



# The unique properties of our most valued gemstone

Peter Simpson

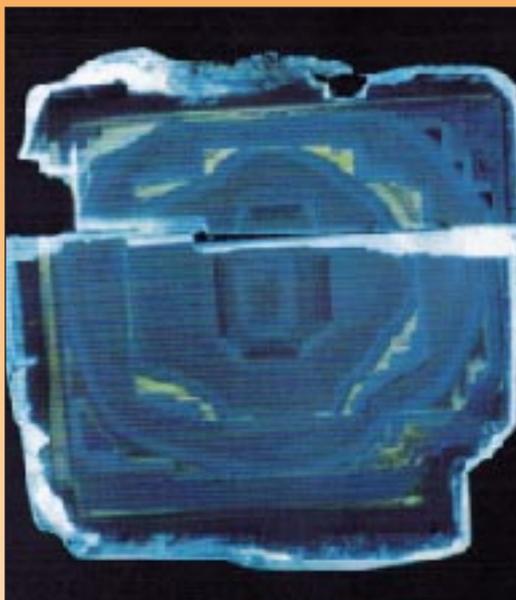
Keyworth

**D**iamond is a very rare mineral. It is the hardest substance known in the universe and the oldest known gemstone on planet Earth. It is prized above all other gemstones for its exceptionally high lustre, spectacular fire and intrinsic hardness and durability. These characteristics ensure diamond's pride of place, as a highly distinctive personal decoration and as a convenient, portable storage of wealth. Diamond is also the basis of many industrial applications which underpin crucial areas of modern science and technology, ranging from space exploration to use as a die or as a tool for working other hard materials (including diamond itself). Without diamond, modern industry would literally grind to a halt.

## History

The history of diamond as a gemstone originated in India before the sixth century AD — perhaps as early as the fourth century BC. Natural, transparent octahedra, which generated strong fire were highly prized by monarchs. The stones were imbued with a range of mystical, magical and religious forces which not only signified the status of

# Forever diamonds



*Luminescence of a polished diamond plate (2.7 mm across) when bombarded with electrons (cathodoluminescence). Viewed in ordinary light, this stone would be colourless and transparent, but the cathodoluminescence displays a series of zones illustrating the complex growth history of the diamond. The growth zones relate to differential uptake of nitrogen during growth, bright blue zones being high in nitrogen and green zones low in nitrogen. The diamond is a natural one from Bultfontein mine, Kimberley, South Africa, formed at 150–200 km below the Earth's surface. Photo: Ben Harte and Jeff Harris, Universities of Edinburgh and Glasgow.*

the wearer but also had the power to influence the ultimate fate of the wearer, a quasi-spiritual status which has attached to diamonds through the ages and persists into the modern era.

## Mineralogy of carbon

Carbon comes in many physical forms, but when it is naturally subjected to high temperatures and pressures (in excess of 1000°C and 50 kilobars) it forms diamond. These conditions are found in, and are characteristic of, the upper mantle, deep beneath the Earth's continental crust. Diamond is the cubic, high-pressure polymorph of graphite, lonsdaleite and buckminsterfullerene, and is metastable at room temperatures (beware — diamond will burn when heated in air).

When the conditions of high temperature and high pressure are reproduced in the laboratory it is possible to produce synthetic diamond grit and synthetic gem diamond from appropriate starting materials. These methods are presently used to generate small quantities of synthetic gem diamond. More importantly, a high proportion of the diamond abrasive and cutting material used by industry is synthetic, since the form of the diamond product can be precisely controlled, replicated and optimised for industrial use.

## Geological setting of diamonds

Diamonds are found in vertical, discordant, pipe-like intrusions of rocks such as kimberlite and lamproite, located in cratons (areas of ancient, stable continental crust). Economically important diamond-bearing kimberlites are mostly located in archons, which are the oldest (more than 2.5 billion years old) components of cratons (e.g. Kaapvaal, South Africa). Protons (1.6–2.5 billion years old) are less likely to contain diamond pipes; such economic pipes as are

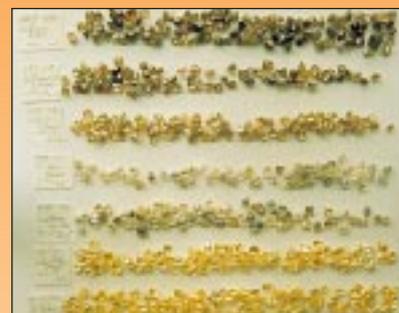


Photo: De Beers

## Coloured diamond in the rough

*Diamond occurs in nature in a wide range of natural colours attributable to the effect of chemical impurities which cause differential absorption of white light and hence colour. Yellow is a common colour, but the most valuable gemstones are generally pure white and flawless.*

present are likely to be lamproite (e.g. Argyle Mine, Australia). The younger components of cratons (800 million to 1.6 billion years old) are called tectons and probably contain neither kimberlites nor lamproites.

Diamonds are usually redistributed from pipes, by uplift, weathering, transport and sedimentation, into secondary placers, both on land and in near-coastal zones (a good example of the latter is on the Namibian coast).



Photo: De Beers

#### Rough diamond octahedra

A packet of natural, rough octahedral diamond crystals of the type which first attracted the attention of man, due to their well-formed crystal shape, exceptionally high lustre, spectacular fire and intrinsic hardness and durability combined with resistance to wear. The earliest use of diamond as a gemstone probably involved wearing such stones uncut in their natural form.

### Gem diamonds: the four Cs

The quality of polished gem diamonds is assessed internationally using the following independent criteria: carat (weight), colour, clarity and cut. These characteristics are well defined and form a common basis for comparison throughout the world. They can be determined directly on unmounted stones by visual examination followed, where necessary, by standard laboratory procedures.

In assessing the quality of a diamond, there is no substitute for knowledge and experience. Diamantaires (who are experts in the visual evaluation of diamonds) are often able to perform much of what is required for a preliminary evaluation of a diamond, leading to an assessment of its quality and price,

with no equipment other than a good quality x10 loupe or lens. The study of gem diamonds is one of the few remaining areas of mineral science where a good eye and brain with relevant knowledge, experience and qualifications, allied to a portable pocket instrument, is sufficient for most purposes of identification and evaluation.



Photo: De Beers

#### Rough diamonds by the shovelfull

The world diamond market in rough stones is managed in large part by the Central Selling Organisation, which is designed to ensure an orderly market and smoothes out the swings between supply, demand and prices of rough stones. The market in cut stones is however unregulated and therefore more sensitive to market conditions.



Photo: De Beers

#### Rough diamond shapes

A packet of natural rough sub-rounded diamond crystals called 'shapes'. The curved faces of many of these stones are attributable to resorption of the natural octahedral faces, which occurs when diamond is no longer stable. Geological processes are responsible for controlling the high-temperature and high-pressure diamond stability field in the upper mantle.



Photo: De Beers

#### There are diamonds and diamonds

The three separate packages of natural uncut rough diamonds are each valued at half a million dollars (US), illustrating the very wide range which exists in the commercial value between industrial-grade material and top quality gemstones. Much of the appraisal and classification of rough diamonds into more than 6000 categories is therefore concerned with the evaluation of each stone by carat weight, colour and clarity.