OCCURRENCE** Found in rhyolites in the Thomas Mountains and Wah Wah Mountains in Utah in the USA.

• **REMARK** Red beryl is also called bixbite (not to be confused with bixbyite, a manganese-iron oxide).


Brilliant



CRYSTAL IN MATRIX

SG 2.80	RI 1.58–1.59	DR 0.008	Lustre Vitreous

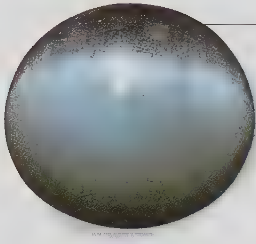
Crystal structure Hexagonal	Composition Calcium phosphate	Hardness 5

APATITE

With a value of only 5 on the Mohs scale of hardness, apatite is seldom faceted as a gemstone, except for collectors. However, when cut correctly, stones are bright with strong colours. Transparent to opaque, apatite occurs as colourless, yellow, blue, violet, or green hexagonal prisms or tabular crystals.

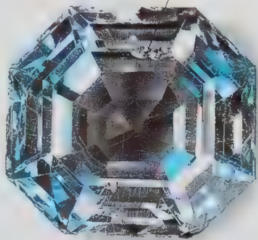
• **OCCURRENCE** Apatite is an abundant mineral, found in many types of rock, but most gem-quality material is associated with pegmatites. Blue Burmese apatite is strongly dichroic, and shows colourless or blue when viewed from different directions. Fibrous blue apatite from Burma and Sri Lanka may be cut *en cabochon* to show a cat's-eye. Chatoyant stones are also found in Brazil, along with yellow, blue, and green varieties. Other localities include the Kola Peninsula (Russia), Canada, East Africa, Sweden, Spain, and Mexico.

• **REMARK** Spanish apatite is often called "asparagus stone", due to its yellowish green colour.

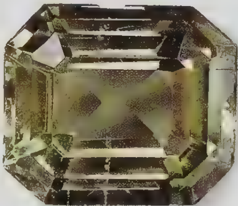


CAT'S-EYE CABOCHON

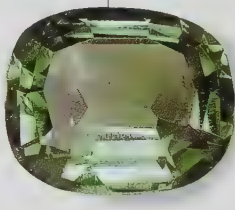
ROUND BRILLIANT-CUT



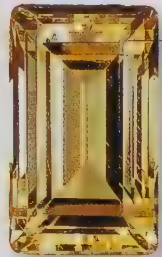
OCTAGONAL STEP-CUT



OCTAGONAL STEP-CUT

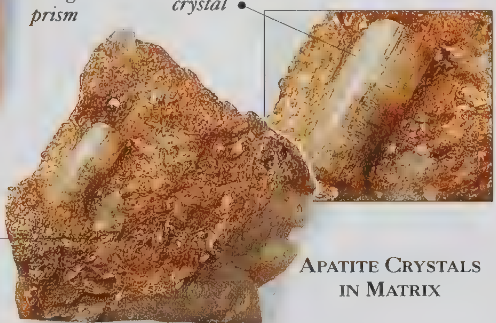


CUSHION MIXED-CUT

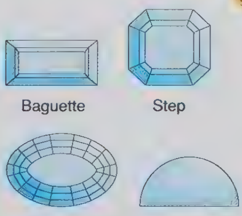


RECTANGULAR STEP-CUT

APATITE CRYSTAL



APATITE CRYSTALS IN MATRIX



SG 3.20	RI 1.63–1.64	DR 0.003	Lustre Vitreous

Crystal structure Hexagonal	Composition Beryllium magnesium aluminium oxide	Hardness 8

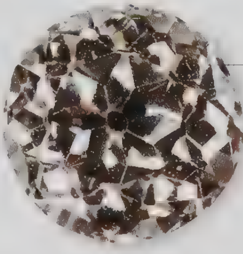
TAAFFEITE

Taaffeite is very rare, and is unique in being the only gemstone not recognized as a new mineral species until it had been faceted. The first specimen (see right) was found by Count Taaffe in Ireland, in a jeweller's box of stones. It looked like spinel, had a pale mauve tinge, and was cushion-cut, but was eventually found to be a new, doubly refractive (rather than singly refractive like spinel) mineral. Since then, more specimens have been found; these range in hue from red to blue to almost colourless.

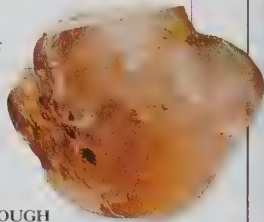
• **OCCURRENCE** Taaffeite occurs in Sri Lanka, China, and the former USSR.

• **REMARK** No imitation taaffeites appear to exist.

CUSHION-CUT



ROUND BRILLIANT-CUT



TAAFFEITE ROUGH

SG 3.61	RI 1.72–1.77	DR 0.004	Lustre Vitreous

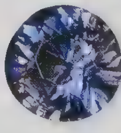
Crystal structure Hexagonal	Composition Barium titanium silicate	Hardness 6½

BENITOITE

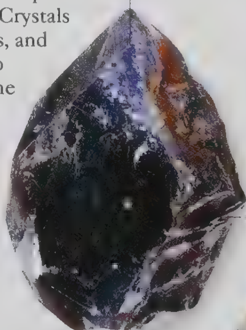
The blue crystals of benitoite were only discovered in 1906, by a mineral prospector who mistook them for sapphires. Crystals are shaped like flattened triangles, and have a strong dispersion similar to diamond, but this is masked by the colour. Dichroism is strong: the stone appears blue or colourless when viewed from different angles. Colourless crystals occur, but are rarely faceted.

• **OCCURRENCE** Crystals occur in veins in blue schists. The sole source is in San Benito County, California (USA), after which the stone is named.

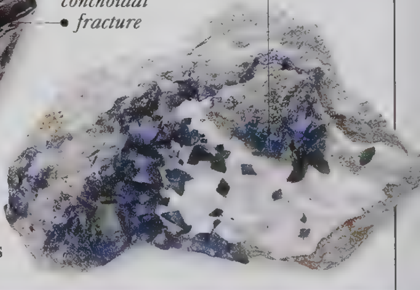
BRILLIANT-CUT



BRILLIANT-CUT



BENITOITE CRYSTAL FRAGMENT



BENITOITE CRYSTALS IN MATRIX

SG 3.67	RI 1.76–1.80	DR 0.047	Lustre Vitreous

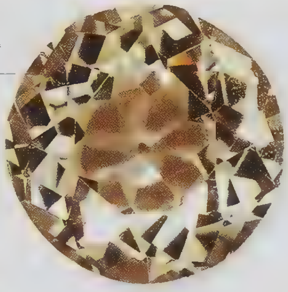
Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

Rock Crystal (Quartz)

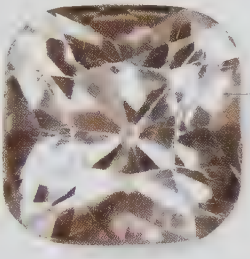
Colourless and transparent, rock crystal is the most widely distributed variety of quartz, one of the most common minerals of the Earth's crust. The crystals are usually found as colourless hexagonal prisms, with pyramidal ends and striations perpendicular to their length; they are often twinned. Cleavage is poor and fracture conchoidal.

• **OCCURRENCE** Although found worldwide, the most important sources of rock crystal are in Brazil. Other localities include the Swiss and French Alps, where fine crystals occur, and Madagascar, the former USSR, and the USA.

• **REMARK** The name "quartz" comes from the Greek word *krustallos*, meaning ice, because it was thought that quartz was ice formed by the gods. Since the Middle Ages, crystal balls made of rock crystal have been used to predict the future. Today, rock crystal is used in lamps, lenses, and the manufacture of glass and precision instruments. Synthetic rock crystal has been produced since 1950 for use in watches.

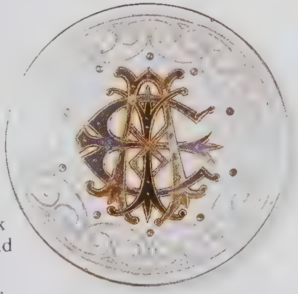


Round Brilliant-cut



Cushion Brilliant-cut

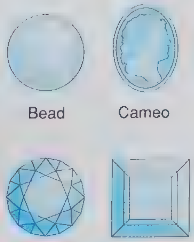
Polished Bead



Polished Rock Crystal
This flat disc of polished rock crystal has been engraved, and set with an enamelled monogram of blue, black, and gold.

Single Crystal

Crystals



SG 2.65	RI 1.54–1.55	DR 0.009	Lustre Vitreous

Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

AMETHYST (QUARTZ)

Crystalline quartz in shades of purple, lilac, or mauve is called amethyst, a stone traditionally worn to guard against drunkenness, and to instil a sober and serious mind. Amethyst is dichroic, showing a bluish or reddish purple tinge when viewed from different angles. Usually faceted as a mixed- or step-cut, amethyst has distinctive inclusions which look like tiger-stripes, thumbprints, or feathers. Some amethyst is heat-treated to change the colour to yellow, producing citrine (see opposite). Crystals that are part citrine and part amethyst are called ametrine.

• **OCCURRENCE** Amethyst is found in alluvial deposits or in geodes. Some of the largest geodes containing amethyst are in Brazil. Amethyst from the Urals (Russia) has a reddish tinge; Canadian amethyst is violet. Other localities include Sri Lanka, India, Uruguay, Madagascar, the USA, Germany, Australia, Namibia, and Zambia.

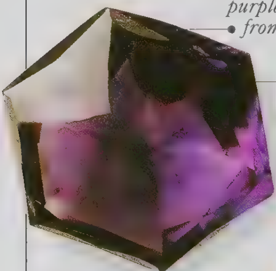
• **REMARK** Poor-quality material is often tumbled to make beads. If a stone is pale it may be set in a closed setting or have foil placed behind it to enhance the colour. Amethyst has been imitated by glass and synthetic corundum.

TIE-PIN
Amethyst jewellery was popular in the late 19th century. This handsome gold tie-pin is adorned with an octagonal step-cut amethyst.

Characteristic tiger-stripe inclusions are caused by parallel, liquid-filled canals.

typical purplish violet colour

OVAL MIXED-CUT



purple stone from Russia

polished, convex front

HEXAGONAL MIXED-CUT

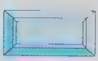
alternate colours due to twinning

slice cut perpendicular to length of crystal

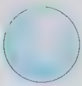
AMETHYST CRYSTAL SLICE

colour darkens towards tip of amethyst crystal

AMETHYST CRYSTALS ASSOCIATED WITH ROCK CRYSTAL



Baguette



Bead

Mixed

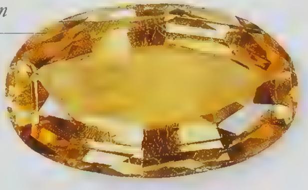
SG 2.65	RI 1.54–1.55	DR 0.009	Lustre Vitreous

Crystal structure	Composition	Hardness
Trigonal	Silicon dioxide	7

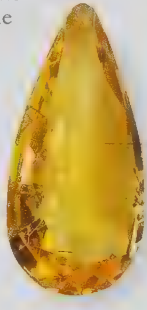
Citrine (Quartz)

Citrine is the yellow or golden yellow variety of quartz. The yellow coloration, due to the presence of iron, is also responsible for the name, derived from the word "citrus". Natural citrine is usually a pale yellow, but rare; most citrine on the market is heat-treated amethyst (see opposite).

- **OCCURRENCE** Gem-quality citrine is extremely rare. The best material is found in Brazil, Spain, Madagascar, and the former USSR.
- **REMARK** Citrine has been used to imitate topaz (see pp.106–107), and was once called Brazilian topaz.



Mixed-cut

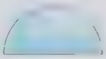


Mixed-cut Pendeloque

Citrine Crystal

Brilliant

Pendeloque



Cabochon

SG	RI	DR	Lustre
2.65	1.54–1.55	0.009	Vitreous

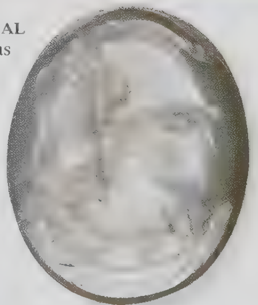
Crystal structure	Composition	Hardness
Trigonal	Silicon dioxide	7

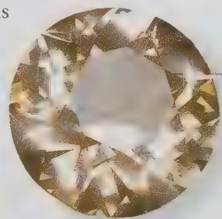
Rose Quartz

Pink or peach-coloured quartz is called rose quartz, and is mainly used in decorative carvings. Its colour is thought to be due to the presence of small amounts of titanium. Crystals of rose quartz are very rare; more usually, massive lumps are found, which can be carved, or cut *en cabochon* or as beads. Transparent material is uncommon; it is usually cloudy or cracked, partly because it is so brittle. Rutile inclusions in rose quartz may produce a star effect when the stone is cut *en cabochon*.

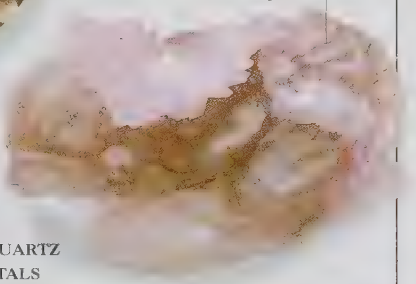
- **OCCURRENCE** Rose quartz is found in pegmatites. The best material is from Madagascar, but Brazil produces a greater quantity. Other sites are Scotland, the former USSR, Colorado (USA), and Spain.

Rose Quartz Seal Intaglio seals such as this, made with an incised rather than a raised design, were very popular in Ancient Rome.

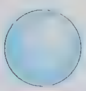




Brilliant-cut



Rose Quartz Crystals



Bead

Mixed

Cameo

SG	RI	DR	Lustre
2.65	1.54–1.55	0.009	Vitreous

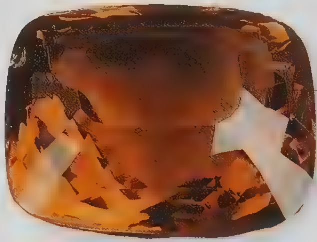
Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

BROWN QUARTZ

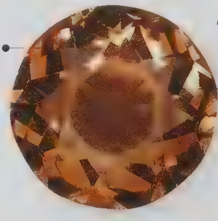
Brown quartz includes quartz of a light brown or dark brown colour, greyish brown "smoky" quartz, and the black variety called morion. Brown or smoky quartz from the Cairngorm Mountains of Scotland is called cairngorm. When irradiated, colourless quartz may change colour to greyish brown, suggesting that brown quartz may have been formed by natural radiation within the ground. Brown quartz crystals are hexagonal prisms with pyramidal ends, in which inclusions of the mineral rutile may be present.

• **OCCURRENCE** Crystals weighing as much as 300kg (650lb) have been found in Brazil. Other localities include Madagascar, the Swiss Alps, Colorado (USA), Australia, and Spain.

• **REMARK** Much of the smoky quartz on the market is in fact irradiated rock crystal. Brown quartz has been confused with andalusite, axinite, idocrase, and brown tourmaline.



FANCY-CUT SMOKY QUARTZ

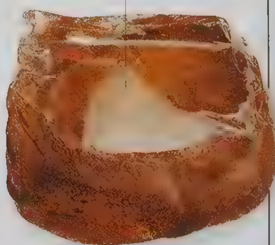


BRILLIANT-CUT SMOKY QUARTZ

SNUFF BOTTLE
Like most varieties of quartz, smoky quartz may be polished and fashioned in many ways. This snuff bottle, with red stopper and spoon, is of Chinese origin.

MORION CRYSTAL

INTAGLIO SEAL
This incised intaglio was carved in smoky quartz, and has been set in a polished oval of obsidian, a natural volcanic glass. Intaglio seals were popular with the Ancient Romans, and this piece depicts a Roman wearing a helmet.



WATERWORN CAIRNGORM PEBBLE

Mixed

Cameo

SG 2.65	RI 1.54–1.55	DR 0.009	Lustre Vitreous

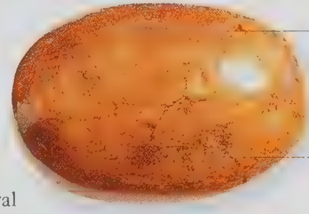
Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

AVENTURINE QUARTZ

This form of quartz contains inclusions of small crystals that reflect light, and which give a range of colours – depending on the nature of the inclusion. Green aventurine quartz has platy inclusions of green fuchsite mica; pyrite inclusions give a brown colour; a greenish brown variety may be due to the mineral goethite. Other inclusions give bluish white, bluish green, or orange varieties.

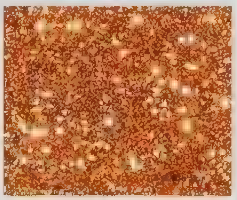
• OCCURRENCE Aventurine quartz is found in Brazil, India, and Russia. Other localities include the USA, Japan, and Tanzania.

• REMARK Aventurine quartz has been confused with aventurine feldspar, amazonite, and jade. A simulant, known as goldstone, has been made to imitate both aventurine quartz and aventurine feldspar. It contains small triangles and hexagons of copper held in glass. With a x10 hand lens it should be possible to see the outlines of the copper spangles.

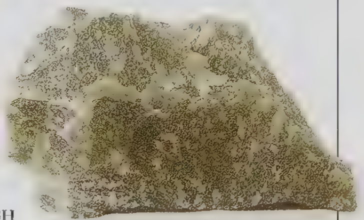


CABOCHON

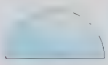
POLISHED SLAB



The copper inclusions in goldstone are visible with a x10 hand lens.

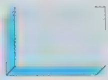


AVENTURINE QUARTZ ROUGH



Cabochon

Cameo



Polished

SG 2.65	RI 1.54–1.55	DR 0.009	Lustre Vitreous

Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

MILKY QUARTZ

This form of quartz derives its distinctive milky white or cream colour from inclusions of gas and liquid bubbles. The degree of milkiness depends on the number and size of inclusions present. Crystals are hexagonal prisms with pyramidal ends.

• OCCURRENCE Very large crystals are found in Siberia. Other localities include Brazil, the European Alps, Madagascar, the USA, and Namibia.

• REMARK When polished or cut *en cabochon*, it may be confused with opal.

Brilliant

Cameo

OVAL CUSHION-CUT

HEXAGONAL CRYSTAL

SG 2.65	RI 1.54–1.55	DR 0.009	Lustre Vitreous

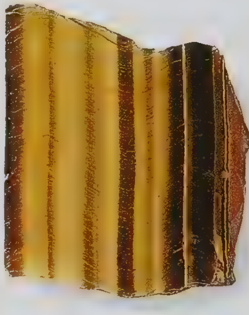
Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

Chatoyant Quartz

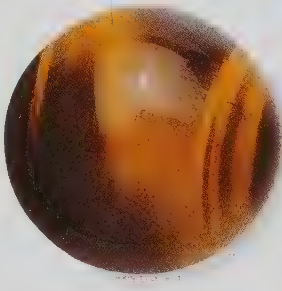
The three varieties of quartz described here all have a fibrous structure, with inclusions of crocidolite (blue asbestos) that cause a "cat's-eye" effect known as chatoyancy. This effect is best seen when the stones are cut *en cabochon*. Each stone displays different colours according to the exact nature of the inclusions. The greyish yellow, semi-translucent appearance of quartz cat's-eye is due to inclusions of crocidolite "asbestos" and, less commonly, hornblende. It has a silky lustre. Tiger's-eye is black, with iron oxide staining that gives yellow and golden brown stripes. Hawk's-eye forms when crocidolite changes to quartz, but the blue-grey or blue-green colour of the original remains.

• **Occurrence** Quartz cat's-eye comes from Sri Lanka, India, and Brazil. The most important source of tiger's-eye is in South Africa, where it is found in thick slabs, together with the less common hawk's-eye. Chatoyant quartz is also found in Australia and the USA.

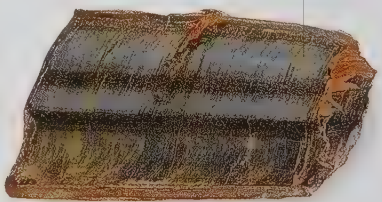
• **Remark** Chatoyant quartz is always called *quartz* cat's-eye to avoid confusion with other chatoyant gems, particularly chrysoberyl.



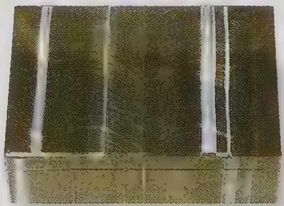
Tiger's-eye Polished Slab



Polished Tiger's-eye

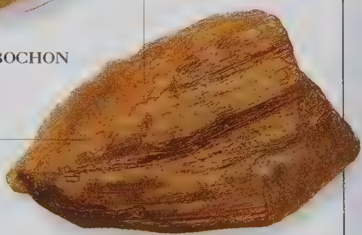


Hawk's-eye Rough

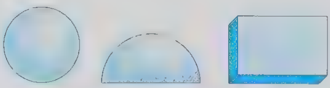


Hawk's-eye Cigarette Box
In this attractive ornament, made of polished slices of blue hawk's-eye, the wavy, fibrous nature of the original asbestos can be clearly seen. Partial oxidation has created a few yellow waves.

Quartz Cat's-eye Cabochon



Quartz Cat's-eye Rough



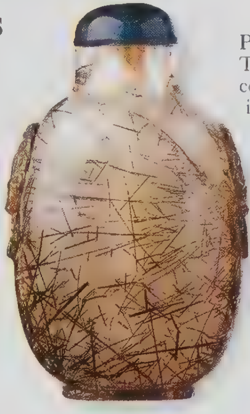
SG 2.65	RI 1.54–1.55	DR 0.009	Lustre Vitreous

Crystal structure	Composition	Hardness
Trigonal	Silicon dioxide	7

QUARTZ WITH INCLUSIONS

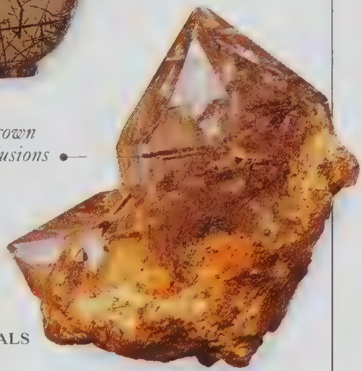
Quartz specimens with mineral inclusions are very common and make attractive gemstones. "Rutilated quartz" or "sagenite", popularly known as Venus-hair stone, is quartz with needle-like rutile crystals. These may be red, black, or brassy yellow, and have a metallic lustre. "Tourmalinated quartz" has inclusions of black tourmaline, which form prismatic or needle-like crystals. Opaque, metallic yellow inclusions of gold are found in specimens of "gold quartz". Inclusions of silver may also be found within quartz, often in branch-like dendrites, and are silvery grey or black, opaque, and metallic. The iron minerals, goethite and pyrite, are also found as inclusions. If cut *en cabochon*, quartz containing goethite may show the cat's-eye effect.

• **OCCURRENCE** Quartz with inclusions is found in Madagascar, Brazil, South Africa, India, Sri Lanka, Germany, and Switzerland.



PERFUME BOTTLE
This piece of quartz contains distinctive inclusions of black, needle-like tourmaline crystals. It has been shaped, hollowed out, and polished to make a bottle.

• *needle-like tourmaline inclusions*



reddish brown rutile inclusions

hexagonal quartz prisms

RUTILATED QUARTZ CRYSTALS IN MATRIX

Brilliant Bead Cabochon Cameo

SG	RI	DR	Lustre
2.65	1.54–1.55	0.009	Vitreous

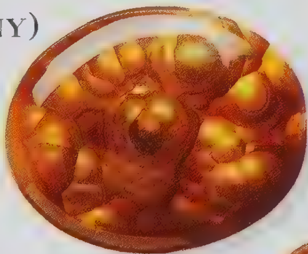
Crystal structure	Composition	Hardness
Trigonal	Silicon dioxide	7

FIRE AGATE (CHALCEDONY)

Fire agate belongs to the chalcedony family of microcrystalline quartzes. These are either solid-coloured stones, or have bands or moss-like or dendritic inclusions (agates). The distinctive iridescent colours of fire agate are caused by layers of iron oxide within the quartz. This rainbow effect may be brought out by cutting *en cabochon*.

• **OCCURRENCE** Fire agate is found in Arizona (USA) and Mexico.

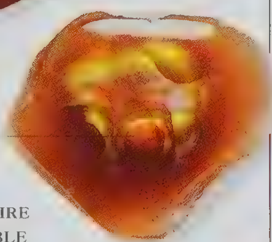
• **REMARK** Iris quartz has a similar iridescence, but this is caused by internal cracks.



• *iridescence brought out by cabochon-cut*

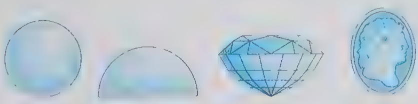
• *iron oxide inclusions give "oily" effect*

FIRE AGATE CABOCHON



rainbow colours

POLISHED FIRE AGATE PEBBLE



Bead Cabochon Mixed Cameo

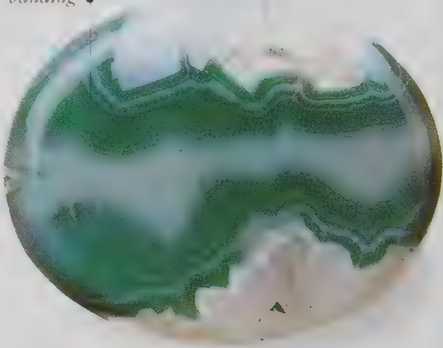
SG	RI	DR	Lustre
2.61	1.53–1.54	0.004	Vitreous

Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

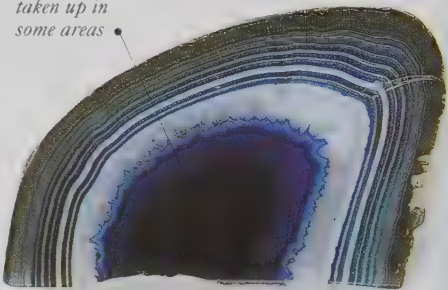
AGATE (CHALCEDONY)

Agate occurs in nodular masses in rocks such as volcanic lavas. When split open, they reveal an amazing variety of colours and patterns, and a distinct banding that distinguishes agate from other kinds of chalcedony (the compact, micro-crystalline variety of quartz). Band colours are determined by the differing impurities present, although, being porous, agate is often dyed or stained to enhance the natural colour. Agate also occurs in several distinct forms. Fortification agate has angularly arranged bands resembling an aerial view of a fortress. Moss agate (or mocha stone) is translucent and colourless, white or grey, with dark, moss- or tree-like (dendritic) inclusions. It is usually cut as thin slabs, or polished as ornaments, brooches, or pendants. Agatized wood is fossilized wood that has had its organic matter replaced by agate.

• **OCCURRENCE** Probably the most famous area for agates is Idar-Oberstein in Germany, where agate has been collected since 1548. It now imports agates from the huge deposits in Uruguay and Brazil. Moss agate occurs in the Hindustan area of India; also China and the USA. The most famous agatized wood is found in the Petrified Forest in Arizona (USA). Agates are also found in Mexico, Madagascar, Italy, Egypt, India, China, and Scotland.

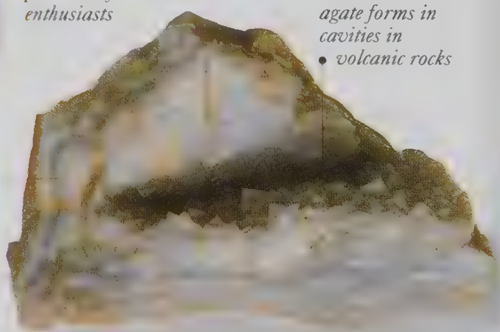


STAINED AND POLISHED OVAL



STAINED AND POLISHED SLICE

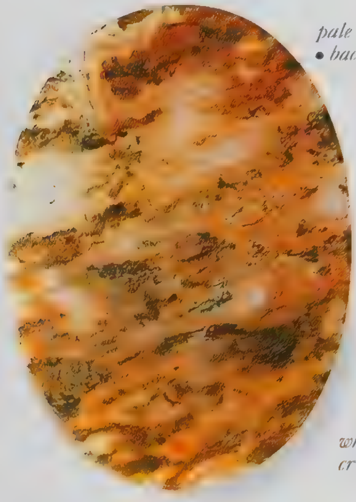
POLISHED SLICE



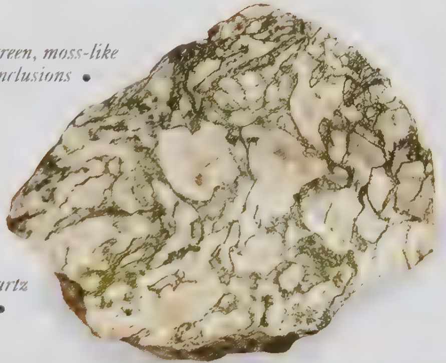
AGATE ROUGH

SG 2.61	RI 1.53–1.54	DR 0.004	Lustre Vitreous

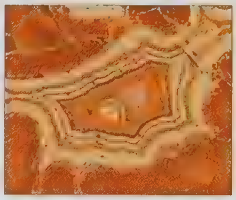
"LANDSCAPE" AGATE



MOSS AGATE BROOCH STONE



MOSS AGATE ROUGH



CARVED BOWL
Agate is a very popular stone for carving and polishing, although a piece as delicate as this bowl could only be worked by an expert lapidary. The parallel banding is typical of agate.

FORTIFICATION AGATE ROUGH

Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

Onyx, Sard, and Sardonyx (Chalcedony)

Onyx, sard, and sardonyx are all varieties of the microcrystalline quartz, chalcedony. Onyx is similar to agate (see pp.88–89), but it has straight rather than curved bands. These may be brown and white or black and white. Sard is a brownish red variety, also similar to agate. Sardonyx, a blend of sard and onyx, has the straight white bands of onyx and the brownish red of sard. All three varieties are carved as small sculptures and intaglios, or may be polished, tumbled, or cut as beads. They are renowned as excellent materials for inlay work. Since Ancient Egyptian times, onyx has been stained to improve or change its colour. Much onyx has been produced by soaking agate in a sugar solution, then heating it in sulphuric acid to carbonize the sugar particles. Sard may be imitated by saturating chalcedony with an iron solution.

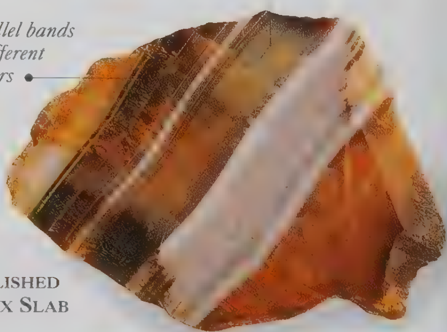
• **Occurrence** Found worldwide, they are formed by the deposition of silica in gas cavities in lavas, which results in the distinctive bands.

• **Remark** Onyx seals were very popular with the Romans, who carved the pattern of the seal in negative relief to give a raised print. They often used stones with several layers, each of a different colour, which were then individually carved to produce a different pattern in each layer.

Flower Cameo
This cameo was worked from a single piece of onyx. The dark, opaque layer has been carved away in the shape of a flower to reveal the pale layer beneath.

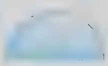
Straight Seal
The straight layers of onyx have been exposed to dramatic effect in this seal, an ornament popular with the Romans.

Onyx with White Opal



Polished Onyx Slab

Bead



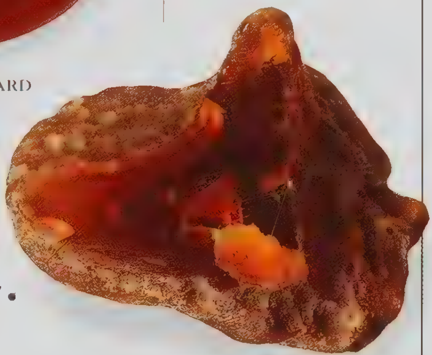
Cabochon

Polished

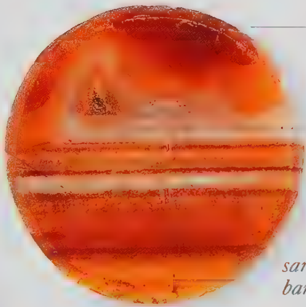
SG 2.61	RI 1.53–1.54	DR 0.004	Lustre Vitreous

Oval Polished Sard

Sard Pebble



Sard Rough



Polished Sardonyx

Sardonyx Cameo
In this intricately carved cameo, the pattern of a woman's head and winged dragon has been cut from three different layers – dark brown, white, and red-brown. A laurel garland is carved just inside the raised rim.

Sardonyx Rough

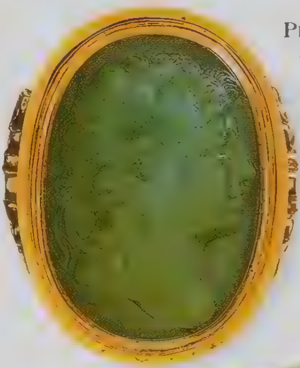
Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

CHRYSOPRASE/PRASE (CHALCEDONY)

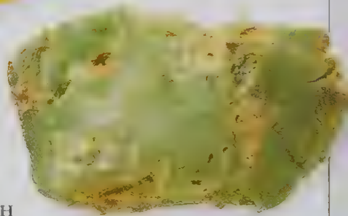
Used by both the Greeks and Romans as a decorative stone, chrysoprase, a translucent, apple-green stone, is the most valued variety of chalcedony. The colour, derived from the presence of nickel, may fade in sunlight, and stones may then be confused with fine jade (see pp.124–125).

• **OCCURRENCE** Mines in Poland and Czechoslovakia once produced very fine chrysoprase. However, since 1965 the best-quality material has come from Queensland (Australia). Other localities are the Urals (Russia), California (USA), Brazil, and Austria.

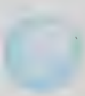
• **REMARK** Another green chalcedony, prase, has a more sombre hue and is very rare.



PRASE CAMEO Set in gold as an ornamental pin, this piece of fine green prase has been carved and polished into a classically styled cameo.



CHRYSOPRASE ROUGH



Bead

Cabochon

Cameo

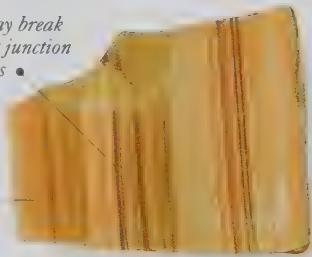
SG 2.61	RI 1.53–1.54	DR 0.004	Lustre Vitreous to waxy

Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

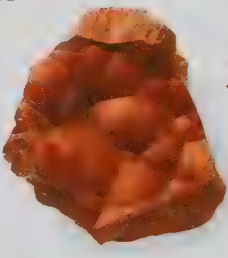
JASPER (CHALCEDONY)

Jasper is a massive, fine-grained, opaque variety of chalcedony, believed to protect against sight defects and drought. It occurs in shades of brown, greyish blue, red, yellow, and green, and mixtures of these. "Orbicular" jasper has white or grey, eye-shaped patterns surrounded by red jasper. "Riband" jasper is striped and used in carvings, cameos, and intaglios, which show off its layered structure. Hornstone is a grey variety.

• **OCCURRENCE** Red jasper occurs in India and Venezuela; various colours occur in the USA, especially orbicular jasper in California; red and green riband jasper occurs in Russia. It also occurs in France and Germany.



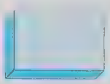
RIBAND JASPER FRAGMENT



RED JASPER ROUGH

RED JASPER ROUGH

Cameo



Polished

SG 2.61	RI 1.53–1.54	DR 0.004	Lustre Vitreous

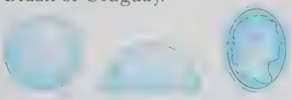
Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

CARNELIAN (CHALCEDONY)

Also called cornelian, this translucent, reddish orange variety of chalcedony was once thought to still the blood and calm the temper. Its various shades of red are due to the presence of iron oxide. Stones may be uniformly coloured or faintly banded.

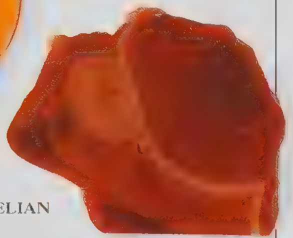
• OCCURRENCE The best carnelian is from India, where it is placed in the sun to change brown tints to red.

• REMARK Most carnelian on the market is stained chalcedony from Brazil or Uruguay.



Bead Cabochon Cameo

POLISHED STONE



POLISHED CARNELIAN FRAGMENT

SG 2.61	RI 1.53–1.54	DR 0.004	Lustre Vitreous to waxy

Crystal structure Trigonal	Composition Silicon dioxide	Hardness 7

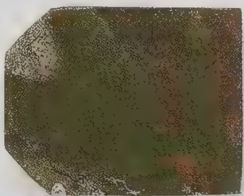
BLOODSTONE AND PLASMA (CHALCEDONY)

Bloodstone (also called heliotrope) and plasma are both opaque, green, spotted varieties of chalcedony, used for decorative carvings and cameos. The dark green of bloodstone is spotted with red, due to the presence of iron oxides. These distinctive spots seem to resemble blood, and give the stone its name. Plasma is also green and may have yellowish spots.

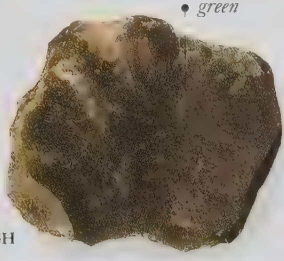
• OCCURRENCE India is the primary source of bloodstone, but it also occurs in Brazil, China, Australia, and the USA. Plasma is mined in Zimbabwe.

• REMARK In the Middle Ages, bloodstone was attributed with special powers, as the spots were thought to be the blood of Jesus Christ. In Germany, hematite is also called bloodstone, so this variety is known as bluestone.

ROMAN CAMEO
The typical red spotting in dark green bloodstone appears as an almost solid mass in the high relief of this cameo.



POLISHED BLOODSTONE SLAB



PLASMA ROUGH

Bead Cameo Polished

SG 2.61	RI 1.53–1.54	DR 0.004	Lustre Vitreous

Crystal structure Trigonal	Composition Aluminium oxide	Hardness 9

RUBY (CORUNDUM)

Ruby – the name given to red, gem-quality corundum – is one of the best gemstones for jewellery settings. Rubies may be any shade of red, from pinkish to purplish or brownish red, depending on the chromium and iron content of the stone. Frequent twinning of the crystals makes the material liable to fracture, yet ruby is a tough mineral, second only to diamond in hardness. Crystal prisms are hexagonal with tapering or flat ends. As the crystals grow they form new layers, and depending on the geological conditions and minerals present, colour variations, called zoning, occur.

• **OCCURRENCE** Worldwide in igneous and metamorphic rocks, or as waterworn pebbles in alluvial deposits. The finest stones come from Burma; those from Thailand, the main source, are brownish red; Afghanistan, Pakistan, and Vietnam produce bright red stones; those from India, North Carolina (USA), Russia, Australia, and Norway are dark, sometimes even opaque.

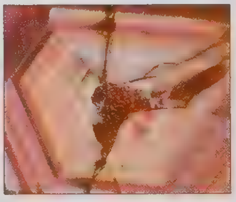
• **REMARK** In 1902, a Frenchman, Auguste Verneuil, produced a synthetic ruby crystal by exposing powdered aluminium oxide and colouring material to the flame of a blowtorch.

Rutile inclusions cause a silky appearance, which heat treatment will remove.

CUSHION MIXED-CUT

ROSSER REEVES RUBY

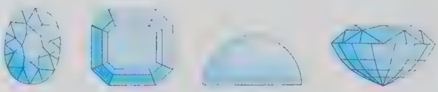
STEP-CUT SYNTHETIC



Colour zoning indicates the layers of growth in a crystal. They can be seen here as a series of concentric hexagons, which appear parallel to the prismatic crystal faces.

CABOCHON

BURMESE RUBY CRYSTAL



SG 4.00	RI 1.76–1.77	DR 0.008	Lustre Vitreous

Crystal structure Trigonal	Composition Aluminium oxide	Hardness 9

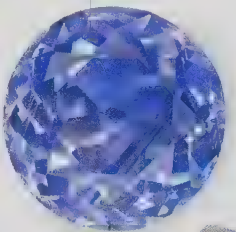
SAPPHIRE (CORUNDUM)

All gem-quality corundum that is not red is called sapphire, yet this name is popularly associated with the colour blue. Variation in colour, due to iron and titanium impurities, spans many shades, but the most valuable is a clear, deep blue. Some stones, called "colour-change sapphire", exhibit different shades of blue in artificial and natural light.

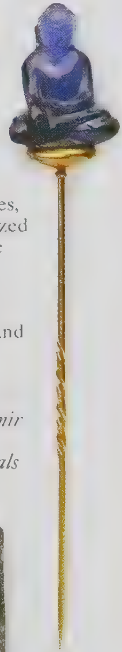
• **OCCURRENCE** Good quality sapphire is found in Burma, Sri Lanka, and India. The best Indian sapphire is cornflower blue, and found in Kashmir, either in pegmatites or as waterworn pebbles in alluvial deposits. Sapphire from Thailand, Australia, and Nigeria is dark blue, and may appear nearly black. Montana (USA) produces sapphire of an attractive metallic blue. Other localities include Cambodia, Brazil, Kenya, Malawi, and Colombia.

• **REMARK** Synthetic sapphire production began in the late 19th century. Commercial quantities became available in the early 20th century.

STAR CABOCHON



BRILLIANT-CUT



CARVED BUDDHA
Since the Middle Ages, sapphire has symbolized the tranquillity of the heavens, bestowing peace and amiability upon the wearer, and suppressing wicked and impure thoughts.

BLUE SAPPHIRE CRYSTAL

Brilliant

Cabochon

Cameo

SG 4.00	RI 1.76–1.77	DR 0.008	Lustre Vitreous

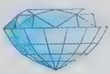
Crystal structure Trigonal	Composition Aluminium oxide	Hardness 9

PADPARADSCHA (CORUNDUM)

Padparadscha is a very rare, pinkish orange sapphire. It is the only variety of corundum other than ruby that is given its own name, rather than being referred to as a sapphire of a particular colour. The name derives from a Sinhalese word, meaning lotus blossom.

• **OCCURRENCE** Sri Lanka.

• **REMARK** Like all varieties of corundum, padparadscha is an excellent jewellery stone, as it is second only to diamond in hardness.



Mixed

MIXED-CUT

SG 4.00	RI 1.76–1.77	DR 0.008	Lustre Vitreous

Crystal structure Trigonal	Composition Aluminium oxide	Hardness 9

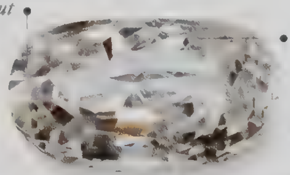
Colourless Sapphire (Corundum)

The different colours found within members of the corundum group are due to small amounts of metal oxide impurities. Corundum without impurities (and therefore without colour) is rare, but when found is classified as colourless sapphire. Stones made up of different colours, including colourless areas, are more common. Stones like these are generally orientated by the cutter so that the colour is at the base. Then, when viewed from above, colour fills the stone.

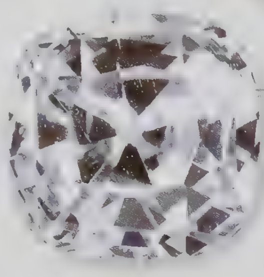
• **OCCURRENCE** Truly colourless sapphire is found in Sri Lanka. Cloudy or milky coloured sapphire is also found in Sri Lanka, and referred to locally as *geuda*. Heat treatment of *geuda* produces blue sapphire, much of which is faceted and used in jewellery. Some Sri Lankan corundum shows red, blue, and colourless areas, which may be faceted or polished to give an interesting stone.

• **REMARK** Synthetic colourless corundum has been produced by the Verneuil method since about the 1920s, and has been called diamondite.

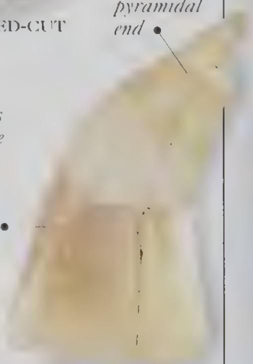
Star-stone Cabochon



Oval Mixed-cut

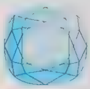


Mixed-cut

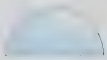


Colourless Crystal

Brilliant



Brilliant



Cabochon

SG 4.00	RI 1.76–1.77	DR 0.008	Lustre Vitreous

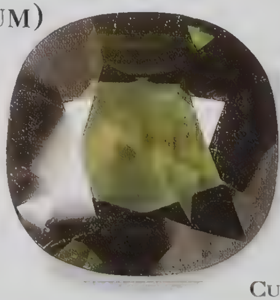
Crystal structure Trigonal	Composition Aluminium oxide	Hardness 9

Green Sapphire (Corundum)

From medieval times until the end of the 19th century green sapphire was referred to as "oriental peridot". Many sapphires that appear green actually consist of very fine alternating bands of blue and yellow sapphire, which may be visible under a microscope.

• **OCCURRENCE** Green sapphires are found in Thailand, Sri Lanka, and Australia (Queensland and New South Wales).

Brilliant



Cushion-cut

SG 4.00	RI 1.76–1.77	DR 0.008	Lustre Vitreous

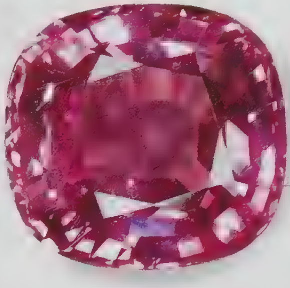
Crystal structure Trigonal	Composition Aluminium oxide	Hardness 9

PINK SAPPHIRE (CORUNDUM)

Pure pink sapphire is coloured by very small quantities of chromium, and with increasing amounts of chromium it forms a continuous colour range with ruby. Tiny amounts of iron may produce pink-orange stones called padparadscha (see p.95), or iron and titanium impurities together may make a purplish stone. Pink sapphires are often cut with a deep profile.

• **OCCURRENCE** Pink sapphires, from a very pale and delicate pink to a near-red, occur in Sri Lanka, Burma, and East Africa.

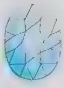
• **REMARK** Like rubies (see p.94), pink sapphires are believed to ward off ill-health and misfortune. For the wearer to gain the benefit of the stone, however, it is thought necessary for it to be worn directly on the skin. Therefore stones are cut so that, when set in a piece of jewellery, the back makes contact with the skin.



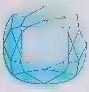
CUSHION MIXED-CUT

OVAL MIXED-CUT

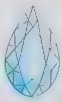
PINK SAPPHIRE CRYSTAL



Brilliant



Cushion



Pendeloque

SG 4.00	RI 1.76–1.77	DR 0.008	Lustre Vitreous

Crystal structure Trigonal	Composition Aluminium oxide	Hardness 9

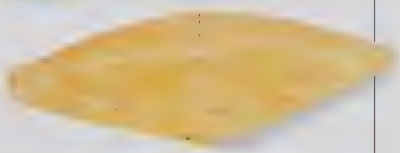
YELLOW SAPPHIRE (CORUNDUM)

Up until the end of the 19th century yellow sapphire was known as "oriental topaz" (only blue corundum was called sapphire). Nevertheless yellow and greenish yellow sapphires make unusual and attractive gemstones in their own right.

• **OCCURRENCE** In Queensland and New South Wales (Australia), a greenish yellow sapphire is found that may be faceted. Similar stones occur in Thailand, and purely yellow stones in Sri Lanka, Montana (USA), and East Africa.

CUSHION MIXED-CUT

Brilliant



WATERWORN CRYSTAL

SG 4.00	RI 1.76–1.77	DR 0.008	Lustre Vitreous

Crystal structure Trigonal	Composition Calcium carbonate	Hardness 3

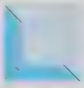
CALCITE

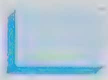
Common worldwide, calcite is the principal component of limestones and marbles, and of most stalactites and stalagmites. It can also be found as large, transparent, colourless, complex crystals, or as prismatic crystals intergrown with other minerals. Because of its softness it is only faceted for the collector, but marbles and brown, banded calcite from limestone caves are both used for decoration and carving.

• OCCURRENCE Italy is famous for fine quality marbles, particularly the creamy Carrara marble. Transparent, colourless rhombs are known as "Iceland spar"; a white fibrous variety, cut *en cabochon*, shows the cat's-eye effect. Pink and green crystals occur in the USA, Germany, and England.

"ICELAND SPAR" RHOMB

PRISMATIC CALCITE CRYSTALS


Step


Polished

SG 2.71	RI 1.48–1.66	DR 0.172	Lustre Vitreous to pearly

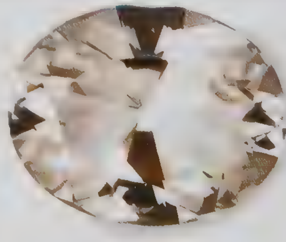
Crystal structure Trigonal	Composition Beryllium silicate	Hardness 7½

PHENAKITE

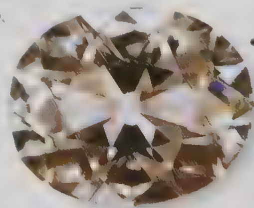
Phenakite is a rare mineral, found as white or colourless tabular crystals or stubby prisms. Twinning is common and distinguishes it from rock crystal (see p.81), with which it is often confused (hence its name, derived from the Greek word for cheat). Transparent crystals are faceted for the collector, and are hard and bright.

• OCCURRENCE Phenakite occurs in pegmatites, granites, and mica schists. The best crystals are found in the Urals (Russia), Brazil, and Colorado (USA). Other localities include Italy, Sri Lanka, Zimbabwe, and Namibia.

• REMARK A pebble weighing 1,470 carats was found in Sri Lanka, and faceted to a 569-carat oval and several smaller stones.



BRILLIANT-CUT



BRILLIANT-CUT

PHENAKITE CRYSTAL


Brilliant


Mixed

SG 2.96	RI 1.65–1.67	DR 0.015	Lustre Vitreous

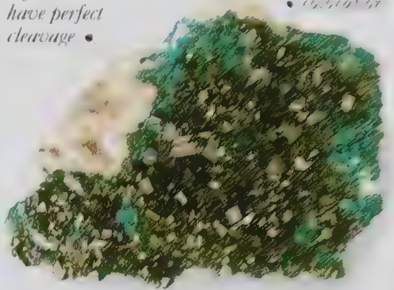
Crystal structure	Composition	Hardness
Trigonal	Hydrated copper silicate	[illegible]

DIOPTASE

Dioptase is a beautiful, vivid emerald-green, with a hint of blue. It has very high fire, but this is masked by its strong colour, which may make stones translucent rather than transparent. Prized by the collector for its colour, it is nonetheless rarely faceted, as stones are brittle and fragile, and too soft to be worn. It is sometimes confused with emerald.

• OCCURRENCE The best quality crystals are found in copper deposits in Russia, Namibia, Zaire, Chile, and Arizona (USA).


Brilliant Cabochon



DIOPTASE CRYSTALS

SG	RI	DR	Lustre
3.31	1.67–1.72	0.053	Vitreous

Crystal structure	Composition	Hardness
Trigonal	Magnesium and calcium carbonate	[illegible]

DOLOMITE

Dolomite is found as colourless, white, pink, or yellow crystals, often with distinctive curved faces. Rarely faceted, because of its softness and perfect cleavage, its main use is in massive form, as a decorative stone.

• OCCURRENCE Found in limestones and marbles, the best crystals are from Italy, Switzerland, Germany, and the USA.


Step Step

TWIN CRYSTAL

TWINNED DOLOMITE CRYSTALS IN MATRIX

SG	RI	DR	Lustre
2.85	1.50–1.68	0.179	Vitreous to Pearly

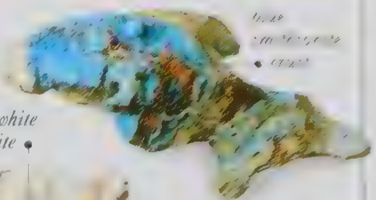
Crystal structure	Composition	Hardness
Trigonal	Zinc carbonate	[illegible]

SMITHSONITE

Smithsonite is usually found as bluish green or green botryoidal masses or soft layers, which are polished and used as an ornamental stone (sometimes called bonamite). It may also be coloured pink by cobalt, or yellow by cadmium. Crystals may also be found, but are faceted for the collector only.

• OCCURRENCE Colourless crystals in Namibia and Zambia; blue-green masses in the USA, Spain, and Greece; yellow in the USA and Sardinia.


Cabochon


SMITHSONITE ON MATRIX

SMITHSONITE ON MATRIX

SG	RI	DR	Lustre
4.35	1.62–1.85	0.230	Pearly

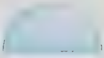
Crystal structure Trigonal	Composition Manganese carbonate	Hardness 4

RHODOCHROSITE

Rhodochrosite derives its pink colour from manganese. Gem-quality crystals do occur, and are cut for collectors, but the fine-grained, banded rock is more commonly used for decoration.

• **OCCURRENCE** Rhodochrosite occurs in veins associated with manganese, copper, silver, and lead deposits. Argentina has the oldest mines, and banded rhodochrosite from there is sometimes called "Inca rose". Today, the prime commercial sources are in the USA.


Bead


Cabochon


Cameo

BANDED RHODOCHROSITE

RHODOCHROSITE CRYSTALS IN MATRIX

SG 3.60	RI 1.60–1.80	DR 0.220	Lustre Vitreous to pearly

Crystal structure Trigonal	Composition Iron oxide	Hardness 6½

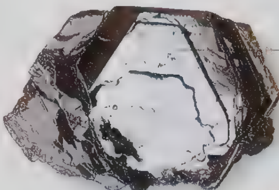
HEMATITE

Hematite usually occurs as massive, opaque material with a metallic lustre, showing a blood-red colour when cut into thin slices. However, it can also occur as short, black, rhombohedral crystals, and may have iridescent surfaces. When arranged like the petals of a flower, hematite is called an "iron rose". Shiny crystals may be called "specular" hematite, a name derived from their traditional use in mirrors.

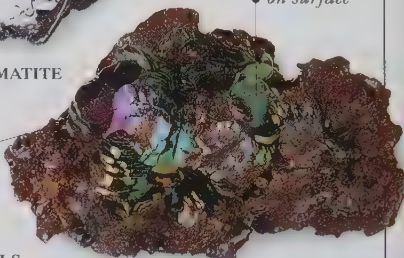
• **OCCURRENCE** Main deposits are in igneous rocks in North America (Lake Superior and Quebec), Brazil, Venezuela, and England. Iron roses are found in Switzerland and Brazil; cuttable material in England, Germany, and Elba.

• **REMARK** Powdered, it may be used as an artist's pigment or for polishing. In the past it was used to protect the wearer from bleeding.

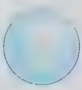

CARVED FROG
With a hardness of 6½, hematite is easily carved, but care must be taken to prevent scratching. This oriental-style frog has a grey metallic lustre.



"SPECULAR" HEMATITE



IRIDESCENT HEMATITE CRYSTALS


Bead


Cabochon


Cameo

SG 5.20	RI 2.94–3.22	DR 0.280	Lustre Metallic

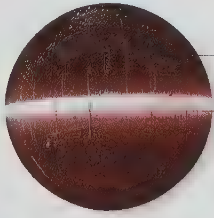
Crystal structure Trigonal	Composition Complex borosilicate	Hardness 7½

RUBELLITE (TOURMALINE)

Members of the tourmaline family of minerals have the same basic crystal structure, but occur in many colours. Rubellite (from the Latin for red) is the name given to the pink or red variety, with ruby-red stones the most highly prized. Rubellite crystals are striated, with a triangular cross-section and a rounded outline. They may also occur with a fibrous habit, and show a cat's-eye when cut *en cabochon*.

• **OCCURRENCE** Russian pink and red tourmaline occurs in weathered granites. Other sites include Madagascar, the USA, Brazil, Burma, and East Africa.

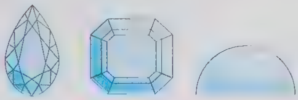
• **REMARK** The specific gravity of tourmaline varies with colour – dark red has a higher SG than pink.



CABOCHON

RECTANGULAR STEP-CUT

RUBELLITE CRYSTALS IN MATRIX



SG 3.06	RI 1.62–1.64	DR 0.018	Lustre Vitreous

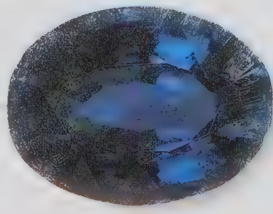
Crystal structure Trigonal	Composition Complex borosilicate	Hardness 7½

INDICOLITE (TOURMALINE)

Dark blue tourmaline is called indicolite or, occasionally, indigolite. Indicolite is often heat-treated to lighten its colour and produce a more attractive stone.

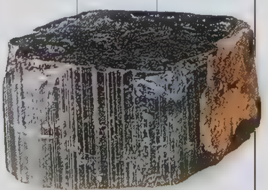
• **OCCURRENCE** An important source for indicolite is Siberia (Russia), where it occurs in yellow clays formed from weathered granites. Fine, bright blue tourmaline has recently been found in Paraiba, Brazil. Other localities include Madagascar and the USA.

• **REMARK** A lilac to violet-blue or reddish blue variety (first found in Russia) is known as siberite.

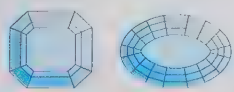


OVAL MIXED-CUT

RECTANGULAR STEP-CUT



INDICOLITE CRYSTAL



SG 3.06	RI 1.62–1.64	DR 0.018	Lustre Vitreous

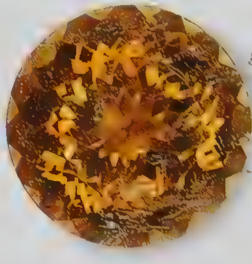
Crystal structure Trigonal	Composition Complex borosilicate	Hardness 7½

DRAVITE (TOURMALINE)

Dravite is a very dark coloured (usually brown) form of tourmaline, rich in magnesium. It is possible to lighten the colour by heat treatment. Dravite shows strong dichroism, and should therefore be cut with the table facet parallel to the length of the crystal in order to show a lighter and more attractive colour.

• **OCCURRENCE** Dravite can occur as single crystals, or as parallel or radiating groups. Brown tourmaline and yellow tourmaline occur together in the gem gravels of Sri Lanka. It is also found in the USA, Canada, Mexico, Brazil, and Australia.

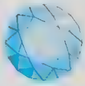
• **REMARK** The name "dravite" is derived from the district of Drave, in Austria.

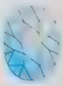


ROUND BRILLIANT-CUT

CUSHION MIXED-CUT

CRYSTAL FRAGMENT


Brilliant


Brilliant


Cushion

SG 3.06	RI 1.61–1.63	DR 0.018	Lustre Vitreous

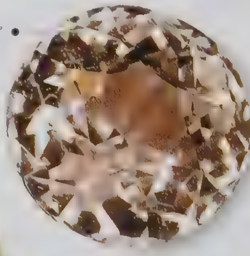
Crystal structure Trigonal	Composition Complex borosilicate	Hardness 7½

ACHROITE (TOURMALINE)

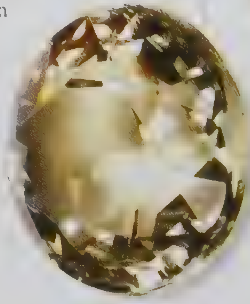
This particularly rare, colourless stone is a variety of elbaite, a member of the tourmaline group. It does not show the strong dichroism characteristic of most tourmaline varieties and therefore can be cut with the table facet either parallel or perpendicular to the length of the crystal. Colourless tourmaline may also be produced by applying heat to light pink tourmalines.

• **OCCURRENCE** Achroite occurs with coloured tourmalines in the pegmatites of Madagascar and Pala (in California in the USA).

• **REMARK** Achroite is named after the Greek word *achroos*, meaning "without colour".



ROUND BRILLIANT-CUT



OVAL BRILLIANT-CUT

ACHROITE CRYSTAL


Brilliant


Brilliant


Mixed

SG 3.06	RI 1.62–1.64	DR 0.018	Lustre Vitreous

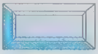
Crystal structure	Composition	Hardness
Trigonal	Complex borosilicate	7½

WATERMELON TOURMALINE

Tourmaline crystals with a pink centre and a green rim, or vice-versa, are called watermelon tourmaline, because their colouring is similar to the pink flesh and green rind of a watermelon. Many other tourmalines are made up of two or more colours, individual crystals containing up to 15 different colours or shades.

• **OCCURRENCE** Watermelon tourmaline is found in South Africa, East Africa, Brazil, and in many other localities.

• **REMARK** Parti- and multicoloured tourmaline is carved or cut and polished to show off the different colours to best effect.


Baguette


Cabochon

TABLE-CUT

CRYSTAL SECTION

SG	RI	DR	Lustre
3.06	1.62–1.64	0.018	Vitreous

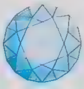
Crystal structure	Composition	Hardness
Trigonal	Complex borosilicate	7½

SCHORL (TOURMALINE)

Schorl is the black, iron-rich form of tourmaline, and is very common. The opaque, prismatic crystals may be several metres in length.

• **OCCURRENCE** Found in pegmatites.

• **REMARK** During the Victorian era, black tourmaline was widely used for mourning jewellery, but today it has little, if any, value as a gemstone.


Brilliant


Mixed

SCHORL CRYSTAL

SG	RI	DR	Lustre
3.06	1.62–1.67	0.018	Vitreous

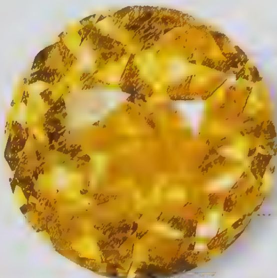
Crystal structure	Composition	Hardness
Trigonal	Complex borosilicate	7½

GREEN AND YELLOW TOURMALINE

Yellow-green is the most common of all tourmaline colour varieties, but emerald-green is much rarer and more valuable. Indeed, until the 18th century it was often confused with emerald.

• **OCCURRENCE** Emerald-green stones are found in Brazil, Tanzania, and Namibia; fibrous yellow material occurs in Sri Lanka.


Brilliant



BRILLIANT-CUT

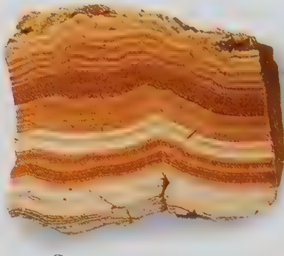
SG	RI	DR	Lustre
3.06	1.62–1.64	0.018	Vitreous

Crystal structure Orthorhombic	Composition Calcium carbonate	Hardness 3½

ARAGONITE

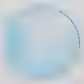
Aragonite is usually transparent or translucent, and colourless or white when pure. Impurities may cause shades of yellow, blue, pink, or green to occur. It is found in many different habits: small, elongate, prismatic crystals form in radiating groups, and concretions and stalactites are also common. It has poor cleavage.

• OCCURRENCE Found mainly in sedimentary environments, aragonite may form as tufa (porous rock) in Czechoslovakia and Turkey. Other localities include Spain, Colorado (USA), France, and Cumbria (England).



STALACTITIC POLISHED SLAB

CRYSTAL SPRAYS ON MATRIX



Bead

Polished

SG 2.94	RI 1.53–1.68	DR 0.155	Lustre Vitreous

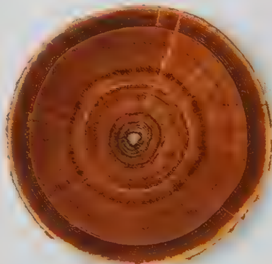
Crystal structure Orthorhombic	Composition Barium sulphate	Hardness 3

BARYTE

Baryte occurs in a variety of colours, including colourless, white, yellow, and blue, but its softness, perfect cleavage, brittleness, and high density make it of little use as a gemstone, and it is cut for collectors only. Crystals vary a great deal and may be transparent to opaque, with a variety of habits from tabular to massive.

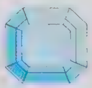
• OCCURRENCE Baryte is commonly found in lead and silver mines. It also occurs in limestones, and may be deposited by hot springs. Crystals up to 1m (40in) in length have been found in Cumbria, Cornwall, and Derbyshire, in England. Other good localities include Czechoslovakia, Romania, Germany, the USA, and Italy.

OCTAGONAL MIXED-CUT



STALAGMITE SECTION

BARYTE CRYSTAL



Step

Mixed

Polished

SG 4.45	RI 1.63–1.65	DR 0.012	Lustre Vitreous to pearly

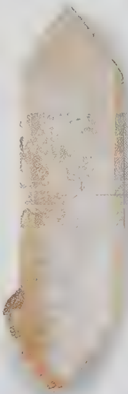
Crystal structure	Composition	Hardness
Orthorhombic	Strontium sulphate	3½

Celestine

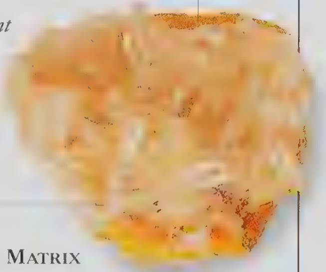
Celestine is usually found as colourless, milky white, yellow, orange, or pale blue prismatic crystals, or in fine-grained masses. With a hardness of only 3½ on Mohs' scale and perfect cleavage, celestine is extremely fragile. It has been cut for the collector, however, and some fine specimens can be seen in museums.

• **OCCURRENCE** Celestine may occur with sandstones or limestones, in evaporite deposits, in pegmatites, in cavities in volcanic rocks, or with galena and sphalerite in mineral veins. Most of the material that is capable of being faceted is found in either Namibia or Madagascar. It is also found in Italy (including Sicily), England, Czechoslovakia, the USA, and Canada.

MIXED-CUT

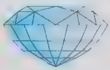


CELESTINE CRYSTAL



CRYSTALS IN MATRIX

Brilliant



Mixed

SG	RI	DR	Lustre
3.98	1.62–1.63	0.010	Vitreous to pearly

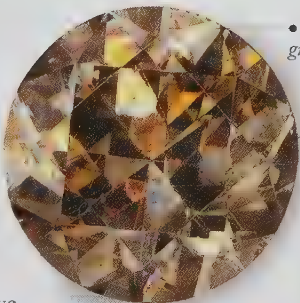
Crystal structure	Composition	Hardness
Orthorhombic	Lead carbonate	3½

Cerussite

Cerussite is usually colourless, but white, grey, and black specimens have been found. Its two most distinctive features are its high density and its adamantine lustre. Crystals have a stubby tabular or elongate habit. Although attractive, it is too soft to have much value as a gem-stone, and is cut solely for collectors.

• **OCCURRENCE** Cerussite is usually found around lead ores. Large, clear, transparent, colourless, cuttable crystals have been found in Tsumeb (Namibia). Other localities include Austria, Australia, Czech-oslovakia, the USA, Germany, Scotland, and Italy, including Sardinia.

• **REMARK** Sometimes confused with diamond and other colourless gems, it may be distinguished by its higher density.



ROUND BRILLIANT-CUT

PRISMATIC CRYSTAL

Brilliant

Brilliant

SG	RI	DR	Lustre
6.51	1.80–2.08	0.274	Adamantine

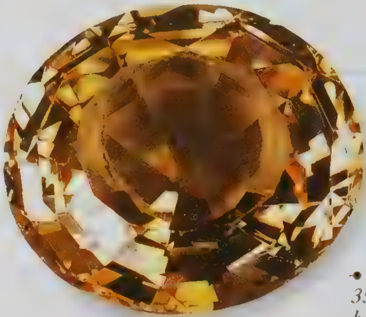
Crystal structure Orthorhombic	Composition Aluminium fluorohydroxysilicate	Hardness 8

TOPAZ

Topaz occurs in a range of different colours: deep golden yellow topaz (sometimes called sherry topaz) and pink topaz are the most valuable; blue and green stones are also popular. Natural pink stones are rare – most pink topaz is heat-treated yellow material. Much colourless topaz is irradiated and heat-treated to a range of blues, some almost indistinguishable from aquamarine when seen with the naked eye. Some topaz has tear-shaped cavities, containing a gas bubble or several immiscible (non-mixing) liquids. Other inclusions such as cracks, streaks, and veils also occur. Prismatic topaz crystals have a characteristic lozenge-shaped cross-section and striations parallel to their length. Topaz has one perfect cleavage.

• **OCCURRENCE** Topaz occurs in igneous rocks such as pegmatites, granites, and volcanic lavas. It may also be found in alluvial deposits as waterworn pebbles. Localities include Brazil, the USA, Sri Lanka, Burma, the former USSR, Australia, Tasmania, Pakistan, Mexico, Japan, and Africa. Brazil, Pakistan, and Russia are sources of pink topaz.

• **REMARK** In the 17th century the Braganza diamond (1,640 carats) in the Portuguese crown was thought to be the largest diamond ever found. This was never confirmed and it is now believed to have been a colourless topaz. The name "topaz" is thought to be derived from the Sanskrit word *tapas*, meaning fire.



OVAL MIXED-CUT

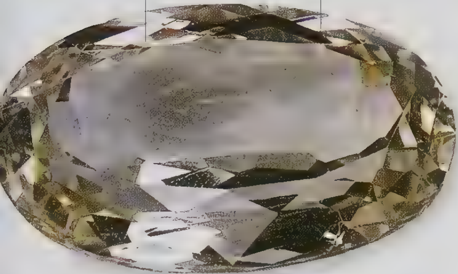
OVAL STEP-CUT

TRANSPARENT, SHERRY-COLOURED CRYSTAL

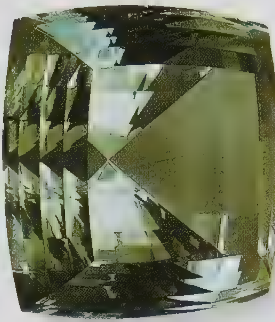
TOPAZ RING A salmon-pink, step-cut, eight-sided topaz, set in a gold ring.

FLOWER BROOCH The heart of this flower-shaped brooch is a round brilliant-cut topaz, surrounded by 36 sherry-coloured topaz gems – some triangular, some diamond-shaped.

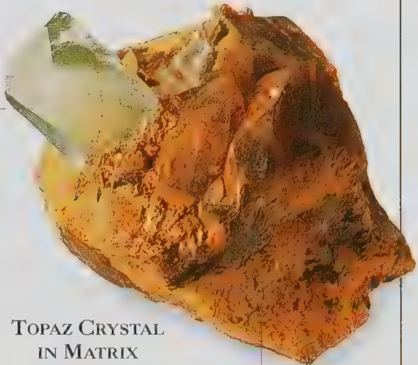
SG 3.54	RI 1.62–1.63	DR 0.010	Lustre Vitreous



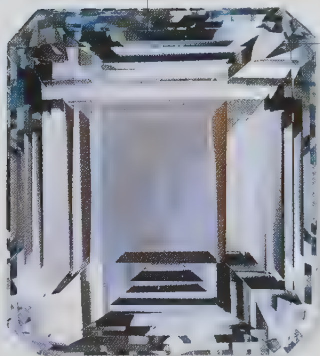
ELONGATED OVAL MIXED-CUT



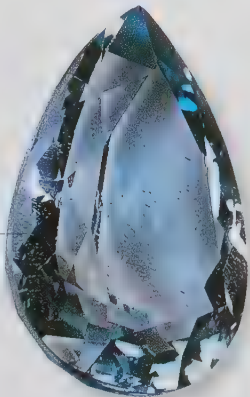
SQUARE CUSHION-CUT ("THE BRAZILIAN PRINCESS")



TOPAZ CRYSTAL IN MATRIX

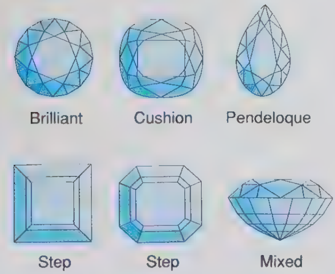


OCTAGONAL STEP-CUT



PENDELOQUE CUT

COLOURLESS, PARTIALLY FACETED PEBBLE



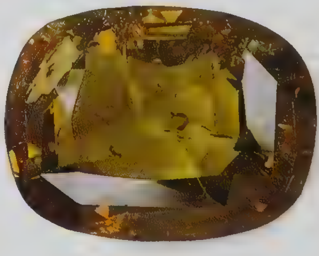
Crystal structure Orthorhombic	Composition Beryllium aluminium oxide	Hardness 8½

CHRYSOBERYL

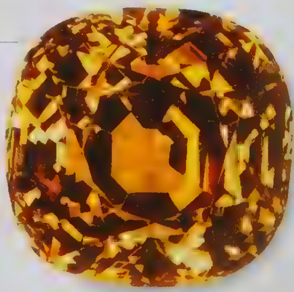
Chrysoberyl occurs in a range of colours, from green, greenish yellow, and yellow, to brown. It is a hard, durable stone, particularly suitable for use in jewellery. When cut well, gems are brilliant but lack fire. Two varieties, alexandrite and cat's-eye, have unique qualities of their own. The very rare and valuable alexandrite changes from green in daylight to red, mauve, or brown under incandescent light, such as a light bulb. Synthetic chrysoberyl, synthetic corundum, and synthetic spinel have all been produced to imitate alexandrite's colour change. Cat's-eye, when cut *en cabochon*, has a near-white line across a yellowish grey stone, due to canal- or feather-like fluid inclusions, or needle-like inclusions of rutile. The most highly prized cat's-eye colour is a light golden brown, often with a shadow that gives a light and dark, "milk and honey" effect. Pale yellow chrysoberyl, popular in 18th- and 19th-century Portuguese jewellery, was also known as chrysolite.

• **OCCURRENCE** Although mainly worked out, the best chrysoberyl, including alexandrite, has been found in mica schists in the Urals (Russia). The largest faceted chrysoberyl from Russia weighs 66 carats. Large waterworn pebbles of various colours are found in the gem gravels of Sri Lanka. Chrysoberyl also occurs in Burma, Brazil, Zimbabwe, Tanzania, and Madagascar. Cat's-eye is found in Sri Lanka, Brazil, and China.

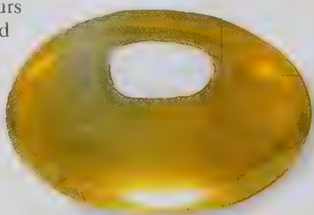
• **REMARK** The name is from the Greek *chrysos*, meaning golden, and *beryllos*, which refers to the beryllium content. Known for thousands of years in Asia, it was highly valued for the protection it afforded from the "evil eye".



CUSHION MIXED-CUT



CUSHION MIXED-CUT

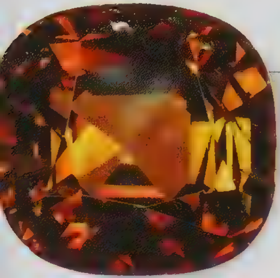


POLISHED CABOCHON

FINGER RING
This ring, made of many cushion-cut chrysoberyl stones in a gold setting, is probably of 18th-century Spanish origin. The chrysoberyl was collected from a vein running through chalk.

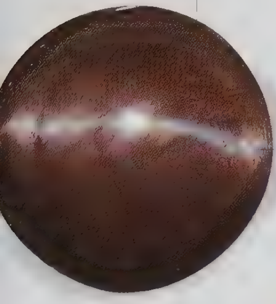
SPRAY OF CHRYSOBERYL CRYSTALS

SG 3.71	RI 1.74–1.75	DR 0.009	Lustre Vitreous

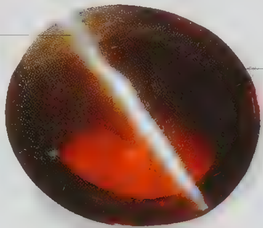


ALEXANDRITE MIXED-CUT

ALEXANDRITE CRYSTALS

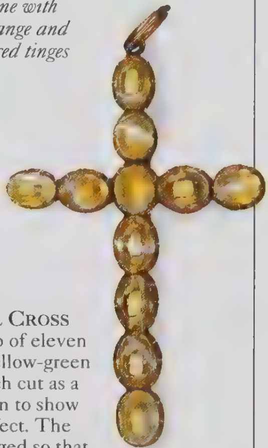


CAT'S-EYE CABOCHON



CAT'S-EYE DOUBLE CABOCHON

CAT'S-EYE DOUBLE CABOCHON



CHRYSOBERYL CROSS
A cross made up of eleven specimens of yellow-green chrysoberyl, each cut as a double cabochon to show the cat's-eye effect. The stones are arranged so that the flash across the centre of each cabochon is in a variety of positions.

VICTORIAN BROOCH
This exquisite brooch from the Victorian era in Britain is made up of greenish yellow, faceted chrysoberyls set in gold filigree. Its hardness and durability make chrysoberyl a particularly good stone for use in jewellery.

Crystal structure Orthorhombic	Composition Aluminium silicate	Hardness 7½

ANDALUSITE

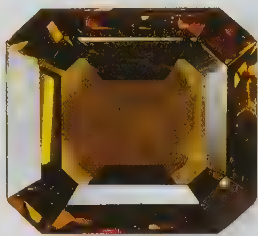
Andalusite varies in colour from a pale yellowish brown to a dark bottle-green, dark brown, or the most popular greenish red. It has very strong and distinctive pleochroism, so that, when turned, the same stone may appear yellow, green, and red. Large crystals may be vertically striated prisms with a square cross-section and pyramidal ends, but are rare. More usual are opaque, rod-like aggregates of crystals or waterworn pebbles. It is the pebbles that are usually cut as gemstones.

• **OCCURRENCE** Andalusite is usually found in pegmatites. Pebbles occur in the gem gravels of Sri Lanka and Brazil. Other localities include Spain, Canada, Russia, Australia, and the USA.

• **REMARK** An opaque, yellowish grey variety, chiastolite, occurs as long prisms, which make a cross when cut and polished.


Brilliant


Baguette

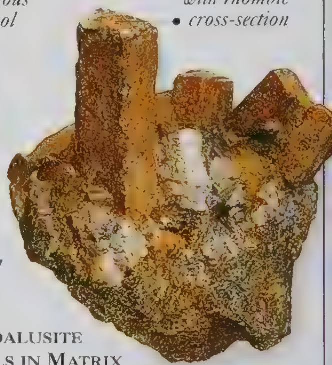

• pleochroism creates flashes of yellow, green, and red

OCTAGONAL STEP-CUT


"cross" once used as religious • symbol

• cut and polished surface

CHIASTOLITE CROSS-SECTION


opaque crystals with rhombic • cross-section

ANDALUSITE CRYSTALS IN MATRIX

SG 3.16	RI 1.63–1.64	DR 0.010	Lustre Vitreous

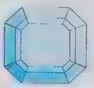
Crystal structure Orthorhombic	Composition Calcium borosilicate	Hardness 7

DANBURITE

Generally colourless, danburite crystals may also be yellow or pink. They form wedge-shaped prisms, similar to those of colourless topaz but distinguishable by cleavage (poor in danburite, perfect in topaz) and specific gravity (lower in danburite).

• **OCCURRENCE** First found in the town of Danbury, Connecticut (USA). Gem-quality crystals occur in Burma, Mexico, Switzerland, Italy, and Japan.


Brilliant


Step


Mixed

Burmese stone with slight yellowish tinge •

stones are bright but • lack fire


BRILLIANT-CUT

characteristic wedge-shaped • end


WHITE DANBURITE CRYSTALS

SG 3.00	RI 1.63–1.64	DR 0.006	Lustre Vitreous to greasy

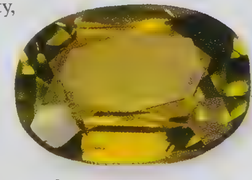
Crystal structure Orthorhombic	Composition Magnesium iron silicate	Hardness 5½

ENSTATITE

Enstatite is one of the pyroxene family – a series of magnesium- to iron-rich silicates. Crystals occur as short prisms, but are rare: most gem-quality material is faceted from rolled pebbles. Cuttable enstatite varies in colour from a grey- to yellowish green or olive-green, to an iron-rich brownish green. A brilliant emerald-green variety, coloured by chromium, also occurs.

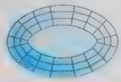
• **OCCURRENCE** Enstatite is often found with kimberlites in South Africa. Brownish green enstatite is found in Burma, Norway, and California (USA). Some Sri Lankan and Indian enstatite is chatoyant. It also occurs in the USA, Switzerland, Greenland, Scotland, Japan, and the former USSR.

CAT'S-EYE CABOCHON



OVAL MIXED-CUT

ENSTATITE ROUGH



Step

Cabochon

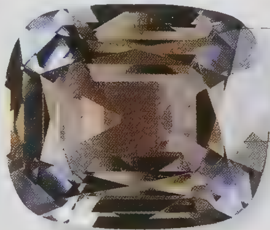
SG 3.27	RI 1.66–1.67	DR 0.010	Lustre Vitreous

Crystal structure Orthorhombic	Composition Aluminium silicate	Hardness 7½

SILLIMANITE

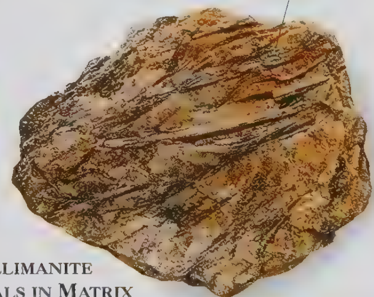
Sillimanite (named after Professor Silliman of Yale University, USA) is blue to green, with distinct pleochroism showing pale yellowish green, dark green, and blue from different angles. When crystals occur in long slender prisms in parallel groups, resembling fibres, the material is often called fibrolite.

• **OCCURRENCE** Sillimanite is found in metamorphic rocks and occasionally in pegmatites. Blue and violet stones are found in Burma; greenish grey stones in Sri Lanka; fibrolite in Idaho (USA). Other sites include Czechoslovakia, India, Italy, Germany, and Brazil.

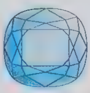


CUSHION MIXED-CUT

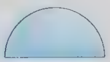
FIBROLITE CABOCHON



SILLIMANITE CRYSTALS IN MATRIX



Cushion



Cabochon

SG 3.25	RI 1.66–1.68	DR 0.019	Lustre Vitreous

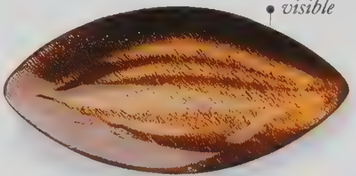
Crystal structure Orthorhombic	Composition Iron magnesium silicate	Hardness 5½

HYPERSTHENE

Hypersthene is an iron-rich pyroxene in the same series of minerals as enstatite (see p.111) and bronzite. It is distinguished by its reddish iridescence, which is due to platy inclusions of goethite and hematite. Often too dark to facet, it may be cut *en cabochon* instead to show the sparkling inclusions. Bronzite, a greenish brown variety with a bronze-like lustre, is also a collector's stone – dark, slightly brittle, and not generally used in jewellery.

• **OCCURRENCE** Most gem hypersthene is found in India, Norway, Greenland, Germany, and the USA. Bronzite is found in Austria.

RECTANGULAR STEP-CUT



POLISHED BRONZITE

HYPERSTHENE ROUGH

Cushion

Baguette

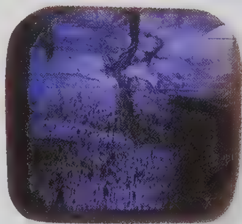
SG 3.35	RI 1.65–1.67	DR 0.010	Lustre Vitreous

Crystal structure Orthorhombic	Composition Magnesium aluminium silicate	Hardness 7

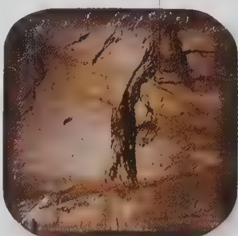
IOLITE

Violet-blue iolite (also known as cordierite) has been called water sapphire because of its similarity to blue sapphire when cut. It can be recognized by its strong pleochroism, visible without equipment, which gives the gem its other name of dichroite. The best blue colour is seen down the length of prismatic crystals; they may appear colourless when viewed across.

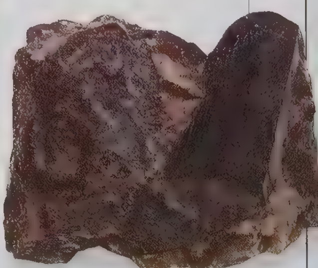
• **OCCURRENCE** Gem-quality iolite is found in alluvial deposits as small, transparent, waterworn pebbles in Sri Lanka, Burma, Madagascar, and India. Other localities include Namibia and Tanzania. Crystals are found in Germany, Norway, and Finland.



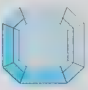
IOLITE CUBE – VIEW 1



IOLITE CUBE – VIEW 2



CRYSTAL IN MATRIX



Step

Cabochon

Mixed

SG 2.63	RI 1.53–1.55	DR 0.010	Lustre Vitreous

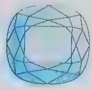
Crystal structure Orthorhombic	Composition Magnesium aluminium borosilicate	Hardness 6½

KORNERUPINE

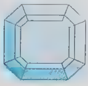
Although kornerupine was named in 1884, it was not until 1912 that gem-quality material was found. Even now it is uncommon and cut only for collectors. Strongly pleochroic, it appears green or reddish brown when viewed from different directions. To show the best colour, it is cut with the table facet parallel to the length of the crystal.

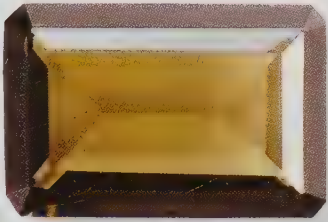
• OCCURRENCE Localities include Madagascar, Sri Lanka, and East Africa, which also produces an emerald-green variety. Cat's-eye gems are cut from Sri Lankan and East African stones.

• REMARK It has been confused with tourmaline and enstatite.


Cushion

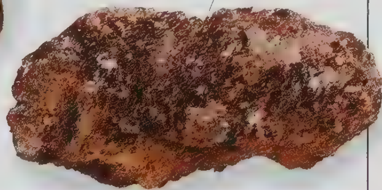

Baguette


Step



RECTANGULAR STEP-CUT

MIXED-CUT



CRYSTALS IN MATRIX

SG 3.32	RI 1.66–1.68	DR 0.013	Lustre Vitreous

Crystal structure Orthorhombic	Composition Magnesium iron silicate	Hardness 6½

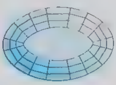
PERIDOT

Gem-quality specimens of the mineral olivine are called peridot by gemmologists. Peridot has an olive- or bottle-green colour due to the presence of iron, and a distinctive oily or greasy lustre. It has a high birefringence, so doubling of the back facets can easily be seen in larger specimens when viewed from the front. Good-quality crystals are very rare.

• OCCURRENCE Peridot is found on St. John's Island (Egypt), in China, Burma, Brazil, Hawaii and Arizona (USA), Australia, South Africa, and Norway.

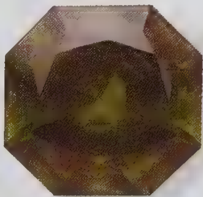
• REMARK The Crusaders brought peridot to Europe in the Middle Ages, transporting stones from St. John's Island in the Red Sea, where it had been mined for over 3,500 years.


Pendeloque

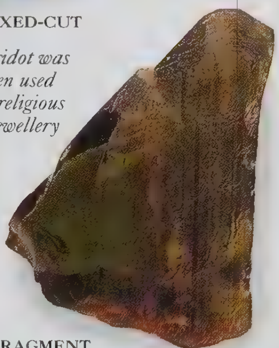

Step


Cabochon

OVAL MIXED-CUT



OCTAGONAL MIXED-CUT



CRYSTAL FRAGMENT

SG 3.34	RI 1.64–1.69	DR 0.036	Lustre Vitreous to greasy

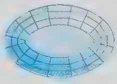
Crystal structure Orthorhombic	Composition Lead sulphate	Hardness 3

ANGLESITE

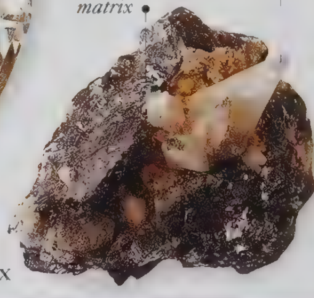
Anglesite is usually colourless or with a slight yellowish tinge, but may also be found as grey, green, purple, brown, or black crystals (the black colouring is due to inclusions of galena). Crystals are heavy, but are fragile and soft, with perfect cleavage, and so are faceted for collectors only.

• **OCCURRENCE** Anglesite is formed by oxidation of galena (lead sulphide) and may be found in Anglesey in Wales (hence the name) and in the Leadhills district of Scotland. The best crystals are found in Tsumeb (Namibia) and Morocco. Other localities include Germany, the USA, and Sardinia.

FANCY-CUT



Step



ANGLESITE CRYSTALS IN MATRIX

SG 6.35	RI 1.87–1.89	DR 0.017	Lustre Waxy to adamantine

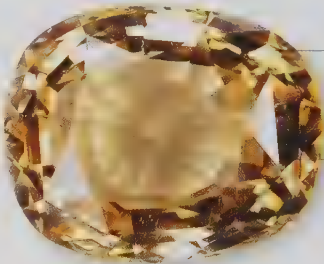
Crystal structure Orthorhombic	Composition Magnesium aluminium iron borate	Hardness 6½

SINHALITE

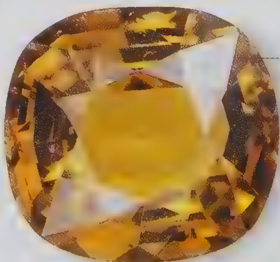
Until 1952, sinhalite was thought to be a brown variety of peridot, but on closer investigation it was found to be a completely new mineral. It varies from a pale yellowish brown to a dark greenish brown. Crystals have distinct pleochroism, showing pale brown, greenish brown, and dark brown when viewed from different directions. Although uncommon, sinhalite has been faceted for the collector. Cut stones may be confused with peridot, chrysoberyl, and zircon.

• **OCCURRENCE** Most gem-quality sinhalite is found as rolled pebbles in the gem gravels of Sri Lanka. Crystals occur in Burma but are rare. Sinhalite is also found in the former USSR, and non-gem-quality material in the USA.

• **REMARK** Sinhalite is named after *sinhala*, which is the Sanskrit name for Sri Lanka.

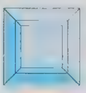


CUSHION MIXED-CUT



CUSHION MIXED-CUT

SINHALITE CRYSTAL



Step

Mixed

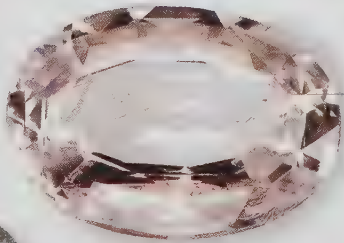
SG 3.48	RI 1.67–1.71	DR 0.038	Lustre Vitreous

Crystal structure	Composition	Hardness
Orthorhombic	Beryllium hydroxyborate	7½

HAMBERGITE

Hambergite, named after Axel Hamberg, the Swedish mineralogist, occurs as colourless to yellowish white crystals, but is rarely gem-quality. Brittle, with perfect cleavage, it is very fragile and suitable only for collectors. When cut, it looks like glass, but double images of the back facets may be seen through the table facet due to its high birefringence.

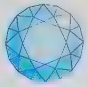
• **OCCURRENCE** Gem-quality hambergite is found in Kashmir (India), and also in Madagascar.



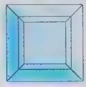
OVAL MIXED-CUT

OVAL MIXED-CUT

HAMBERGITE CRYSTAL



Brilliant



Step

SG	RI	DR	Lustre
2.35	1.55–1.63	0.072	Vitreous

Crystal structure	Composition	Hardness
Orthorhombic	Calcium aluminium hydroxysilicate	6

PREHNITE

Often an oily green, prehnite may also range from pale yellowish to brown. Columnar or tabular crystals are rare: it occurs more usually as aggregates of barrel-shaped crystals or as botryoidal masses. Some pale yellowish brown prehnite is fibrous enough to be cut *en cabochon*, and may show the cat's-eye effect.

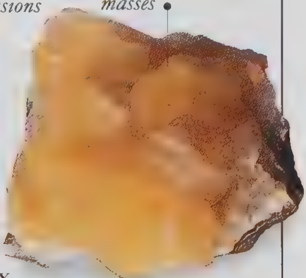
• **OCCURRENCE** Prehnite is found in basaltic volcanic rocks, intrusive igneous rocks, and in some metamorphic rocks. Pale green masses are found in Scotland; dark green or greenish brown masses in Australia; aggregates of crystals in France.

• **REMARK** Prehnite is named after Colonel von Prehn, who first introduced prehnite to Europe.

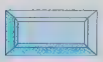
BRILLIANT-CUT STONES

STEP-CUT

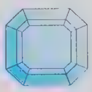
POLISHED FRAGMENT



CRYSTALS ON MATRIX



Baguette



Step

Cabochon

SG	RI	DR	Lustre
2.87	1.61–1.64	0.016	Vitreous

Crystal structure Orthorhombic	Composition Calcium aluminium hydroxysilicate	Hardness 6½

ZOISITE

Zoisite occurs in a number of varieties, the most sought-after being tanzanite, a variety coloured sapphire-blue by the presence of vanadium. Tanzanite crystals have distinct pleochroism, showing either purple, blue, or slate-grey depending on the angle they are viewed from. There may also be a slight colour change in incandescent light (such as that from a light bulb), when stones may appear more violet. A massive green variety of zoisite, containing rubies and occasionally dark hornblende inclusions, may be polished, carved, or tumbled to make ornaments or an attractive decorative stone. Thulite, a massive, pinkish red variety coloured by manganese, is also polished or carved to make small ornaments. Tanzanite has been confused with sapphire, and thulite with rhodonite. Some heating of zoisite varieties may enhance their colour.

• **OCCURRENCE** Tanzanite was first found in Tanzania (hence the name). Yellow and green zoisite occurs in Tanzania and Kenya. Thulite is found in Norway, Austria, western Australia, Italy, and North Carolina (USA).

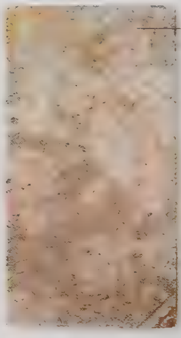
• **REMARK** Discovered by Baron von Zois in the Sau-Alp mountains of Austria, zoisite was first called saualpite.

TANZANITE MIXED-CUT

TANZANITE STEP-CUT

TANZANITE CRYSTAL

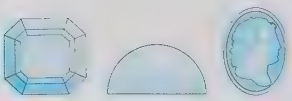
TANZANITE CRYSTAL IN MATRIX



THULITE SLAB

THULITE CABOCHON

THULITE ROUGH



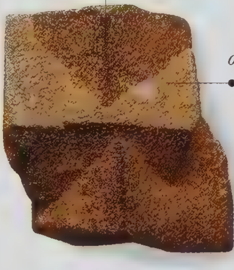
SG 3.35	RI 1.69–1.70	DR 0.010	Lustre Vitreous

Crystal structure	Composition	Hardness
Orthorhombic	Aluminium iron hydroxysilicate	7

STAUROLITE

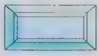
Opaque, cross-shaped staurolite "twins" are used in jewellery more often than the transparent stones, which are rare and cut only for collectors. "Cross-stones", as twins are called, have been used as amulets and in religious jewellery. Crystals are reddish brown to black, with distinct pleochroism.

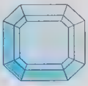
• OCCURRENCE Staurolite occurs in Switzerland, Germany, the former USSR, the USA, Brazil, France, and Scotland.



CROSS-STONE

CRYSTALS IN MATRIX


Baguette


Step


Cameo

SG	RI	DR	Lustre
3.72	1.74–1.75	0.013	Vitreous

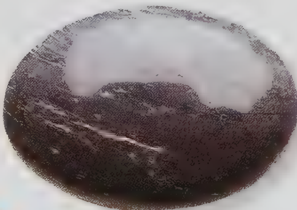
Crystal structure	Composition	Hardness
Orthorhombic	Aluminium iron borosilicate	7

DUMORTIERITE

Dumortierite is best known in its massive form, which makes an attractive violet and blue decorative stone when polished. Reddish brown and red varieties also occur. Prismatic crystals larger than 1mm (1/25in) are very rare. Dumortierite is also found intergrown with rock crystal (colourless quartz), and is then called dumortierite quartz. This material is usually cut *en cabochon* or polished to make decorative stones.

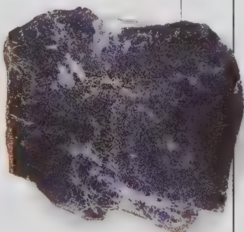
• OCCURRENCE Most gem-quality material is found in Nevada (USA). Other localities include France, Madagascar, Norway, Sri Lanka, Canada, Poland, Namibia, and Italy.

• REMARK Dumortierite was named after the French scientist, M.E. Dumortier.

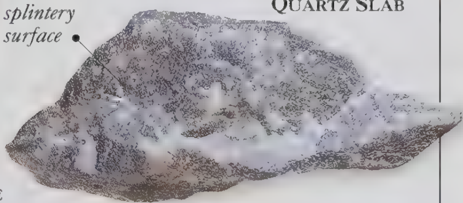


DUMORTIERITE QUARTZ CABOCHON

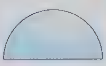

CARVED BOTTLE Hard but attractive, dumortierite is often polished and carved to make decorative objects, like this bottle adorned by the image of a bird.



DUMORTIERITE QUARTZ SLAB



MASSIVE DUMORTIERITE


Cabochon


Cameo


Polished

SG	RI	DR	Lustre
3.28	1.69–1.72	0.037	Vitreous

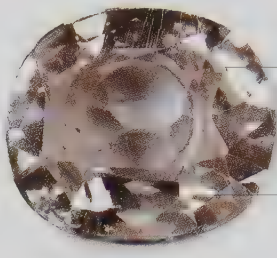
Crystal structure Monoclinic	Composition Sodium beryllium phosphate	Hardness 5½

BERYLLONITE

Beryllonite crystals are colourless, white, or pale yellow, but its weak fire and low dispersion make it a dull gemstone. In addition, its softness, perfect cleavage, and brittle fracture make it fragile, although with care it may be faceted for collectors.

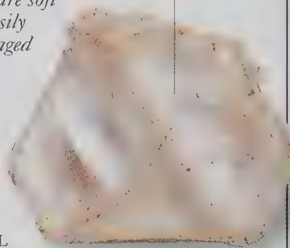
• OCCURRENCE Beryllonite is a pegmatite mineral, found associated with the minerals phenakite and berylin in Maine in the USA. It is also found in Finland and Zimbabwe, but remains a rare gem.

• REMARK Beryllonite is named after the beryllium content in its chemical composition. It has been confused with other colourless gemstones of low dispersion.

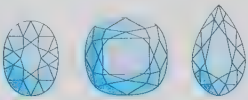


CUSHION MIXED-CUT

CUSHION MIXED-CUT



BERYLLONITE CRYSTAL



SG 2.83	RI 1.55–1.56	DR 0.009	Lustre Vitreous

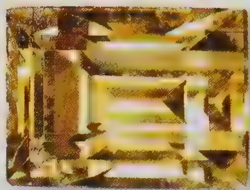
Crystal structure Monoclinic	Composition Aluminium sodium hydroxyphosphate	Hardness 5½

BRAZILIANITE

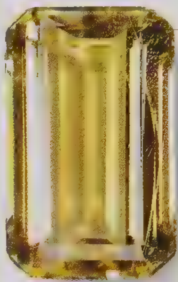
Brazilianite is a rare and unusual gemstone. Cut for collectors only, its yellow or yellowish green colour is nonetheless striking. Crystals are fragile and brittle, with conchoidal fracture and perfect cleavage perpendicular to their length.

• OCCURRENCE The main localities are in Brazil, where crystals up to 15cm (6in) have been found. Smaller crystals have been mined in New Hampshire in the USA.

• REMARK Found in Minas Gerais in Brazil in 1944, brazilianite was first thought to be chrysoberyl, but closer examination revealed it to be a completely new mineral. It was named after the country in which it was found, but has since been confused with chrysoberyl, beryl, and topaz.

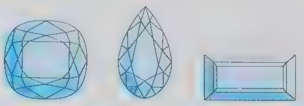


RECTANGULAR STEP-CUT



STEP-CUT

GROUP OF CRYSTALS



SG 2.99	RI 1.60–1.62	DR 0.021	Lustre Vitreous

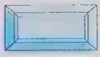
Crystal structure Monoclinic	Composition Calcium magnesium silicate	Hardness 5½

DIOPSIDE

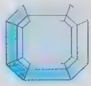
Crystals of diopside may be colourless, but are more usually bottle-green, brownish green, or light green. The more iron-rich and magnesium-poor they are, the darker the colour – almost to black. Very bright green diopside, coloured by chromium, is known as chrome diopside. Violet-blue crystals, coloured by manganese, have been found in Italy and the USA, and may be called violane. It is polished as beads when massive; cut for collectors when transparent; and cut *en cabochon* when fibrous.

• **OCCURRENCE** Gem-quality chrome diopside is found in Burma, Siberia (Russia), Pakistan, and South Africa. Other diopside localities include Austria, Brazil, Italy, the USA, Madagascar, Canada, and Sri Lanka. Dark green to black diopside, which shows a 4-rayed star when cut *en cabochon*, has been found in southern India since 1964.

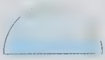
Brilliant



Baguette



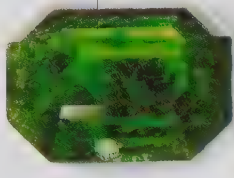
Step



Cabochon

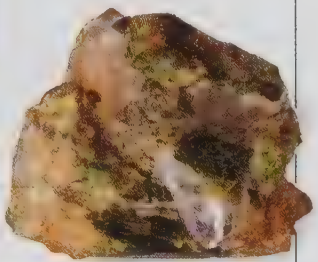
flaws are due to diopside's fragility

RECTANGULAR STEP-CUT



chrome diopside variety is bright emerald-green

OCTAGONAL STEP-CUT



dark green diopside crystals

DIOPSIDE IN MATRIX

SG 3.29	RI 1.66–1.72	DR 0.029	Lustre Vitreous

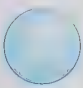
Crystal structure Monoclinic	Composition Hydrated magnesium silicate	Hardness 2½

MEERSCHAUM

Meerschaum, also known as sepiolite, is a very fine-grained, soft, light rock. Found as compact, opaque masses with an earthy or chalky appearance, it may be white or grey with a yellowish or reddish tinge. Easily fashioned and often intricately carved, meerschaum is still used in Turkey for bowls for tobacco pipes. With use, the smoke changes the white stone to an attractive yellow colour.

• **OCCURRENCE** Today the most important source is Eskischehir in Turkey. Other localities include Czechoslovakia, Spain, Greece, and the USA.

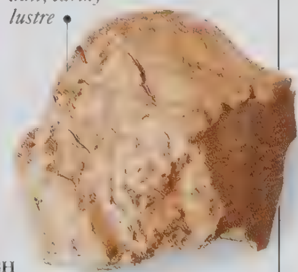
• **REMARK** Light and porous enough to float on water, meerschaum derives its name from the German for sea foam.



Bead

Cameo

BEAD NECKLACE
Soft and light, meerschaum is easy to carve into intricate objects, such as the individually worked beads on this delicate Turkish necklace.



dull, earthy lustre

light, porous, creamy white meerschaum

MASSIVE ROUGH

SG 1.50	RI 1.51–1.53	DR None	Lustre Dull to greasy

Crystal structure Monoclinic	Composition Lithium aluminium silicate	Hardness 7

SPODUMENE

Spodumene occurs in a range of colours, although the most common is yellowish grey. Two gem varieties – lilac-pink kunzite (coloured by manganese) and bright emerald-green hiddenite (coloured by chromium) – are very popular with collectors, although perfect cleavage makes them fragile gemstones. Strong pleochroism is easily seen in gem material, showing colourless and two shades of the body colour when viewed from different directions. Stones should always be cut to show the best colour through the table facet. The pink colour may fade with time, but some material is irradiated to intensify it.

• **OCCURRENCE** Spodumene was discovered in 1877 in Brazil, although it was not until 1879 that kunzite and hiddenite were recognized as different varieties of the same mineral. Spodumene is also found in Madagascar, Burma, the USA, Canada, the former USSR, Mexico, and Sweden.

• **REMARK** Lilac-pink kunzite is named after the gemmologist G.F. Kunz, who first described it in 1902; hiddenite is named after W.E. Hidden, who discovered it in North Carolina in 1879.

CUSHION-CUT KUNZITE

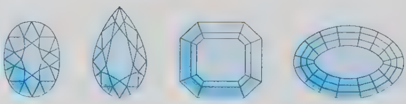
KUNZITE CRYSTAL

OCTAGONAL STEP-CUT

HIDDENITE CRYSTAL FRAGMENTS

STEP-CUT HIDDENITE

HIDDENITE CRYSTALS IN MATRIX



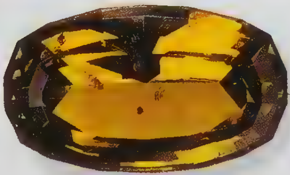
SG 3.18	RI 1.66–1.67	DR 0.015	Lustre Vitreous

Crystal structure	Composition	Hardness
Monoclinic	Calcium aluminium iron hydroxysilicate	6½

EPIDOTE

This fairly dense, fragile mineral has distinct cleavage and is rarely cut as a gemstone. Crystals are yellow, green, or dark brown columnar prisms, with faces finely striated parallel to the crystal's length. Pleochroism is strong, showing either yellow, green, or brown. Rock made up mainly of epidote may be polished or tumbled and sold as "unakite".

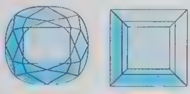
• OCCURRENCE Dark green crystals occur in the Austrian and French Alps. Epidote is also found in the former USSR, Italy, the island of Elba (Italy), Mozambique, and Mexico.



MIXED-CUT

RECTANGULAR TABLE-CUT

EPIDOTE CRYSTALS IN MATRIX



Cushion Step

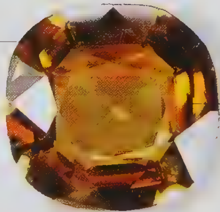
SG	RI	DR	Lustre
3.40	1.74–1.78	0.035	Vitreous

Crystal structure	Composition	Hardness
Monoclinic	Calcium titanium silicate	5

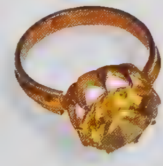
TITANITE

Titanite, also referred to as sphene, is known for its strong fire (its dispersion is higher than that of diamond) and rich colours, but it is seldom used in jewellery as it is too brittle and soft. Nevertheless, transparent yellow, green, or brown gem-quality material is cut for collectors. Titanite is strongly pleochroic (showing three different colours), and has high birefringence (seen as doubling of the back facets) and adamantine lustre.

• OCCURRENCE Gem-quality titanite occurs in cavities in metamorphic rocks such as gneiss and schist, and also in granite. Main localities are Austria, Canada, Switzerland, Madagascar, Mexico, and Brazil.

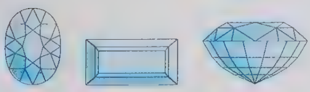


CUSHION MIXED-CUT



TITANITE RING
Faceted stones, like this bright yellow brilliant-cut set in gold, have high fire and rich colours.

TITANITE CRYSTALS IN MATRIX



Brilliant Baguette Mixed

SG	RI	DR	Lustre
3.53	1.84–2.03	0.120	Adamantine

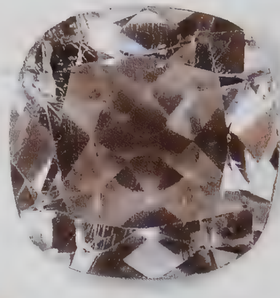
Crystal structure Monoclinic	Composition Potassium aluminium silicate	Hardness 6

Colourless Orthoclase

Orthoclase, an alkali feldspar, occurs in a range of colours, the most common being colourless. Adularia, a colourless, transparent variety from Adular-Bergstock in Switzerland, has a bluish white "schiller" or sheen, called adularescence.

• **OCCURRENCE** Orthoclase feldspar occurs in intrusive igneous rocks and is one of the main constituents of granitic pegmatites. It is also found in metamorphic rocks such as schist and gneiss. Clear, colourless orthoclase occurs in Madagascar. Yellow and colourless cuttable material, cat's-eyes, and some star stones occur in the gem gravels of Sri Lanka and Burma.

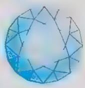
• **REMARK** Feldspars are the most common rock-forming minerals at the Earth's surface. They are divided into two groups: the alkali feldspars and the plagioclase feldspars (see p.130). Orthoclase derives its name from the Greek for "break straight", a reference to the stone's perfect cleavage at near 90 degrees.



ADULARIA CUSHION-CUT

ADULARIA CRYSTAL

ORTHOCLASE WITH QUARTZ


Brilliant


Mixed

SG 2.56	RI 1.51–1.54	DR 0.005	Lustre Vitreous

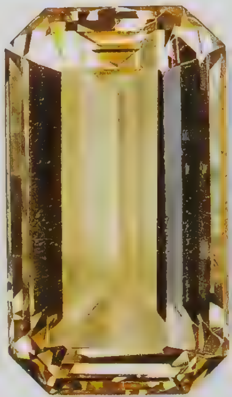
Crystal structure Monoclinic	Composition Potassium aluminium silicate	Hardness 6

Yellow Orthoclase

The yellow variety of orthoclase feldspar (see colourless orthoclase above) is usually faceted as a step-cut, because the stones are often fragile. The yellow colour is due to the presence of iron. Orthoclase crystals are columnar or tabular prisms, and are often twinned.

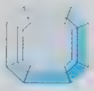
• **OCCURRENCE** The best yellow orthoclase is found in Madagascar in pegmatites, and may be faceted for the collector. Yellow orthoclase from Madagascar and Germany may be cut *en cabochon* to show the cat's-eye effect.

• **REMARK** Feldspars form in igneous and metamorphic rocks. Which type is formed depends on the temperature it forms at, and how it cools.



RECTANGULAR STEP-CUT

CRYSTAL FRAGMENT


Step

SG 2.56	RI 1.51–1.54	DR 0.005	Lustre Vitreous

Crystal structure	Composition	Hardness
Monoclinic	Potassium aluminium silicate	6

MOONSTONE (ORTHOCLASE)

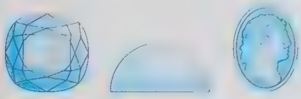
Moonstone is the opalescent variety of orthoclase, with a blue or white sheen (or "schiller"), rather like the shine of the moon after which it is named. This is caused by the reflection of light from the internal structure, made up of alternating layers of albite and orthoclase feldspar. Thin albite layers give an attractive blue; thicker layers produce a white "schiller". Stones of large size and fine quality are rare.

• OCCURRENCE The best material is from Burma and Sri Lanka. Other localities include India, Madagascar, Brazil, the USA, Mexico, Tanzania, and the European Alps.

BLUE MOON
The moonstone in this finely detailed cameo has a distinct blue "schiller". Moon-worshippers through the ages have used it in their jewellery.

CUSHION BRILLIANT-CUT

WATERWORN PEBBLE



SG	RI	DR	Lustre
2.57	1.52–1.53	0.005	Vitreous

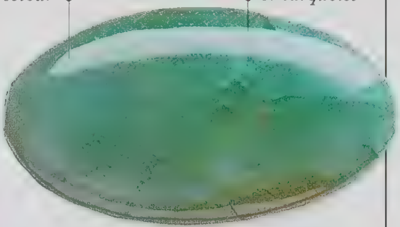
Crystal structure	Composition	Hardness
Triclinic	Potassium aluminium silicate	6

MICROCLINE

A form of alkali feldspar, microcline may be colourless, white, yellow, pink, red, grey, green, or blue-green. However, the semi-opaque, blue-green variety called amazonite (named after the Amazon River) is most commonly used in jewellery, and may be cut, usually *en cabochon*, up to almost any size. Its striking colour is due to the presence of lead.

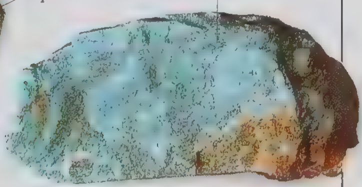
• OCCURRENCE The most important source of amazonite is in India. Other localities include the USA, Canada, the former USSR, Madagascar, Tanzania and Namibia.

• REMARK Although microcline has the same composition as orthoclase, its crystal structure is triclinic.

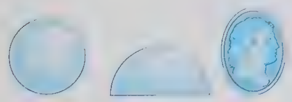


AMAZONITE CABOCHON

AMAZONITE SLAB



AMAZONITE ROUGH

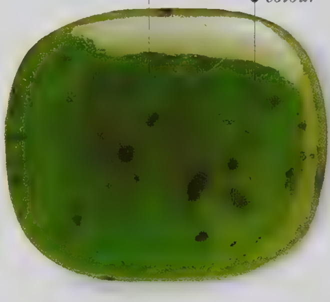


SG	RI	DR	Lustre
2.56	1.52–1.53	0.008	Vitreous to silky

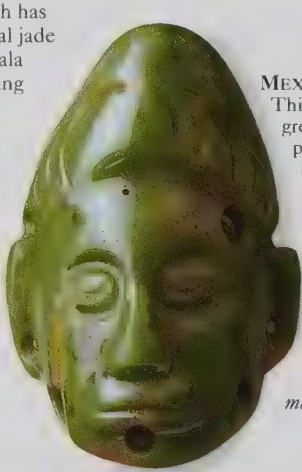
Crystal structure Monoclinic	Composition Sodium aluminium silicate	Hardness 7

JADEITE (JADE)

For centuries jade was thought to be a single gemstone, but in 1863 two types were recognized: jadeite and nephrite. Nephrite (opposite) is more common, but both are tough, fine-grained rocks, suitable for carving. Jadeite, made up of interlocking, granular pyroxene crystals, occurs in a wide range of colours including green, lilac, white, pink, brown, red, blue, black, orange, and yellow. The most prized variety, imperial jade, is a rich emerald-green, due to chromium. Jadeite commonly has a dimpled surface when polished.
• **OCCURRENCE** Jadeite is found in metamorphic rocks and as alluvial pebbles and boulders. Some boulders develop a brown skin, due to weathering, and this is often incorporated into carvings and worked pieces. The most important source of jade is Burma, which has supplied China with translucent imperial jade for over 200 years. Historically, Guatemala was an important source of jade, providing the material for the carvings of the Central American Indians. Jadeite also occurs in Japan and California (USA).
• **REMARK** The Spanish *conquistadores* adopted the use of jadeite when they invaded Central America, and often wore amulets made from it. They called it *piedra de hijada* (loin stone) or *piedra de los rinones* (kidney stone), believing it prevented or cured hip and kidney complaints.

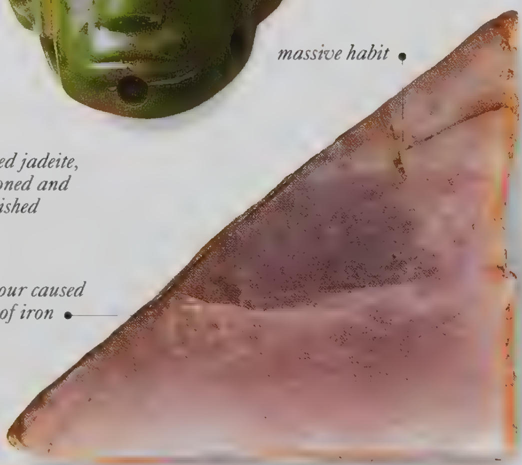


POLISHED IMPERIAL JADE

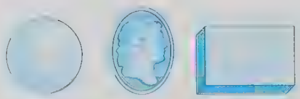


MEXICAN MASK
This opaque, mottled green mask was probably carved in Mexico, prior to 1753. Older jadeite carvings have a characteristic pitted surface; modern abrasives give a smoother finish.

JADEITE SPHERE



POLISHED SLAB



Bead Cameo Polished

SG 3.33	RI 1.66–1.68	DR 0.012	Lustre Greasy to pearly

Crystal structure	Composition	Hardness
Monoclinic	Calcium magnesium iron silicate	6½

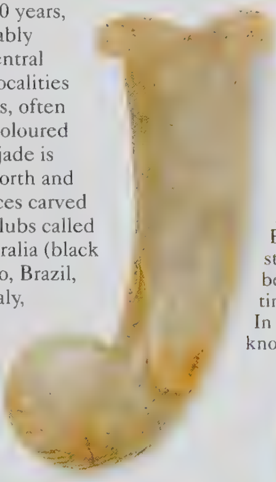
NEPHRITE (JADE)

Nephrite, recognized as a separate type of jade since 1863 (see opposite), is found as aggregates of fibrous amphibole crystals. These form an interlocking structure tougher than steel, hence nephrite's popularity as a material for carving – first for weapons and later for ornaments. Colours vary from a dark green, iron-rich nephrite to a cream-coloured, magnesium-rich variety. Nephrite jade may be homogeneous in colour, blotchy, or banded.

• **OCCURRENCE** Nephrite jade has been carved by the Chinese for over 2,000 years, although the raw material was probably imported first from Turkestan in Central Asia, and later from Burma. Other localities include Siberia (dark green boulders, often with black spots), Russia (spinach-coloured stones), and China itself. Nephrite jade is also found in various rocks in the North and South Islands of New Zealand (pieces carved in the 17th century include Maori clubs called *meres*). Other localities include Australia (black nephrite), the USA, Canada, Mexico, Brazil, Taiwan, Zimbabwe (dark green), Italy, Poland, Germany, and Switzerland.

• **REMARK** Nephrite may be confused with bowenite serpentine, may be imitated by composite stones, or dyed to improve colour.

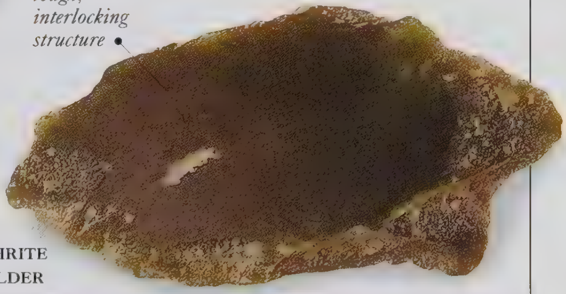
CHINESE CARVING
Nephrite jade has been carved in China for centuries, and is tough enough to be worked into intricate designs. China is still one of the world's main cutting centres.



DAGGER HANDLE
Because of its great strength, nephrite has been used since prehistoric times to make weapons. In fact at one time it was known as "axe stone".

FABERGÉ SNAIL
The greasy lustre of nephrite jade enhances this witty carving by the famous Russian jeweller, Fabergé.

CHINESE CAMEL
The shape of the original boulder has been integrated into the design of this carving. Only one side of the boulder has been fashioned.



NEPHRITE BOULDER

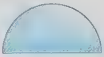
SG	RI	DR	Lustre
2.96	1.61–1.63	0.027	Greasy to pearly

Crystal structure Monoclinic	Composition Copper hydroxycarbonate	Hardness 4

MALACHITE

Malachite is usually found in opaque green masses; the colour is due to the copper content. Crystals are too small for faceting, but the massive material is carved or polished in many ways to reveal the alternating bands of light and dark green. In the past, malachite was worn to ward off danger and illness.

• OCCURRENCE Malachite occurs in small quantities worldwide, but in larger quantities in copper-mining areas. Zaire is the most important producer.


Cabochon

POLISHED MALACHITE

MALACHITE ROUGH

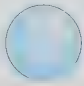
SG 3.80	RI 1.85 (mean)	DR 0.025	Lustre Vitreous to silky

Crystal structure Monoclinic	Composition Hydrated copper silicate	Hardness 2

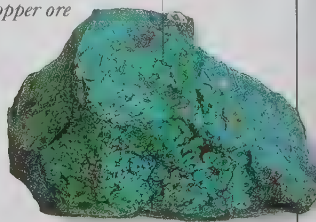
CHRYSOCOLLA

Chrysocolla usually occurs as a bright green or bluish crust, or as compact, grape-like groups. Crystals intergrown with quartz or with opal are more commonly used in jewellery.

• OCCURRENCE Copper-mining areas, particularly Chile, the former USSR, and Zaire. "Eilat Stone" (intergrown with malachite and turquoise) reputedly came from King Solomon's mines.


Bead

POLISHED CHRYSOCOLLA



CHRYSOCOLLA ROUGH

SG 2.20	RI 1.57–1.63	DR 0.030	Lustre Greasy to vitreous

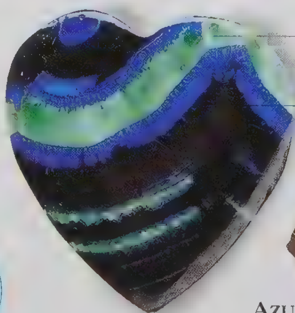
Crystal structure Monoclinic	Composition Copper hydroxycarbonate	Hardness 3½

AZURITE

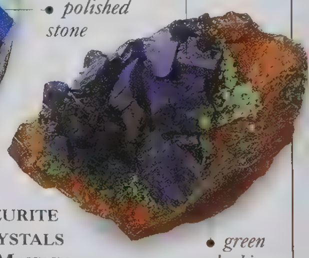
Azurite is an azure-blue copper mineral, occasionally found as prismatic crystals (rarely faceted), but more usually in massive form intergrown with malachite.

• OCCURRENCE Found particularly in copper-mining areas such as Australia, Chile, the former USSR, Africa, and China. Stones from Chessy, near Lyons in France, are called chessylite.


Cameo



BANDED CHESSYLITE



AZURITE CRYSTALS ON MATRIX

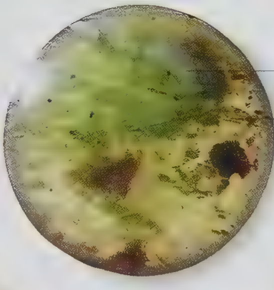
SG 3.77	RI 1.73–1.84	DR 0.110	Lustre Vitreous

Crystal structure Monoclinic	Composition Magnesium hydroxysilicate	Hardness 5

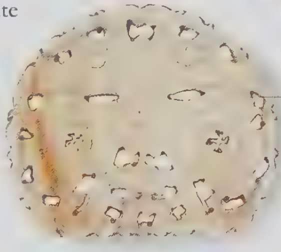
SERPENTINE

The name serpentine refers to a group of predominantly green minerals that occur in masses of tiny intergrown crystals. The two main types used in jewellery are bowenite (translucent green or blue-green) and the rarer williamsite (translucent, oily green, veined or spotted with inclusions). They may be carved, engraved, or polished. Various marbles also contain serpentine veins.

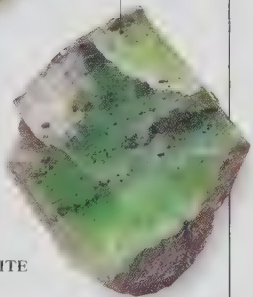
• OCCURRENCE Bowenite is found in New Zealand, China, Afghanistan, South Africa, and the USA; Williamsite occurs in Italy, England, and China.



WILLIAMSITE CABOCHON

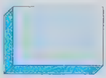


BOWENITE PENDANT



SERPENTINITE ROCK


Cameo


Polished

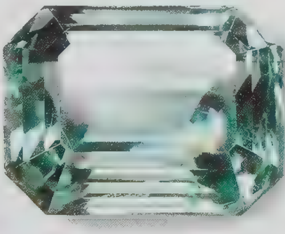
SG 2.60	RI 1.55–1.56	DR 0.001	Lustre Vitreous to greasy

Crystal structure Monoclinic	Composition Hydrated zinc phosphate	Hardness 3½

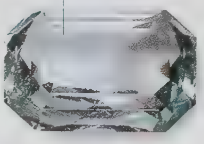
PHOSPHOPHYLLITE

This is one of the rarest of gemstones, and is highly prized by collectors. The crystals, which are prismatic or with a thick, tabular habit, range from colourless to deep bluish green, but the best specimens are a very delicate bluish green. Nevertheless, phosphophyllite is rarely cut, as the material is brittle and fragile, and large crystals are too valuable to be broken up.

• OCCURRENCE The finest crystals, and the only ones to be faceted, are from Bolivia. Other localities include Germany and New Hampshire (USA).

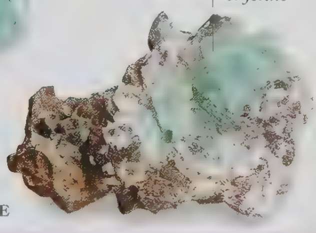


RECTANGULAR STEP-CUT



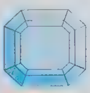
STEP-CUT

PHOSPHOPHYLLITE CRYSTALS



PHOSPHOPHYLLITE CRYSTALS ON PYRITE


Brilliant


Step

SG 3.10	RI 1.59–1.62	DR 0.021	Lustre Vitreous

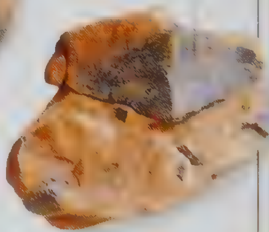
Crystal structure Monoclinic	Composition Magnesium aluminium hydroxyphosphate	Hardness 5½

LAZULITE

Crystals of lazulite are rare. Colours vary from a mottled pale blue to dark blue. Transparent stones are pleochroic, showing blue and colourless, but often lazulite is not transparent. Semi-translucent or opaque stones, found as small crystal fragments, may be polished, carved, or tumbled to make beads or decorative stones.

• **OCCURRENCE** Localities include the USA, Brazil, India, Sweden, Austria, Switzerland, Madagascar, and Angola.

POLISHED CABOCHON



LAZULITE IN MATRIX

Cabochon

SG 3.10	RI 1.61–1.64	DR 0.031	Lustre Vitreous

Crystal structure Monoclinic	Composition Hydrated calcium borosilicate	Hardness 3½

HOWLITE

Howlite is a soft, light mineral with a chalky white colour, commonly with black or brown veins. Crystals are occasionally found in groups. It is very porous and may be dyed to imitate other minerals, especially turquoise.

• **OCCURRENCE** Howlite has been found in large quantities in California (USA).

• **REMARK** Even though it is soft, howlite will withstand a polish, and is occasionally used as a decorative stone.

STAINED HOWLITE

MASSIVE ROUGH

Bead

SG 2.58	RI 1.58–1.59	DR 0.022	Lustre Vitreous

Crystal structure Monoclinic	Composition Hydrated calcium sulphate	Hardness 2

GYPSUM

Several varieties of gypsum are used as decorative stones. The most important, alabaster, is found as fine-grained masses in pastel shades, but is commonly stained in stronger colours. Selenite is colourless, occasionally cut for collectors, but very soft. Satin spar is a fibrous variety, polished or cut *en cabochon*. Rose shapes (called "desert rose") also occur.

• **OCCURRENCE** Localities include Italy and England (alabaster); Italy, Mexico, the USA, and Chile (selenite).

POLISHED SATIN SPAR

SATIN SPAR ROUGH

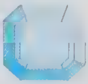
Cabochon

SG 2.32	RI 1.52–1.53	DR 0.010	Lustre Silky to vitreous

Crystal structure Monoclinic	Composition Calcium hydroxyborosilicate	Hardness 5

Datolite

Transparent, colourless crystals of datolite are cut for the collector only. A tinge of yellow, green, or white may also be present. More often, however, datolite occurs as a massive material, which may contain copper inclusions.
• OCCURRENCE Localites include Austria, Italy, Norway, the USA, Germany, and England. The main source of massive datolite with inclusions is the Lake Superior area of North America.


Step

crystals are cut for collectors only •


Octagonal Step-cut

colourless, with tinge of yellow •


Crystal

SG 2.95	RI 1.62–1.65	DR 0.044	Lustre Vitreous

Crystal structure Monoclinic	Composition Lithium aluminium silicate	Hardness 6

Petalite

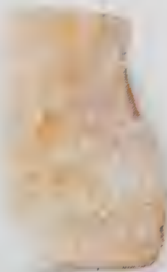
Fine petalite is rare and fragile. For this reason it is only occasionally cut for the collector. Crystals are transparent, colourless or white, occurring as tabular or columnar prisms with a glassy appearance. Massive petalite is more common, cut *en cabochon*.
• OCCURRENCE Elba (Italy), Brazil, Australia, Sweden, Finland, USA, Zimbabwe, and Namibia.


Cushion

fine stones are • *rare and fragile*


Cushion Mixed-cut

fibrous, massive material •

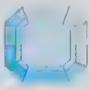

Petalite Rough

SG 2.42	RI 1.50–1.51	DR 0.014	Lustre Vitreous to pearly

Crystal structure Monoclinic	Composition Beryllium aluminium hydroxysilicate	Hardness 7½

Euclase

Euclase is a rare gem. The most attractive colour is a pale aquamarine blue, but it also occurs in white, green, and colourless forms. Crystals are prismatic with a perfect cleavage, which means they are fragile and must be cut and handled with care.
• OCCURRENCE Euclase occurs mainly in pegmatites. Localities include Brazil, Tanzania, Zaire, Kenya, the former USSR, India, Zimbabwe, and the USA.

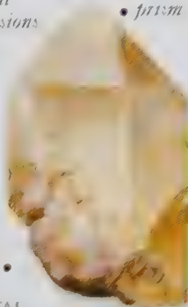

Step

black mineral • *inclusions*


Square Step-cut

striated • *prism*

conchoidal fracture •


Prismatic Crystal

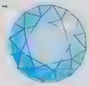
SG 3.10	RI 1.65–1.67	DR 0.019	Lustre Vitreous

Crystal structure	Composition	Hardness
Triclinic	Sodium calcium aluminosilicate	6

ALBITE

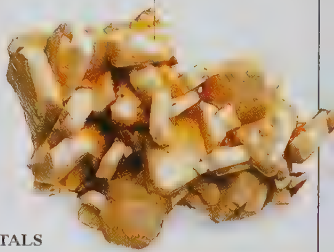
Albite is one of six species in the plagioclase feldspar series. Each species is defined by its albite and anorthite content: albite itself has the highest albite content. It is usually white, though gems are often colourless. Peristerite, an albite-oligoclase mix, has a blue sheen, like moonstone (see p.123).

• **OCCURRENCE** The best peristerite is from Canada.


Brilliant


Brilliant

MIXED-CUT



ALBITE CRYSTALS

SG	RI	DR	Lustre
2.64	1.54–1.55	0.009	Vitreous to pearly

Crystal structure	Composition	Hardness
Triclinic	Sodium calcium aluminosilicate	6

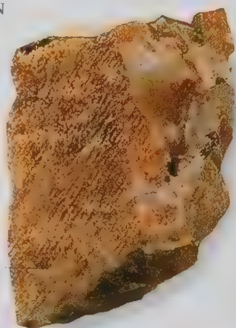
OLIGOCLASE

Oligoclase is a species of plagioclase feldspar (see above). The variety used in jewellery is called sunstone or, less commonly, aventurine feldspar. It has reflective inclusions of red, orange, or green platy crystals, which give it a metallic glitter. Sunstone may be faceted or carved – often as cabochons.

• **OCCURRENCE** Sunstone occurs in metamorphic and igneous rocks in Norway, the USA, India, the former USSR, and Canada.


Cabochon


SUNSTONE PIN The bright spangles in this cabochon, set as a tie-pin, are caused by tiny inclusions of hematite.



SUNSTONE ROUGH

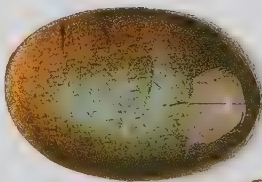
SG	RI	DR	Lustre
2.64	1.54–1.55	0.007	Vitreous

Crystal structure	Composition	Hardness
Triclinic	Sodium calcium aluminosilicate	6

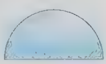
LABRADORITE

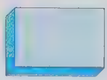
Labradorite is the plagioclase feldspar (see albite, above) most commonly faceted as a gem. It occurs in orange, yellow, colourless, and red, but the material that shows a play of colour, or "schiller", is the most popular for use in jewellery.

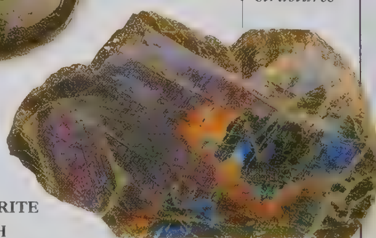
• **OCCURRENCE** Occurs in metamorphic and igneous rocks in Labrador (Canada), Finland, Norway, and the former USSR.



CABOCHON


Cabochon


Polished



LABRADORITE ROUGH

SG	RI	DR	Lustre
2.70	1.56–1.57	0.010	Vitreous

Crystal structure	Composition	Hardness
Triclinic	Hydrated copper aluminium phosphate	6

TURQUOISE

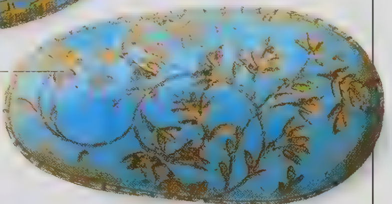
One of the first gemstones to be mined, turquoise has long been prized for its intense colour, which varies from sky-blue to green, depending on the quantities of iron and copper within it. Turquoise is commonly found in microcrystalline, massive form, usually as encrustations, in veins, or as nodules. It is opaque to semi-translucent, light and very fragile, with conchoidal fracture. Some material is very porous, leading to fading and cracking, so it may be impregnated with wax or resin to maintain its appearance.

• **OCCURRENCE** Sky-blue turquoise from Iran is generally regarded as the most desirable, but in Tibet a greener variety is preferred. Localities in Mexico and the USA produce a greener, more porous material that tends to fade more quickly. Other localities include the former USSR, Chile, Australia, Turkestan, and Cornwall (England).

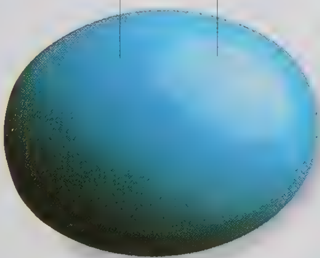
• **REMARK** Turquoise has been thought to warn the wearer of danger or illness by changing colour. It has been imitated by stained howlite, fossil bone or tooth, limestone, chalcedony, glass, and enamel. In 1972, an imitation turquoise was produced in France by Gilson.

GREEN FACE This greenish blue turquoise stone has been carved in the image of a child's face, set in relief in a swivel ring.

PERSIAN BLUE These two ornaments, engraved and inlaid with gold, are made from the finest sky-blue turquoise, mined in Persia (now Iran) for over 3,000 years. The distinctive colour is due to the presence of copper and traces of iron. Persian turquoise was introduced to Europe via Turkey – hence its name, derived from the word "turkish".



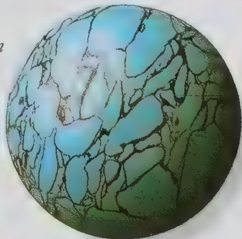
pattern engraved and inlaid with gold



cut and polished as cabochon

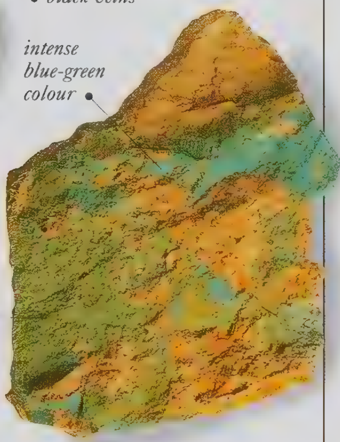
laboratory-made stone has uniform colour

GILSON IMITATION



"spiderweb" turquoise has black veins

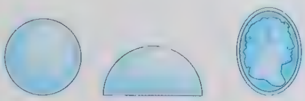
GILSON "SPIDERWEB" IMITATION



intense blue-green colour

thin crust of turquoise on matrix

TURQUOISE IN MATRIX



Bead Cabochon Cameo

SG	RI	DR	Lustre
2.80	1.61–1.65	0.040	Waxy to dull

Crystal structure	Composition	Hardness
Triclinic	Manganese silicate	6

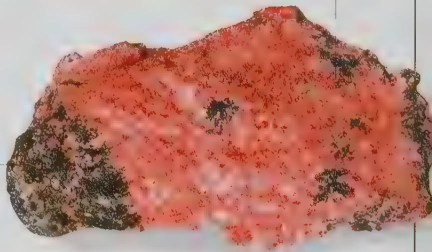
RHODONITE

Rhodonite has a distinct pink or rose-red colour, although material containing black veins is more popular than a uniform pink. Massive rhodonite is usually opaque to translucent, and is carved, or cut as cabochons or beads. Transparent crystals are rare and fragile, but some have been cut for collectors.

• **OCCURRENCE** Both crystals and massive material have been found in the Urals (Russia), Sweden, and Australia. Other localities for fine-grained rhodonite include Brazil, Mexico, the USA, Canada, Italy, India, Madagascar, South Africa, Japan, New Zealand, and England.

• **REMARK** The name comes from *rhodos*, the Greek for "rose", referring to the distinct colour.

OVAL CABOCHON



RHODONITE ROUGH


Bead Cabochon Cameo

SG	RI	DR	Lustre
3.60	1.71–1.73	0.014	Vitreous

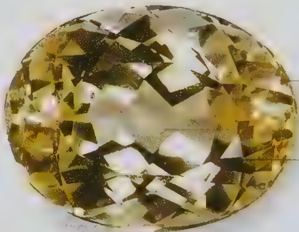
Crystal structure	Composition	Hardness
Triclinic	Lithium aluminium hydroxyphosphate	6

AMBLYGONITE

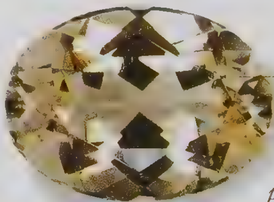
Amblygonite is found in a wide range of colours from white, pink, green, and blue to golden yellow and, more rarely, colourless. Large, transparent to translucent crystals may occur, but, as amblygonite is relatively soft, they are cut solely for collectors. Amblygonite is also found as cleavable or compact masses.

• **OCCURRENCE** Amblygonite is found in pegmatites. Brazil is the source of most gem-quality material, but it is also found in the USA. A pale mauve variety occurs in Namibia.

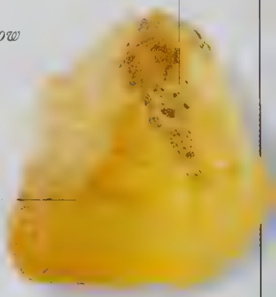
• **REMARK** Amblygonite has been confused with brazilianite and scapolite.



OVAL BRILLIANT-CUT



OVAL BRILLIANT-CUT



INCOMPLETE CRYSTAL


Brilliant Brilliant Mixed

SG	RI	DR	Lustre
3.02	1.57–1.60	0.026	Vitreous

Crystal structure	Composition	Hardness
Triclinic	Complex borosilicate	7

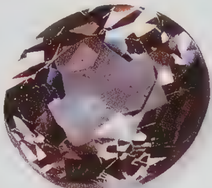
AXINITE

Axinite gets its name from its sharp-edged, axehead-shaped crystals. Although attractive and hard, they are brittle and rarely flawless, and faceted for collectors only. Brown is the most usual colour, although it also occurs in honey-yellow and plum-purple varieties. A rare Tanzanian axinite is blue. Axinite is strongly pleochroic.

• **OCCURRENCE** Axinite is found in cavities in granite and in metamorphic rocks. Localities include New Jersey (USA), where the attractive honey-yellow crystals are found, Mexico, Cornwall (England), France, and in the gem gravels of Sri Lanka.

• **REMARK** Darker axinite has been confused with smoky quartz.

OVAL STEP-CUT



BRILLIANT-CUT

AXINITE CRYSTALS


Brilliant Brilliant Mixed

SG	RI	DR	Lustre
3.28	1.67–1.70	0.011	Vitreous

Crystal structure	Composition	Hardness
Triclinic	Aluminium silicate	5 or 7

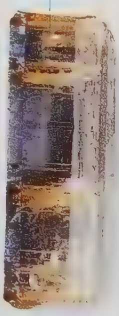
KYANITE

Gem-quality kyanite crystals are pale to deep blue, or white, grey, or green. Colour distribution in crystals may be uneven, with darker blue patches towards the interior.

• **OCCURRENCE** Kyanite is found in metamorphic gneiss and schist, and in pegmatite veins through metamorphic rocks. It may be weathered out into alluvial deposits. Gem-quality crystals are found in Burma, Brazil, Kenya, and the European Alps. Alluvial deposits are found in India, Australia, and Kenya, and in several localities in the USA.

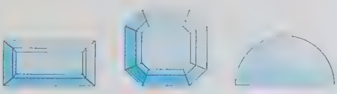
• **REMARK** Kyanite crystals have two hardness values: they are softer parallel to the direction of cleavage, and harder perpendicular to it.

RECTANGULAR STEP-CUT



CRYSTAL

CRYSTALS IN MATRIX


Baguette Step Cabochon

SG	RI	DR	Lustre
3.68	1.71–1.73	0.017	Vitreous to pearly

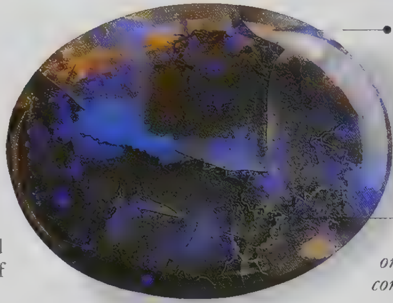
Crystal structure Amorphous	Composition Hydrated silica gel	Hardness 6

OPAL

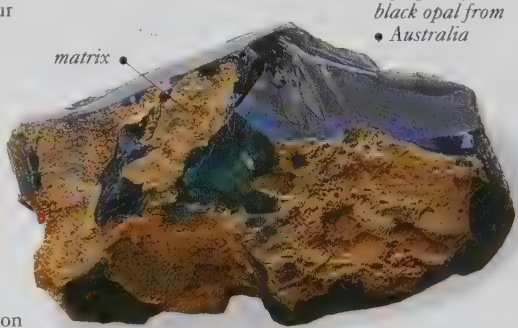
Opal is a hardened silica gel, usually containing 5–10 per cent water. It is therefore non-crystalline, unlike most other gemstones, and may eventually dry out and crack. There are two varieties: precious opal, which shows flashes of colour (iridescence), depending on the angle of viewing; and common or "potch" opal, which is often opaque and displays no iridescence. The iridescence of precious opal is caused by the way the structure, a regular arrangement of tiny silica spheres, diffracts light – the larger the spheres, the greater the range of colours. Precious opal occurs in a number of colour varieties, some of which are shown here.

• OCCURRENCE Opal fills cavities in sedimentary rocks, or veins in igneous rocks. It forms stalagmites or stalactites, and replaces organic material in fossil wood, shell, and bone. Australia has been the main producer of opals since the 19th century. Other localities include Czechoslovakia, the USA, Brazil, Mexico, and southern Africa.

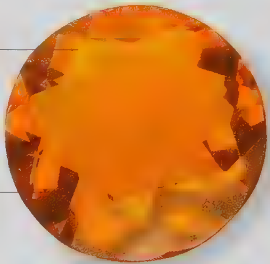
• REMARK Opals have been imitated by Slocum stone, a tough, man-made glass, and in 1973 Gilson made an imitation opal in the laboratory (see p.36).



BLACK PRECIOUS OPAL



BLACK PRECIOUS OPAL IN MATRIX

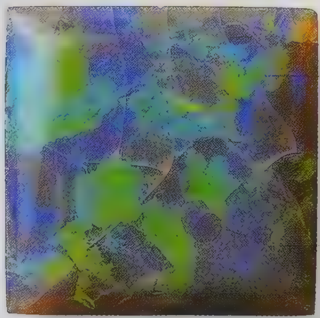


FIRE OPAL BRILLIANT

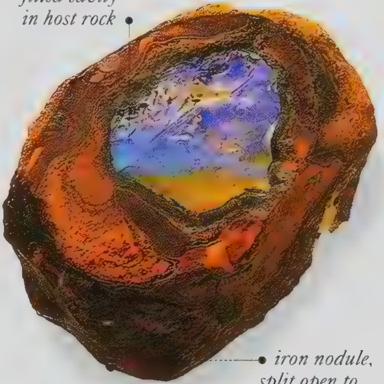
OPAL IN MATRIX

FIRE OPAL RING
Although many opals are cut *en cabochon*, this transparent fire opal has been faceted as an octagonal step-cut, and set in a gold ring.

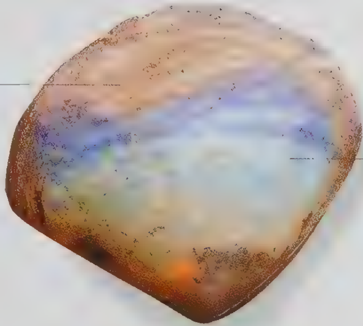
SG 2.10	RI 1.37–1.47	DR None	Lustre Vitreous



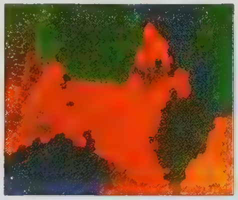
POLISHED PRECIOUS OPAL



MATRIX OPAL



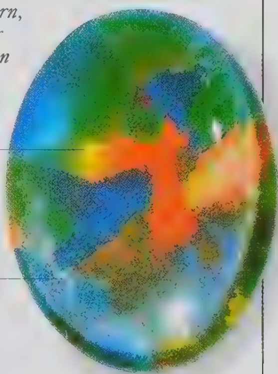
OPALIZED FOSSIL



Magnification reveals the mosaic-like structure of this Gilson imitation opal.

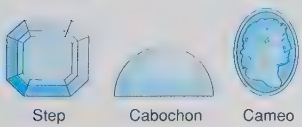
WHITE OPAL
Although soft and easily damaged, precious opal remains a popular stone for rings.

OPALS AND PEARLS
This exquisite gold cross, designed to be worn on a chain, is set with five precious white opals, cut *en cabochon*, and two pearls. The opals show flashes of red, blue, and green.



GILSON IMITATION OPAL

SLOCUM STONE



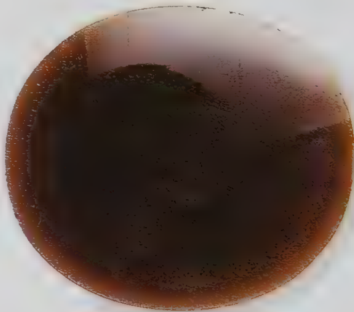
Crystal structure	Composition	Hardness
Amorphous	Mainly silicon dioxide	5

Obsidian

Obsidian is a natural glass. It is formed from volcanic lava that cooled too quickly for significant crystallization to occur. Hence it is amorphous, with no cleavage; fracture is conchoidal. Obsidian is usually black, but brown, grey, and, more rarely, red, blue, and green material is found. The colour may be uniform, striped, or spotted. Some inclusions give obsidian a metallic sheen, while internal bubbles or crystals (called crystallites) produce a "snowflake" effect (hence snowflake obsidian) or an iridescence seen as flashes of colour.

• OCCURRENCE Obsidian is found in areas where there is, or has been, volcanic activity: for example, Hawaii (USA), Japan, and Java. Other localities include Iceland, Hungary, the Lipari Islands off Italy, the former USSR, Mexico, Ecuador, and Guatemala. Dark nodules found in Arizona and New Mexico (USA) are called "Apache tears".

• REMARK Obsidian has been used since prehistoric times for making tools, weapons, masks, mirrors, and jewellery. The very sharp shards of the natural glass have been fashioned as blades, arrowheads, and daggers. Today most obsidian jewellery comes from North and Central America.



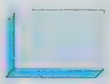
Obsidian Cabochon

Polished Obsidian Slice

Apache Tears

Obsidian Rough

Cabochon



Polished

SG	RI	DR	Lustre
2.35	1.48–1.51	None	Vitreous

Crystal structure Amorphous	Composition Mainly silicon dioxide	Hardness 5

TEKTITES

The first tektites were found in 1787 in the Moldau River in Czechoslovakia, hence their original name of "moldavites". Other colour varieties of this natural glass have since been found in many different localities. Tektites are usually translucent, and occur in a range of colours from green to brown. Their surfaces are usually uneven or rough, with a distinctive lumpy, jagged, or scarred texture. Tektites do not contain the crystallites found in obsidian (opposite). They may, however, have characteristic inclusions of round or torpedo-shaped bubbles or treacle-like swirls.

• **OCCURRENCE** The Moldau River in Czechoslovakia is now the only known locality for green, transparent tektite. Tektites from Thailand have been carved as small, decorative objects, worn in the belief that they give protection from evil.

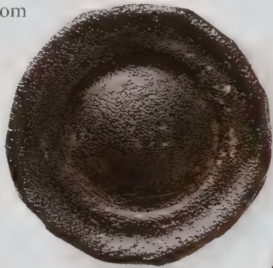
• **REMARK** Several ideas have been put forward to explain the mysterious origin of tektites. One theory is that they came to Earth from outer space, melting as they passed through the atmosphere and thus forming their characteristic shape and surface texture. A second theory is that the impact of a large meteorite caused the surrounding rocks to melt and scatter, with cracks and scars then appearing as they cooled.

dark brown, semi-translucent stone

dark stones are only rarely faceted

OVAL BRILLIANT-CUT

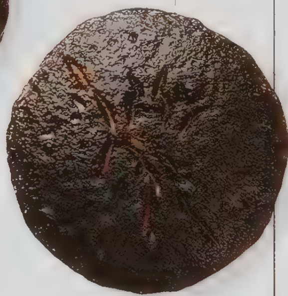
button shape caused by way molten glass has cooled



TEKTITE ROUGH

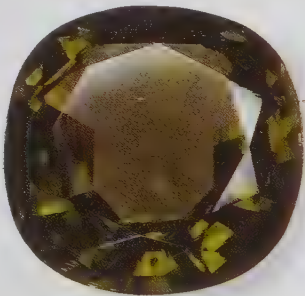
surface shows cooling cracks

tektite varieties are named after their place of origin



AUSTRALITE ROUGH

stone may be confused with diopside due to green colour



green, transparent material is most suitable for faceting

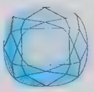
MOLDAVITE BRILLIANT-CUT

distinctive craggy, uneven surface

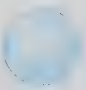
translucent and transparent in parts

MOLDAVITE ROUGH

Brilliant



Cushion



Bead

SG 2.40	RI 1.48–1.51	DR None	Lustre Vitreous

Crystal structure	Composition	Hardness
Orthorhombic	Calcium carbonate, conchiolin, and water	3

PEARL

Pearls are formed in shellfish – especially oysters and mussels – as a natural defence against an irritant, such as a piece of grit. Layers of aragonite, known as nacre, are secreted around the irritant, and gradually build up to form the solid pearl. Light reflecting from these overlapping layers produces a characteristic iridescent lustre, also known as the "orient of pearl". In cultured pearls an irritant is introduced to initiate the formation of a pearl. In a "nucleated" cultured pearl a small bead is used as the nucleus, upon which the layers of nacre are secreted. Pearls vary in colour from white, white with a hint of colour (often pink), to brown or black, depending on the type of mollusc and the water. They are sensitive to acids, dryness, and humidity, and so are less durable than many other gems.

• **OCCURRENCE** Natural pearls have been harvested from the Persian Gulf, the Gulf of Manaar (Indian Ocean), and the Red Sea for thousands of years. The coasts of Polynesia and Australia produce mainly cultured pearls. Both freshwater and saltwater pearls are cultivated in Japan and China. Freshwater pearls occur in the rivers of Scotland, Ireland, France, Austria, Germany, and Mississippi (USA).

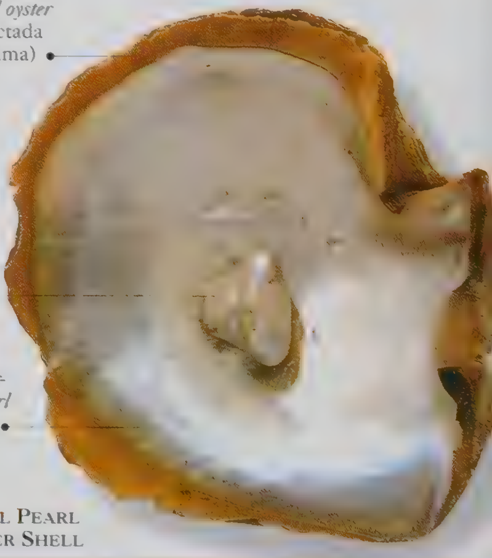
• **REMARK** Pearls were once thought to be the tears of the gods.

NATURAL PINK PEARL

NATURAL WHITE PEARL

NATURAL FRESHWATER PEARLS

NATURAL FRESHWATER PEARLS



NATURAL PEARL IN OYSTER SHELL

SG	RI	DR	Lustre
2.71	1.53–1.68	Not applicable	Pearly

A "Bombay Bunch"

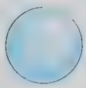
For hundreds of years Bombay (in India) has been an important centre for the buying and selling of pearls. To present them for selling, pearls are sorted by size, then strung into bunches on silk thread.

Buddha Pearls

To produce miniature images of the Buddha, tiny casts were placed into the shell of this pearl mussel (*Cristaria plicata*). The mussel laid down nacreous layers over the casts, forming "blister" pearls. The pearls are later removed and the backs hidden in the mount or covered with mother-of-pearl.

Japanese Culture

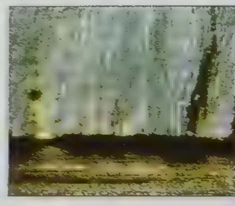
This necklace, made by the Mikimoto company of Japan, uses saltwater cultured pearls. Japan leads the world in the production of cultured pearls, although they have been used by the Chinese for hundreds of years.


Bead

Hardness 2½

JET

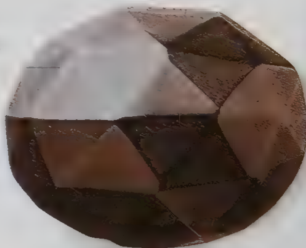
[illegible]



Because jet is organic, it may dry out, causing the surface to crack.

opaque, with velvety lustre

OVAL CABOCHON



ROSE-CUT

Lustre Velvety to waxy

VICTORIAN EARRINGS
Jet is light to wear, and so particularly suitable for earrings. During the Victorian era in Britain it was very popular for mourning jewellery.

BLACK ROSE
This piece of carved Whitby jet, with a finely wrought rose at the centre, dates from the latter part of the 19th century.

FOSSIL-BEARING JET
The ammonite and bivalve fossils trapped in this jet specimen are evidence of its organic origin.

JET PENDANT
This exquisite pendant of a dove with a heart in its beak shows how well jet can be carved and polished.

TURKISH BEADS
This necklace from eastern Turkey is made from beads of polished and drilled jet. The high polish has given the beads an attractive lustre.

Crystal structure	Composition	Hardness
Trigonal	Calcium carbonate or conchiolin	3

CORAL

Coral is made up of the skeletal remains of marine animals called coral polyps. These tiny creatures live in colonies which form branching structures as they grow, eventually forming coral reefs and atolls. The surface of these coral "branches" has a distinctive patterning made by the original skeleton – either striped or like wood grain. Most corals – red, pink, white, and blue varieties – are made of calcium carbonate; black and golden corals are made of a horn-like substance called conchiolin. Red coral is the most valuable, and has been used in jewellery for thousands of years. Dull at first, all coral has a vitreous lustre when polished, but is sensitive to heat and acids and may fade with wear. Coral may be imitated by porcelain, stained bone, glass, plastic, or rubber and gypsum mixtures.

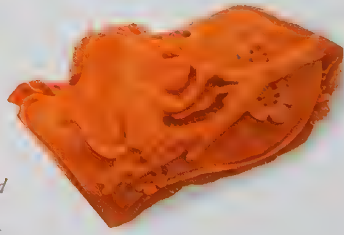
• **OCCURRENCE** Most precious coral is found in warm waters. Japanese coral is red, pink, or white. Red and pink coral is also found on the Mediterranean and African coasts, the Red Sea, and the waters off Malaysia and Japan. Black and golden coral is found off the coasts of the West Indies, Australia, and the Pacific islands.

• **REMARK** Coral has been associated with the protection of children, and parents may still give a gift of coral to their young children.

RED CORAL CABOCHON

RED CORAL SLICE

RED CORAL



RED CORAL CARVING

This piece of red coral (*Corallium rubrum*) from the Mediterranean has been carved to show a monkey climbing a blossoming tree.

SG	RI	DR	Lustre
2.68	1.49–1.66	Not applicable	Dull to vitreous

distinctive pitted surface

Heliopora caerules *coral found in seas around Philippines*

blue coral is often used to make beads

Blue Coral

highly polished surface

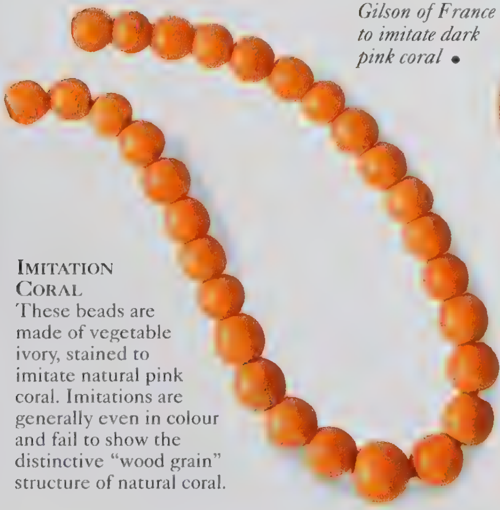
oval cabochon

Black Coral Cabochon

coral colonies naturally form branched, tree-like structures

black coral is made from horn-like conchiolin

Black Coral



Imitation Coral

These beads are made of vegetable ivory, stained to imitate natural pink coral. Imitations are generally even in colour and fail to show the distinctive "wood grain" structure of natural coral.

polished bead manufactured by Gilson of France to imitate dark pink coral

Imitation Coral Bead

imitation slabs may be carved, polished, or fashioned as beads

Imitation Coral

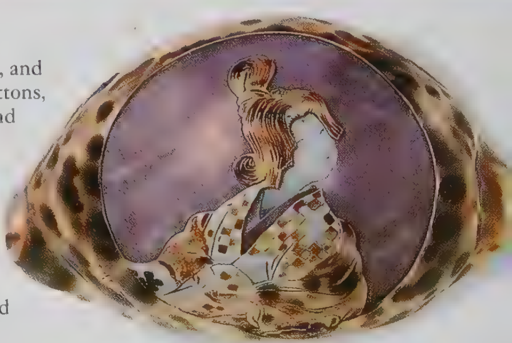
Crystal structure Various	Composition Calcium carbonate	Hardness 2½

SHELL

Shells come in a wide variety of sizes, shapes, and colours, and may be fashioned into beads, buttons, jewellery, inlay, knife handles, snuff boxes, and other decorative items. Conch shells with pink and white layers may be carved into intricate and attractive cameos, as may helmet shells, which have white outer layers and golden brown or orange inner layers. The large pearl oysters (*Pinctada maxima* and *P. margaritifera*), abalones (paua), and topshells (Trochidae) are all prized for their iridescent (mother-of-pearl) shell linings. Tortoiseshell comes, not from the tortoise, but from the hard shell (carapace) of the Hawksbill Turtle. It has rich brown mottling or flame-like patterns on a warm, translucent, golden yellow background, and is fashioned by warming the shell to flatten it and to scrape off the ridges, followed by polishing and cutting to shape.

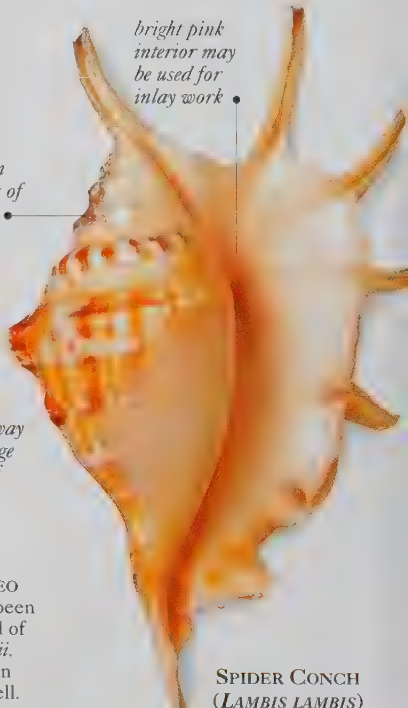
• OCCURRENCE *Pinctada* oysters are found off northern Australia. Abalones are found off the coasts of the USA and paua shells off New Zealand. The Hawksbill Turtle is found in the warm waters of Indonesia and the West Indies.

• REMARK Tortoiseshell has now been largely replaced by plastic imitations.



TIGER COWRIE CAMEO
This oriental lady has been carved in a Tiger Cowrie shell (*Cypraea tigris*). The different coloured layers have been cut away to create the effect of foreground and background.

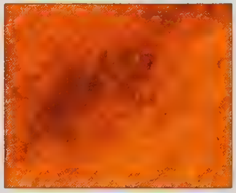
ROMAN CAMEO
This cameo has been carved into the shell of *Cassidae madagascarensii*. The detail is picked out in the upper layers of the shell.



SPIDER CONCH (*LAMBIS LAMBIS*)

SG 1.30	RI 1.53–1.69	DR Not applicable	Lustre Dull to vitreous

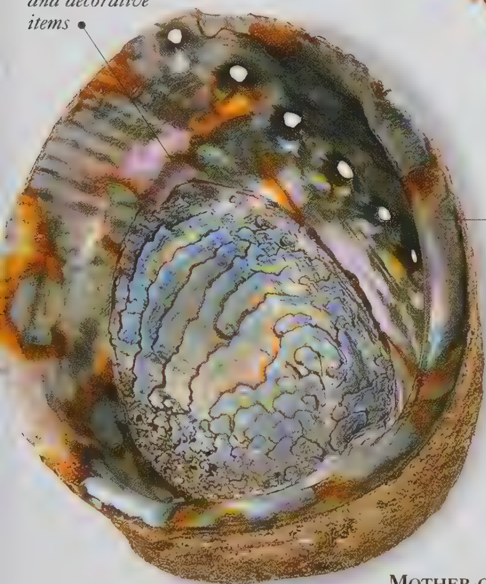
HINGED BOX
The lid and base of this box show the distinctive colouring and patterning of tortoiseshell. Some light areas are transparent to semi-translucent; darker areas are opaque.



When magnified, spots can be seen in natural, but not in imitation, tortoiseshell.

HAIR COMB
This tortoise-shell comb shows attractive, almost fiery, patterns of yellow and brown, with darker patches.

TORTOISESHELL (CARAPACE OF HAWKSBILL TURTLE)



MOTHER-OF-PEARL SHELL

SHELL PILL-BOX
The inlay in the lid of this pill-box has been fashioned from the layered, iridescent lining of a shell from the Haliotis family of shellfish.

Crystal structure	Composition	Hardness
Amorphous	Calcium hydroxyphosphate and organic	2½

IVORY

Ivory has been prized for thousands of years for its rich, creamy colour, its fine texture, and its ease of carving. Until quite recently it was a popular material for both jewellery and ornaments, but international restrictions on trading now help to protect the animals from which ivory can be taken. The teeth or tusks of mammals all have ivory as a constituent. Although usually associated with elephants, ivory from the Hippopotamus, Wild Boar, and Warthog is also used. Marine mammals such as the Sperm Whale, Walrus, Sea Lion, and Narwhal provide ivory as well. Fossil ivory – from prehistoric animals such as mammoths, mastodons, or dinosaurs – can also be carved.

• **OCCURRENCE** The best ivory is from the African Elephant. It has a warm tint and little grain or mottling. Ivory from the Indian Elephant is a denser white, softer, and easier to work, but yellows more easily. Other sources of ivory include Europe, Burma, and Indonesia.

• **REMARK** The use of ivory simulants – bone, horn, jasper, vegetable ivory, plastic, and resin – has been strongly encouraged in order to protect ivory-bearing animals. Ivory carving has a long history: one piece of carved mammoth ivory found in France is estimated to be over 30,000 years old. In China and Japan it remains highly valued, even today.

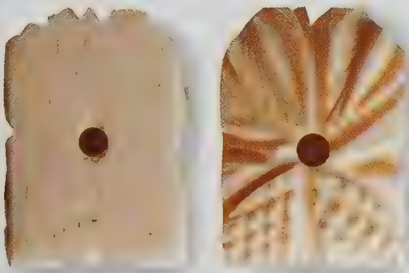
INDIAN ELEPHANT IVORY
This intricately fashioned scene was probably carved from the tusk of an Indian Elephant, whose ivory is softer and whiter than the African Elephant's.

AFRICAN ELEPHANT IVORY
Made from warm, mellow African Elephant ivory, this Roman head is worked in the style popular in the 4th to 5th century BC.

ELEPHANT IVORY CUP
Looking down into this cup, the criss-crossing, curving pattern unique to elephant ivory is visible.

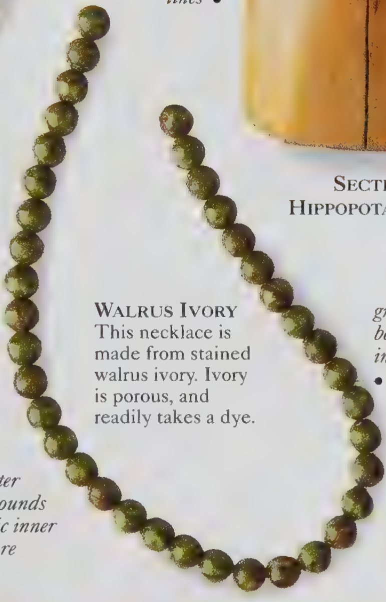
POLISHED SECTION OF ELEPHANT TOOTH

SG	RI	DR	Lustre
1.90	1.53–1.54	Not applicable	Dull to greasy



DRILLED BONE
Bone may be used as an ivory simulant. These two pieces have been worked as buttons or beads, with a plain back and carved front.

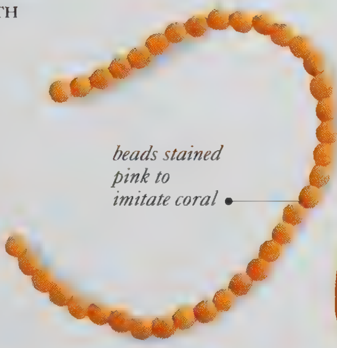
SECTION OF HIPPOPOTAMUS TUSK



WALRUS IVORY
This necklace is made from stained walrus ivory. Ivory is porous, and readily takes a dye.

PART OF WHALE TOOTH

VEGETABLE IVORY
This necklace is made of polished and drilled vegetable ivory beads, given a pale, artificial stain to imitate coral. Imitation ivory is now encouraged, as more and more ivory-bearing animals face premature extinction.



VEGETABLE IVORY IN SHELL

Crystal structure	Composition	Hardness
Amorphous	Mixture of organic plant resins	2½

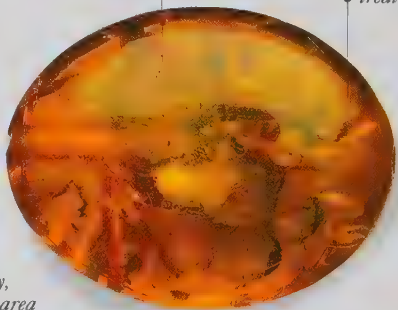
AMBER

Amber is the fossilized resin of trees. Most amber is golden yellow to golden orange, but green, red, violet, and black amber has been found. Transparent to translucent, it usually occurs as nodules or small, irregularly shaped masses, often with a cracked and weathered surface. Amber may contain insects (and more rarely frogs, toads, and lizards), moss, lichen, or pine needles that were trapped millions of years ago while the resin was still sticky. Air bubbles may give amber a cloudy appearance, but heating in oil will clear this. When rubbed, amber produces a negative electrical charge that attracts dust. "Ambroid" is formed by heating and pressing together scraps of amber.

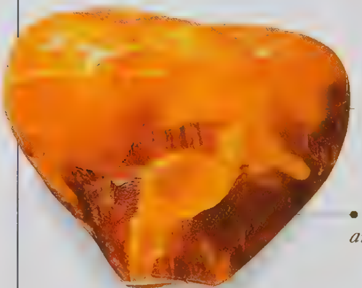
• **OCCURRENCE** The most famous deposits are in the Baltic region, particularly along the coasts of Poland and the former USSR. Baltic amber (known as succinite) washed from the seabed may reach as far as the coasts of England, Norway, and Denmark. Amber from Burma is called burmite; Sicilian amber is known as simetite. Other localities include the Dominican Republic, Mexico, France, Spain, Italy, Germany, Romania, Canada, Czechoslovakia, and the USA.

• **REMARK** Amber has had a number of medicinal uses attributed to it, but today is used almost exclusively for jewellery. It has been imitated by plastic, glass, synthetic resin, and other natural resins, like copal.

POLISHED BEADS



POLISHED SUN-SPANGLED BEAD



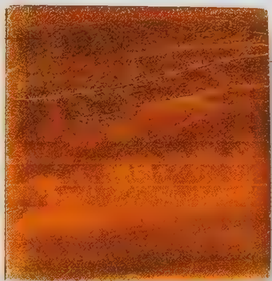
PARTLY POLISHED AMBER

BALTIC AMBER ROUGH

SG	RI	DR	Lustre
1.08	1.54–1.55	Not applicable	Resinous

ROMAN BEAD FOUND IN RIVER SILT

FLY IN AMBER



SQUARE AMBROID

BEAD NECKLACE
Some of the 31 drilled, cut, and polished amber beads that make up this necklace show signs of dehydration. This is a common problem with amber jewellery, which will dry out if left in the sun or worn in the heat of the day.

AMBER ORNAMENT
This Chinese ear ornament has been worked in the shape of a panda bear. The cracked surface is due to dehydration of the stone.

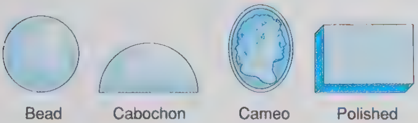


Table of Properties

THIS TABLE BRINGS TOGETHER all the technical information for each gem species, arranged alphabetically by gem name. By so doing, it is intended to give the reader an at-a-glance reference to the more important physical and optical properties of each gem species.

The chemical composition of each gem is shown here by a formula, which includes all essential elements of that gem. Composition may vary slightly, depending on locality and conditions of formation. The physical properties of the gems – their hardness and specific gravity – are given as mean (average) values. Hardness is denoted by a figure from Mohs' scale of hardness, a scale used to classify the hardness of minerals relative to one another. The intervals between successive values are unequal, and an intermediate value such as 3½ denotes that the hardness is between 3 and 4, but it is not necessarily exactly halfway between. Hardness may vary slightly depending upon exact chemical content, so a mean figure is given here. The values for specific gravity (SG) give an indication of the density of a gem, and are also given as mean figures.

The optical properties of the gems are represented here by the refractive indices (RI) and the birefringence (DR). They are related to crystal structure: a gem with cubic structure has a single value as its refractive index (RI); doubly refracting gems have two refractive indices (see p.21). Doubly refracting gems also have a value of birefringence (DR), found by using a refractometer. This figure is the difference between the highest and the lowest refractive indices. Physical and optical properties are continually reviewed, as new minerals are discovered and new deposits exploited, so all figures given here are mean values, to be used as a guide only.

Key to Chemical Elements in this Book

Al	Aluminium	Mg	Magnesium
Ag	Silver	Mn	Manganese
Au	Gold	Na	Sodium
B	Boron	O	Oxygen
Ba	Barium	P	Phosphorus
Be	Beryllium	Pb	Lead
C	Carbon	Pt	Platinum
Ca	Calcium	S	Sulphur
Cl	Chlorine	Si	Silicon
Cr	Chromium	Sn	Tin
Cu	Copper	Sr	Strontium
F	Fluorine	Ti	Titanium
Fe	Iron	W	Tungsten
H	Hydrogen	Zn	Zinc
K	Potassium	Zr	Zirconium
Li	Lithium		

Name & Chemical Composition	Structure	Hardness	SG	RI	DR
Achroite (Tourmaline) $Na(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$	Trigonal	7½	3.06	1.62–1.64	0.018
Agate (Chalcedony) SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
Albite $(Na,Ca)AlSi_3O_8$	Triclinic	6	2.64	1.54–1.55	0.009
Almandine (Garnet) $Fe_3Al_2(SiO_4)_3$	Cubic	7½	4.00	1.76–1.83	None
Amber mainly $C_{10}H_{16}O$	Amorphous	2½	1.08	1.54–1.55	N/A

NAME & CHEMICAL COMPOSITION	STRUCTURE	HARDNESS	SG	RI	DR
AMBLYGONITE $LiAl(F,OH)PO_4$	Triclinic	6	3.02	1.57–1.60	0.026
AMETHYST (QUARTZ) SiO_2	Trigonal	7	2.65	1.54–1.55	0.009
ANDALUSITE Al_2SiO_5	Orthorhombic	7½	3.16	1.63–1.64	0.010
ANDRADITE GARNET $Ca_3Fe_2(SiO_4)_3$	Cubic	6½	3.85	1.85–1.89	None
ANGLESITE $PbSO_4$	Orthorhombic	3	6.35	1.87–1.89	0.017
APATITE $Ca(F,Cl)Ca_4(PO_4)_3$	Hexagonal	5	3.20	1.63–1.64	0.003
AQUAMARINE (BERYL) $Be_3Al_2(SiO_3)_6$	Hexagonal	7½	2.69	1.57–1.58	0.006
ARAGONITE $CaCO_3$	Orthorhombic	3½	2.94	1.53–1.68	0.155
AVENTURINE QUARTZ SiO_2	Trigonal	7	2.65	1.54–1.55	0.009
AXINITE $CaFeMgBAl_2Si_4O_{15}(OH)$	Triclinic	7	3.28	1.67–1.70	0.011
AZURITE $Cu_3(OH)_2(CO_3)_2$	Monoclinic	3½	3.77	1.73–1.84	0.110
BARYTE $BaSO_4$	Orthorhombic	3	4.45	1.63–1.65	0.012
BENITOITE $BaTiSi_3O_9$	Hexagonal	6½	3.67	1.76–1.80	0.047
BERYLLONITE $NaBePO_4$	Monoclinic	5⅕	2.83	1.55–1.56	0.009
BLOODSTONE (CHALCEDONY) SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
BRAZILIANITE $Al_3Na(PO_4)_2(OH)_4$	Monoclinic	5½	2.99	1.60–1.62	0.021
BROWN QUARTZ (SMOKY QUARTZ) SiO_2	Trigonal	7	2.65	1.54–1.55	0.009
CALCITE $CaCO_3$	Trigonal	3	2.71	1.48–1.66	0.172
CARNELIAN (CHALCEDONY) SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
CASSITERITE SnO_2	Tetragonal	6½	6.95	2.00–2.10	0.100
CELESTINE $SrSO_4$	Orthorhombic	3½	3.98	1.62–1.63	0.010
CERUSSITE $PbCO_3$	Orthorhombic	3½	6.51	1.80–2.08	0.274
CHALCEDONY SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
CHATOYANT QUARTZ SiO_2	Trigonal	7	2.65	1.54–1.55	0.009
CHRYSOBERYL $BeAl_2O_4$	Orthorhombic	8½	3.71	1.74–1.75	0.009

NAME & CHEMICAL COMPOSITION	STRUCTURE	HARDNESS	SG	RI	DR
CHRYSOCOLLA $(Cu,Al)_2H_2Si_2O_5(OH)_4.nH_2O$	Monoclinic	2	2.20	1.57–1.63	0.030
CHRYSOPRASE (CHALCEDONY) SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
CITRINE (QUARTZ) SiO_2	Trigonal	7	2.65	1.54–1.55	0.009
CORAL $CaCO_3$ (or $C_3H_{48}N_9O_{11}$)	Trigonal	3	2.68	1.49–1.66	N/A
DANBURITE $CaB_2(SiO_4)_2$	Orthorhombic	7	3.00	1.63–1.64	0.006
DATOLITE $Ca(B,OH)SiO_4$	Monoclinic	5	2.95	1.62–1.65	0.044
DIAMOND C	Cubic	10	3.52	2.42	None
DIOPSIDE $CaMg(SiO_3)_2$	Monoclinic	5½	3.29	1.66–1.72	0.029
DIOPTASE $CuOSiO_2H_2O$	Trigonal	5	3.31	1.67–1.72	0.053
DOLOMITE $CaMg(CO_3)_2$	Trigonal	3½	2.85	1.50–1.68	0.179
DRAVITE (TOURMALINE) $NaMg_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$	Trigonal	7½	3.06	1.61–1.63	0.018
DUMORTIERITE $Al_7(BO_3)(SiO_4)_3O_3$	Orthorhombic	7	3.28	1.69–1.72	0.037
EMERALD (BERYL) $Be_3Al_2(SiO_3)_6$	Hexagonal	7½	2.71	1.57–1.58	0.006
ENSTATITE $Mg_2Si_2O_6$	Orthorhombic	5½	3.27	1.66–1.67	0.010
EPIDOTE $Ca_2(Al,Fe)_3(OH)(SiO_4)_3$	Monoclinic	6½	3.40	1.74–1.78	0.035
EUCLASE $Be(Al,OH)SiO_4$	Monoclinic	7½	3.10	1.65–1.67	0.019
FIRE AGATE (CHALCEDONY) SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
FLUORITE CaF_2	Cubic	4	3.18	1.43	None
GOLD Au	Cubic	2½	19.30	None	None
GOSHENITE (BERYL) $Be_3Al_2(SiO_3)_6$	Hexagonal	7½	2.80	1.58–1.59	0.008
GROSSULAR (GARNET) $Ca_3Al_2(SiO_4)_3$	Cubic	7	3.49	1.69–1.73	None
GYPSUM $CaSO_4.2H_2O$	Monoclinic	2	2.32	1.52–1.53	0.010
HAMBERGITE $Be_2(OH)BO_3$	Orthorhombic	7½	2.35	1.55–1.63	0.072
HAUYNE $(Na,Ca)_{4-8}Al_6Si_6(O,S)_{24}(SO_4Cl)_{1-2}$	Cubic	6	2.40	1.50 (mean)	None
HELIODOR (BERYL) $Be_3Al_2(SiO_3)_6$	Hexagonal	7½	2.80	1.57–1.58	0.005

NAME & CHEMICAL COMPOSITION	STRUCTURE	HARDNESS	SG	RI	DR
HEMATITE Fe_2O_3	Trigonal	6½	5.20	2.94–3.22	0.280
HESSONITE (GROSSULAR GARNET) $Ca_3Al_2(SiO_4)_3$	Cubic	7¼	3.65	1.73–1.75	None
HOWLITE $C_2B_5SiO_9(OH)_5$	Monoclinic	3½	2.58	1.58–1.59	0.022
HYPERSTHENE $(Fe,Mg)SiO_3$	Orthorhombic	5½	3.35	1.65–1.67	0.010
INDICOLITE (TOURMALINE) $Na(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$	Trigonal	7½	3.06	1.62–1.64	0.018
IOLITE $Mg_2Al_4Si_5O_{18}$	Orthorhombic	7	2.63	1.53–1.55	0.010
IVORY $Ca_5(PO_4)_3(OH)$ and organic material	Amorphous	2½	1.90	1.53–1.54	N/A
JADEITE (JADE) $Na(Al,Fe)Si_2O_6$	Monoclinic	7	3.33	1.66–1.68	0.012
JASPER (CHALCEDONY) SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
JET Lignite	Amorphous	2½	1.33	1.64–1.68	N/A
KORNERUPINE $Mg_4(Al,Fe)_6(Si,B)_4O_{21}(OH)$	Orthorhombic	6½	3.32	1.66–1.68	0.013
KYANITE Al_2SiO_5	Triclinic	5 or 7	3.68	1.71–1.73	0.017
LABRADORITE $(Na,Ca)(Al,Si)_4O_8$	Triclinic	6	2.70	1.56–1.57	0.010
LAPIS LAZULI (LAZURITE) $(Na,Ca)_8(Al,Si)_{12}O_{24}(SO_4)Cl_2(OH)_2$	Various	5½	2.80	1.50 (mean)	None
LAZULITE $MgAl_2(PO_4)_2(OH)_2$	Monoclinic	5½	3.10	1.61–1.64	0.031
MALACHITE $Cu_2(OH)_2CO_3$	Monoclinic	4	3.80	1.85 (mean)	0.025
MEERSCHAUM $Mg_4Si_6O_{15}(OH)_2.6H_2O$	Monoclinic	2½	1.50	1.51–1.53	None
MICROCLINE $KAlSi_3O_8$	Triclinic	6	2.56	1.52–1.53	0.008
MILKY QUARTZ SiO_2	Trigonal	7	2.65	1.54–1.55	0.009
MOONSTONE (ORTHOCLASE) $KAlSi_3O_8$	Monoclinic	6	2.57	1.52–1.53	0.005
MORGANITE (BERYL) $Be_3Al_2(SiO_3)_6$	Hexagonal	7½	2.80	1.58–1.59	0.008
NEPHRITE (JADE) $Ca_2(Mg,Fe)_5Si_3O_{22}(OH)_2$	Monoclinic	6½	2.96	1.61–1.63	0.027
OBSIDIAN Mainly SiO_2	Amorphous	5	2.35	1.48–1.51	None
OLIGOCLASE $(Na,Ca)(Al,Si)_4O_8$	Triclinic	6	2.64	1.54–1.55	0.007
ONYX SiO_2	Trigonal	7	2.61	1.53–1.54	0.004

Name & Chemical Composition	Structure	Hardness	SG	RI	DR
Opal $SiO_2.nH_2O$	Amorphous	6	2.10	1.37–1.47	None
Orthoclase $KAlSi_3O_8$	Monoclinic	6	2.56	1.51–1.54	0.005
Padparadscha (Corundum) Al_2O_3	Trigonal	9	4.00	1.76–1.77	0.008
Pearl $CaCO_3,C_3H_{18}N_9O_{11}.nH_2O$	Orthorhombic	3	2.71	1.53–1.68	N/A
Peridot $(Mg,Fe)_2SiO_4$	Orthorhombic	6½	3.34	1.64–1.69	0.036
Petalite $Li_2OAl_2O_38SiO_2$	Monoclinic	6	2.42	1.50–1.51	0.014
Phenakite Be_2SiO_4	Trigonal	7½	2.96	1.65–1.67	0.015
Phosphophyllite $Zn_2(Fe,Mn)(PO_4)_2.4H_2O$	Monoclinic	3½	3.10	1.59–1.62	0.021
Plasma (Chalcedony) SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
Platinum Pt	Cubic	4	21.40	None	None
Prase (Chalcedony) SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
Prehnite $Ca_2Al_2Si_3O_{10}(OH)_2$	Orthorhombic	6	2.87	1.61–1.64	0.016
Pyrite FeS_2	Cubic	6	4.90	None	None
Pyrope (Garnet) $Mg_3Al_2(SiO_4)_3$	Cubic	7¼	3.80	1.72–1.76	None
Rhodochrosite $MnCO_3$	Trigonal	4	3.60	1.60–1.80	0.220
Rhodonite $(Mn,Fe,Mg,Ca)SiO_3$	Triclinic	6	3.60	1.71–1.73	0.014
Rock Crystal (Quartz) SiO_2	Trigonal	7	2.65	1.54–1.55	0.009
Rose Quartz SiO_2	Trigonal	7	2.65	1.54–1.55	0.009
Rubellite (Tourmaline) $Na(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$	Trigonal	7½	3.06	1.62–1.64	0.018
Ruby (Corundum) Al_2O_3	Trigonal	9	4.00	1.76–1.77	0.008
Rutile TiO_2	Tetragonal	6	4.25	2.62–2.90	0.287
Sapphire (Corundum) Al_2O_3	Trigonal	9	4.00	1.76–1.77	0.008
Sard SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
Sardonyx (Chalcedony) SiO_2	Trigonal	7	2.61	1.53–1.54	0.004
Scapolite $Na_4Al_3Si_9O_{24}Cl–Ca_4Al_6Si_6O_{24}(CO_3,SO_4)$	Tetragonal	6	2.70	1.54–1.58	0.020

NAME & CHEMICAL COMPOSITION	STRUCTURE	HARDNESS	SG	RI	DR
SCHEELITE $CaWO_4$	Tetragonal	5	6.10	1.92–1.93	0.017
SCHORL (TOURMALINE) $NaFe_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$	Trigonal	7½	3.06	1.62–1.67	0.018
SERPENTINE $Mg_6(OH)_8Si_4O_{10}$	Monoclinic	5	2.60	1.55–1.56	0.001
SHELL $CaCO_3$ and $C_{32}H_{48}N_2O_{11}$	Various	2½	1.30	1.53–1.69	N/A
SILLIMANITE Al_2SiO_5	Orthorhombic	7½	3.25	1.66–1.68	0.019
SILVER Ag	Cubic	2½	10.50	None	None
SINHALITE $Mg(Al,Fe)BO_4$	Orthorhombic	6½	3.48	1.67–1.71	0.038
SMITHSONITE $ZnCO_3$	Trigonal	5	4.35	1.62–1.85	0.230
SODALITE $3NaAlSiO_4NaCl$	Cubic	5½	2.27	1.48 (mean)	None
SPESSARTINE (GARNET) $Mn_3Al_2(SiO_4)_3$	Cubic	7	4.16	1.79–1.81	None
SPHALERITE (Zn,Fe)S	Cubic	3½	4.09	2.36–2.37	None
SPINEL $MgAl_2O_4$	Cubic	8	3.60	1.71–1.73	None
SPODUMENE $LiAl(SiO_3)_2$	Monoclinic	7	3.18	1.66–1.67	0.015
STAUROLITE $(Fe,Mg,Zn)_2Al_9(Si,Al)_4O_{22}(OH)_2$	Orthorhombic	7	3.72	1.74–1.75	0.013
TAAFFEITE $BeMg_3Al_8O_{16}$	Hexagonal	8	3.61	1.72–1.77	0.004
TEKTITES Mainly SiO_2	Amorphous	5	2.40	1.48–1.51	None
TITANITE (SPHENE) $CaTiSiO_5$	Monoclinic	5	3.53	1.84–2.03	0.120
TOPAZ $Al_2(F,OH)_2SiO_4$	Orthorhombic	8	3.54	1.62–1.63	0.010
TUGTUPITE $Na_4AlBeSi_4O_{12}Cl$	Tetragonal	6	2.40	1.49–1.50	0.006
TURQUOISE $CuAl_6(PO_4)_4(OH)_8.5H_2O$	Triclinic	6	2.80	1.61–1.65	0.040
UVAROVITE (GARNET) $Ca_3Cr_2(SiO_4)_3$	Cubic	7½	3.77	1.86–1.87	None
VESUVIANITE (IDOCRASE) $Ca_6Al(Al,OH)(SiO_4)_5$	Tetragonal	6½	3.40	1.70–1.75	0.005
WATERMELON TOURMALINE $Na(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$	Trigonal	7½	3.06	1.62–1.64	0.018
ZIRCON $ZrSiO_4$	Tetragonal	7½	4.69	1.93–1.98	0.059
ZOISITE $Ca_2(Al,OH)Al_2(SiO_4)_3$	Orthorhombic	6½	3.35	1.69–1.70	0.010

GLOSSARY

WORDS PRINTED in bold type have their own definition elsewhere in the glossary.

• ABSORPTION SPECTRUM
Pattern of dark lines or bands seen when a gem is viewed through a **spectroscope**.

• ALLOCHROMATIC
Refers to gems coloured by impurities, without which the gem would be colourless.

• ALLUVIAL DEPOSITS
Concentrations of material that have been separated by weathering from the host **rock**, then deposited by rivers or streams.

• AMORPHOUS
Without a regular internal atomic structure or external shape.

• ASSOCIATED MINERALS
Minerals found growing together, though not necessarily **intergrown**.

• ASTERISM
Star effect seen on some stones when cut *en cabochon*.

• BASAL PINACOID
Feature relating to **crystal** symmetry. A **columnar** or **prismatic** crystal with flat ends may be referred to as having a basal pinacoid.

• BIREFRINGENCE (DR)
The difference between the highest and the lowest **refractive indices** in **doubly refractive** gems.

• BOTRYOIDAL
Shape similar to a bunch of grapes.

• CABOCHON
Gem cut and polished to have a domed upper surface. Such stones are said to be cut *en cabochon*.

• CAMEO
Design in low relief, around which the background has been cut away.

• CARAT (CT)
Unit of weight used for gems – a carat is one-fifth of a gram. It is also used to describe the purity of gold – pure gold is 24 carat.

• CHATOYANCY
The cat's-eye effect shown by some stones when cut *en cabochon*.

• CLEAVAGE
Breaking of a stone along lines of weakness related to the internal atomic structure. *See also* **Fracture**.

• COLUMNAR
Type of **habit** in which **crystals** form in the shape of columns (elongated prisms).

• COMPOSITE STONE
Stone assembled from several pieces, often to imitate a gem.

• CONCHOIDAL FRACTURE
Shell-like fracture. *See* **Fracture**.

• CROWN
Top part of a cut stone, above the **girdle**.

• CRYPTOCRYSTALLINE
Mineral structure in which **crystals** are so small they are not distinguishable with a microscope.

• CRYSTAL
Solid that has a definite internal atomic structure, producing a characteristic external shape and physical and optical properties.

• CRYSTAL STRUCTURE
Internal atomic structure of a **crystal**. All crystalline gems may be classified in one of seven groups, according to the symmetry of their structure: cubic, tetragonal, hexagonal, trigonal, orthorhombic, monoclinic, and triclinic.

• CUT
Term used to describe the way in which a **stone** is faceted. *See also* **Faceting**.

• DICHROIC
Refers to a gem that appears two different colours or shades when viewed from different directions.

• DIFFRACTION
The splitting of white light into its constituent spectral colours – the colours of the rainbow – when it passes through a hole or grating.

• DISPERSION
The splitting of white light into its constituent spectral colours – the rainbow colours – when it passes through inclined surfaces, such as those on a **prism** or **faceted** gem. Dispersion in gems is called fire.

• DOUBLE REFRACTION (DR)
Phenomenon in which each ray of light is split in two as it enters a non-cubic **mineral**. Each ray travels at a different speed and has its own **refractive index**. *See also* **Birefringence**.

• DOUBLET
Composite stone made of two pieces cemented or glued together.

• EVAPORITE DEPOSIT
Sedimentary rock or **mineral** resulting from the evaporation of water from mineral-bearing fluids, usually sea water.

• FACES
Flat surfaces that make up the external shape of a **crystal**.

• FACET
Surface of a cut and polished gem.

• FACETING
Cutting and polishing of the surfaces of a **gemstone** into **facets**. The number and shape of the facets give the stone its style of **cut**.

• FANCY-CUT
Name applied to a stone given an unconventional shape when cut.

• FIRE
See **Dispersion**.

• FRACTURE
Chipping or breaking of a stone in a way unconnected to the internal atomic structure. Because of this, fracture surfaces are usually uneven. *See also* **Cleavage**.

• GEMSTONE
Decorative material, usually a **mineral**, prized for some or all of the qualities of beauty, durability, and rarity. It is used synonymously with "gem" and "stone" throughout this book.

• GEODE
Cavity within a **rock**, in which **crystals** line the inner surface and grow towards the centre.

• GIRDLE
Band around the widest part of a cut stone, where the **crown** meets the **pavilion**.

• GRANITE
Coarse-grained **igneous rock** comprising mainly quartz, feldspar, and mica.

• HABIT
Shape in which a **crystal** naturally occurs.

• HARDNESS
See **Mohs' Scale of Hardness**.

• HEAT TREATMENT
Application of heat to a gem with the purpose of enhancing the colour or clarity.

• HYDROTHERMAL
Refers to processes that involve the alteration or deposition of minerals by water heated by igneous activity.

• IDIOCHROMATIC
Describes gems whose colour is due to elements that are an essential part of their chemical composition.

• IGNEOUS ROCKS
Rocks formed from erupted volcanic **lava** or solidified **magma**.

• **Imitation gemstone**
Material that has the outward appearance of the gem it is intended to imitate, but which has different physical properties. *See also* **Synthetic gemstone**.
• **Inclusions**
Markings or foreign bodies found within a stone. Some can be used to identify a particular **species**.
• **Intaglio**
Design in which the subject is cut lower than the background.
• **Intergrown**
When two or more **minerals** grow together and become interlocked.
• **Intrusive**
Igneous rock that has solidified within other rocks, below the Earth's surface.
• **Iridescence**
Reflection of light off internal features in a gem, giving rise to rainbow-like play of colours.
• **Lapidary**
Craftsman who cuts and polishes gemstones.
• **Lava**
Molten **rock** erupted from volcanoes. *See also* **Magma**.
• **Lustre**
Shine or "look" of a gemstone due to reflection of light off the surface.
• **Magma**
Rock in a molten state below the Earth's surface. *See also* **Lava**.
• **Mammillated**
Smooth, rounded shape.
• **Massive**
Used to describe **minerals** that have an indefinite shape, or that consist of small **crystals** in masses.
• **Matrix**
The **rock** in which a gem is found. Also known as host or parent rock.
• **Metamict**
Refers to material that is breaking down from a crystalline to an **amorphous** state, due to the presence of radioactive elements.
• **Metamorphic rocks**
Rocks that have been changed by heat and/or pressure to form new rocks consisting of new **minerals**.
• **Microcrystalline**
Mineral structure in which **crystals** are too small to be detected by the naked eye.
• **Minerals**
Inorganic, naturally occurring materials with a constant chemical composition and regular internal atomic structure.
• **Mixed-cut**
Cut in which the **facets** above and below the **girdle** are styled in different ways – usually **brilliant-cut** above and **step-cut** below.
• **Mohs' scale of hardness**
Measure of a **mineral**'s hardness in relation to other minerals, based on its ability to resist scratching.
• **Opalescence**
Milky blue form of **iridescence**.
• **Ore**
Rock that contains metals capable of being extracted commercially.
• **Organic gem**
Gem made by or derived from living organisms.
• **Parti-coloured**
Used to describe single **crystals** made of different coloured parts.
• **Paste**
Glass made to **imitate** gems.
• **Pavilion**
Lower part of a cut stone, below the **girdle**.
• **Pegmatite**
An **igneous rock** formed as residual liquids from **magma** cool, often forming large **crystals**.
• **Placer deposit**
Concentrated (**secondary**) deposit of minerals, usually in rivers or seas.
• **Platy**
Habit characterized by flat, thin, plate-like **crystals**.
• **Pleochroic**
Term used to describe a gem that appears two or more different colours or shades when viewed from different directions.
• **Polycrystalline**
Refers to a **mineral** made of many small **crystals**.
• **Primary deposit**
Material still in its original **rock**. *See also* **Secondary deposit**.
• **Prismatic**
Habit in which parallel pairs of rectangular **faces** form prisms.
• **Pseudomorph**
One **mineral** occurring in the crystal shape of another.
• **Refraction**
Bending of light as it passes from air into a different medium.
• **Refractive index (RI)**
Measure of the slowing down and bending of light rays as they enter a **gemstone**. May be used to identify individual gem **species**.
• **Refractometer**
Apparatus used to measure the **refractive indices** of gems.
• **Rhomb**
Shape rather like a skewed cube.
• **Rock**
Material made up of one or more **minerals**.
• **Rough**
Term used to describe a **rock** or **crystal** still in its natural state, before **faceting** or polishing.
• **Schiller/Sheen**
Form of **iridescence**.
• **Schist**
Metamorphic rock in which the **crystals** are in parallel arrangement.
• **Secondary deposit**
Gems or **minerals** that have been separated from their original **rock** and re-deposited elsewhere. *See also* **Primary deposit**.
• **Sedimentary rocks**
Rocks formed by the consolidation and hardening of **rock** fragments, organic remains, or other material.
• **Species**
Used in this book to refer to individual gems that have distinct characteristics which may be defined and verified.
• **Specific gravity (SG)**
Density, measured as the weight of the material compared with that of an equal volume of water.
• **Spectroscope**
Instrument used to view the **absorption spectra** of **gemstones**.
• **Step-cut (or Trap-cut)**
Cut characterized by a rectangular **table facet** and **girdle**, with rectangular facets parallel to these.
• **Stone**
Term used for any **gemstone**.
• **Striation**
Parallel scratch, groove, or line.
• **Symmetry, axis of**
Imaginary line through a **crystal**. If the crystal were rotated about the axis it would present an identical aspect two or more times in a rotation of 360 degrees.
• **Synthetic gemstone**
Laboratory-made stone whose chemical composition and optical properties are similar to those of its natural equivalent.
• **Table facet**
Central **facet** on a gem's **crown**.
• **Trichroic**
Refers to a gem that appears three different colours or shades when viewed from different directions.
• **Vitreous**
Glass-like (used to describe **lustre**).

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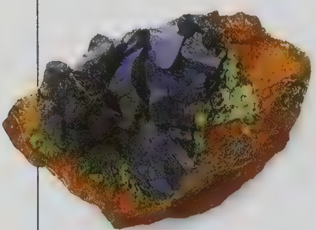

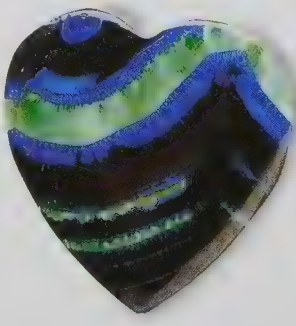

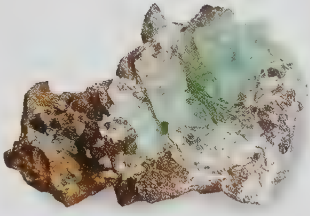

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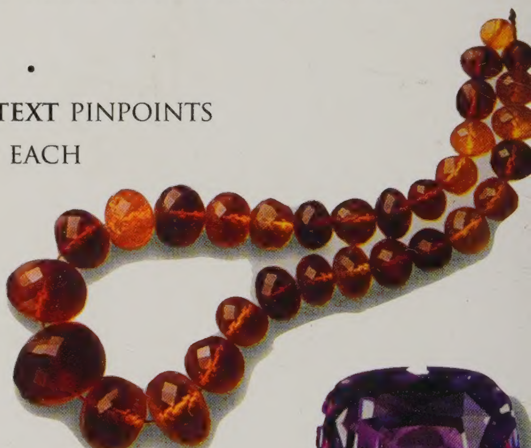

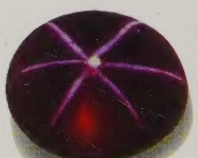

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