Bill's Rocks and Minerals
OPAL

Opal is a mineraloid that can be highly complex in composition, and very varied in physical appearance. Although opal has the appearance of a mineral, it lacks the crystalline structure that defines a mineral. It is hydrated silica, or more correctly a hydrated amorphous form of silica, and has the chemical formula of SiO_2 nH_20 Hydrated because it has a water content, and amorphous because it has a non-crystalline structure. The water content is usually between 6% to 10% but can be as low as 3% and as high as 21%.

The formation of opal is a very slow process, and is the result of the accumulation of silica gel in underground crevices and cavities. Australia is the source of over 90% of the worlds precious opal, and the process which created the silica gel has been subject to debate, but recent new research published in the Australian Journal of Earth Sciences has put forward the most likely theory. Between 100 and 97 million years ago during the Cretaceous period, a large area of central Australia was covered by the Eromanga sea. **(Fig. 1).** As the sea retreated, increased acidity levels at shallow depth released silica through the weathering process of sandstone. As the sea level lowered, further weathering then lowered the acidity, and conditions were created, which allowed precious opal to fill cavities and crevices in the dried up sea bed, even at shallow depths. The cavities and crevices in the seabed occurred for a variety of reasons, The main reason was leaching of carbonates from the rocks, and from fossil remains. Another reason was the formation of voids in ironstone nodules. Cavities were also created as the result of minor, and sometimes major faulting.

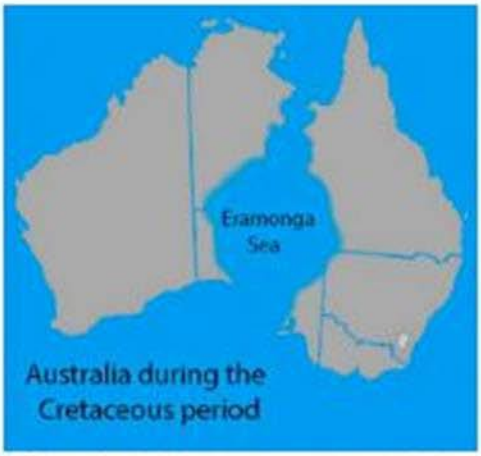

Fig. 1 © Creative commons by Bubbles.org

The basic requirements for the formation of opal have now been described, a source of silica rich fluid, and cavities to accept the fluid.

There are two basic classes of opal, common opal, commonly called "Potch" by miners and precious opal, both of which produce a number of different varieties. The way that silica gel is deposited, and eventually converted to a solid, determines both the class and variety of opal.

The silica rich fluid deposits silica in the form of microscopic spheres,**(Fig. 2)** and it is at this point that the class of opal is determined. The spheres can be deposited in a very orderly fashion, layer by layer, and providing the spheres are regular in size, refraction of light takes place, and precious opal is formed. **(Fig. 3)** However, if the deposition is irregular, and the spheres vary in size, refraction does not take place, and common opal is formed.

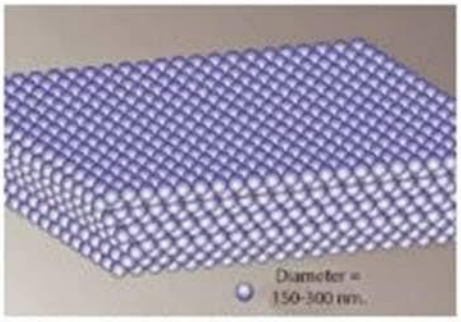

***Fig. 2** Idealised molecular structure of precious opal: an orderly array of silicon dioxide spheres. ©Dpulitzer/Creative Commons.*

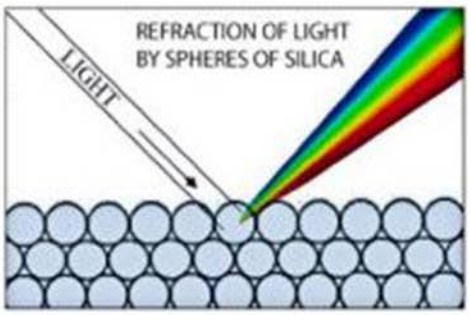

Fig.3

Opal can only form at relatively shallow depths due to limitations imposed by the temperature gradient which states that there is a rise in temperature of approximately 25°C per km of depth. As opal can only form at a maximum temperature of 30°C, it is obvious that it will not form at a depth slightly more than 1km. However these figures may vary slightly due to the influence of local conditions. Local conditions will also determine whether the silica spheres will be deposited in an orderly or disorderly fashion, i.e precious opal, or common opal **(Fig. 4)**.

Even the slightest variation in conditions during deposition has an effect, and for this reason there are different varieties of opal.

Fig. 4 *Common opal, image of unknown provenance.*

Some varieties are easily recognised, and have attracted names which are descriptive of their appearance, but inevitably some opal can only be described as uncategorised. There are far too many varieties to be mentioned in this short article, so the following descriptions are a selection of six of the most well known varieties.

The most sought after type of opal is precious opal, but even here there are different varieties. Black opal is the most sought after variety (**Fig. 5**). Though called black opal, the black is really a reference to any dark background, most often a dark blue, and for this reason it is also referred to as dark opal. It is desirable because the dark background highlights the "play of light".

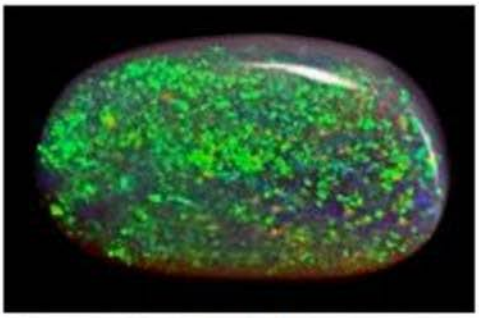

Fig. 5 *Giant black opal by Danmekis.*

In contrast to dark opal, the bulk of precious opal is classed as light opal (**Fig. 6**). This type of opal has a base that is obviously light coloured and may be almost transparent. If the base is very milky in appearance it is sometimes called "milk"opal.

Fig. 6 *Light opal by sevenopal.*

Blue opal is described as a variety exclusively found in Peru, however blue opal is also found on a smaller scale in Slovakia. It is considered to be one of the rarer varieties and is a semi opaque to opaque blue to green stone, which is attractive in it's own right, but even more so when a play of colour is also present (**Fig. 7**).

Fig. 7 *Blue opal by Eva Kröcher.*

Fire opal is really a reference to it's base colour, which can vary between red, orange, and yellow (**Fig. 8**). In all other aspects the opal is no different to dark opal, or light opal. It is said that "beauty is in the eye of the beholder", so different preferences will be expressed by prospective purchasers or collectors.

Fig. 8 *Fire opal by Géry Parent.*

Hyalite is a variety of clear opal which can be called water opal (**Fig. 9**). Mullers opal, or jalite. It exhibits a bubbly appearance, and may occasionally have a touch of colour, probably due to trace impurities. It has a water content between 3% and 8%,and is formed as a volcanic sublimate in volcanic rock. It can be distinguished from silica glass which can have a similar appearance by subjecting it to ultraviolet light, which will cause it to display a bright green fluorescence.

Fig. 9 *Hyalite opal on vesicular porphyritic leucite tephrite by James St. John.*

Almost all opal is deposited in sedimentary rock, However, an exception is boulder opal which is a particular type of opal that is deposited in cracks and crevices in ironstone or ferruginised sandstone boulders and

Fig. 10 *Boulder opal by James St. John.*

Fig. 11 *Matrix opal: Precious opal in basalt (www.mindat.org) by James St. John.*

Fig. 12 *Boulder opal Yowah nut (www.mindat.org) by Robert M Lavinsky.*

concretions. (**Fig. 10**). These deposits are usually very thin , and test the cutters skill in extracting them from the rock. Some boulder

deposits are classed as matrix opal because the opal occurs as a network of infilled voids, or between grains of the host rock (**Fig. 11**). Another type of boulder opal is pipe opal, which as the name suggests is deposited in pipe like structures in the host rock, sometimes several centimetres in diameter. The most unusual type of boulder opal is found exclusively in the Yowah opal field in Queensland, Australia. This precious opal is found as the core in Yowah "nuts" which are ironstone nodules and concretions (**Fig. 12**).

Fig 13 Fossil Wood from my own collection

Although petrified wood is commonly composed of the mineral chalcedony, it can be composed of opal, and it is then called opalised wood (**Fig. 13**). The difference is hard to distinguish by eye, but can be determined by testing specific gravity, hardness, and refractive index. Other fossils can also be opalised, and even major fossils including a complete Mesozoic Pliosaur have been discovered in Coober Pedy, S.Australia (**Fig. 14**).

To summarise, it is obvious that opal is a mineraloid with numerous varieties. It is true that Australia is the worlds main source of opal, but there are other significant deposits in other countries, especially in Ethiopia, Nevada,U.S.A., and Mexico.
Opal may be a well known gemstone, but it is comparatively rare, and only well known because of it's beautiful appearance. It can be manufactured, but the quality obtained falls far short of natural opal.

It is often said that opal can be adversely affected by immersion in water. This is not true, and clean water and mild detergents will not affect opal. However opal is porous, and can be affected by strong common household chemicals such as bleach and cleaning fluids. The recommendation for cleaning is to use lukewarm soapy water and a very soft cloth.It must also be noted that opal has a hardness of 5.5-6.5 on the Mohs scale, but household dust has an average hardness of 7+, so care must be taken when choosing which cloth to use.

Fig. 14 *Opalised Cyrenopsis fossil bivalves by James St. John.*

Reference:
Rey P. F. (2012) *Opalisation of the Great Artesian Basin (central Australia) : an Australian story with a Martian twist. Australian Journal of Earth Sciences, 68 (3), 291-314.*

Postscript

After writing this article I looked at my own collection, and discovered these three specimens, which strangely enough, don't fit neatly into any of the categories mentioned in the article.

Fig. 15 Pinfire Opal.
Opal, SiO_2 nH_20 is a hydrated amorphous form of silica, with a water content between 6% and 10%. Opal is non-crystalline, so it is classed as a mineraloid. Conditions during deposit can determine the gem quality of opal, for instance, if there is undisturbed deposition of identical sized minute spheres of silica, gem quality opal is formed. There is only a hint of "pinfire opal" in the green area of the specimen which was collected in Andamooka, Australia, by the club co-founder, Jim Nicholls.

Fig. 15 *Pinfire opal collected by Jim Nicholls co-founder of MWGC.*

Fig. 16 Rough Opal.
Opal is not a mineral, because it has a water content, and so it is classed as a mineraloid, It is classed as a hydrated amorphous form of silica, with a water content usually in the range of 6% to 10%, but it may have as much as 20%. Opal is composed of microscopic spheres of silicon dioxide molecules, which are deposited in closely packed planes. If the planes are very precise and regular precious opal is produced, however, most of the time slight discrepancies in how the spheres are deposited, result in "rough opal". This specimen is rough opal from Madagascar, with just a hint of regular deposition.

Fig. 16 *Rough opal from Madagascar.*

Fig. 17 Dendritic Opal.
Opal is a hydrated amorphous form of silica, and so it is classed as a mineraloid. This common opal variety is from the Norseman opal mine in Western Australia, and is locally known as gold lace opalite. The variety is described as being a yellow brown opal with black dendritic inclusions. This specimen is as the variety description, and was collected by Jim Nicholls, co-founder of our club while living near Norseman.

Fig. 17 *Dendritic opal found by Jim Nicholls while living near Norseman Australia.*

Better images of my own specimens can be found in the website minerals.

Bill Bagley