THE GEOLOGY OF AUSTRALIAN OPAL DEPOSITS.

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Abstract

Precious opal is defined as opaline silica with a play of colour. Australian opal is referred to as "sedimentary opal" in that it is hosted predominantly by sedimentary rocks of the Mesozoic Great Artesian Basin (GAB) but there are also rare occurrences of "volcanic opal" where opal is associated with igneous rocks. Volcanic opal is generally hosted by acid igneous rocks which contain free silica and the solutions associated with these rocks provided the silica for the deposition of opal, SiO_2nH_2O, hydrated silicon dioxide. The only common factors that volcanic and sedimentary opal have is that there is a source of silica available and that the silica fills available voids.

Occasionally, when conditions are ideal, spheres of silica form and settle under gravity in a void to form layers of silica spheres. If the process allows spheres to reach uniform size, then precious opal commences to form. For precious opal the sphere size ranges from approximately 150 to 400 nanometres producing a play of colour by diffraction in the visible light range of 400 to 700 nanometres.

In volcanic rocks and adjacent environments the opal appears to fill only vughs and cracks whereas in sedimentary rocks there are a variety of voids created by the weathering process. Leaching of carbonate from boulders, nodules, many different fossils, along with existing cracks, open centres of ironstone nodules and horizontal seams provide a myriad of moulds ready for the deposition of secondary minerals such as opal.

The main minerals found filling voids are opaline silica and gypsum often associated with opal in the South Australian fields. It appears that gypsum formed both before and after opal deposition as shown by the sharing of seam space and some fibrous gypsum contained within opal. Much of the opal deposition is not precious. It is called *"potch"* by the miners or *common opal* by the mineralogist as it does not show a play of colour. Opaline silica not only fills the larger voids mentioned but also may fill the pore space in silt and sand size sediments cementing the grains together forming unique deposits known as matrix, opalised sandstone or *"concrete"* which is a more conglomeratic unit near the base of early Cretaceous sediments.

Opaline silica also cements late Cretaceous to early Tertiary thin quartz sandstone forming quartz grains in a sea of precious opal. Much of this mixed material does not polish and has to be coated for presentation.

Opal in sedimentary environments is often associated with lineaments or faults of various sizes. Many faults break up the ground providing waterways for the rising and falling silica rich ground water. Lineaments and faulting have been found particularly useful at Lightning Ridge in NSW and pursued to a limited extent in some of the South Australian fields.
In addition, opal has been found associated with ancient palaeochannels in Queensland, and Lightning Ridge in New South Wales, either in or adjacent to these channels and this also is thought to provide water channels for silica rich water.

Most opal once mined is presented in natural solid, cut and polished form as either cabochon or free form for use in jewellery.

If too thin for solids then opal is presented as either a natural attachment on ironstone (Queensland boulder opal) which provides a dark background to the clear crystal opal lifting its appearance, or attached to a potch or glass with a dark cement considerably darkening and enhancing its appearance. These are referred to as laminated stones.

Treatment of opalised host rock consists of depositing carbon in remaining pore space in both matrix and opalised sandstone and treating with concentrated sulphuric acid or heating to blacken the background which enhances the play of colour. These two products come from Andamooka (SA).

The many variations in the types of opal depend on a number of factors. Firstly the climate provides alternating wet and dry periods creating a rising or more importantly a falling water table which concentrates any silica in solution. The silica itself is formed either by volcanic origin or by deep weathering of Cretaceous clay sediments producing both silica and white kaolin often seen associated with the Australian opal fields. Each local opal field or occurrence must have contained voids or porosity of some sort to provide a site for opal deposition.

Special conditions must also prevail to slow down a falling water table in order to provide the unique situation for the production of its own variety of opal.

Many workers consider that there must be acidic conditions at some stage during the process to form silica spheres and one worker states that these acidic conditions are created by microbes. Another worker advocates that opal forms by ion exchange in an electrolyte and has backed his theory by growing his own opal.
The chemical conditions responsible for producing opal is in its early stages but is currently being pursued at several universities.

Conclusions

Variations in the types of opal depend on a number of factors.

Firstly the climate provides alternating wet and dry periods creating a rising or more importantly, a falling water table which concentrates the silica in solution.

The silica itself is formed by deep weathering of Cretaceous clay sediments producing both silica and kaolin probably in an acidic environment within the changing water table.

Voids are formed by weathering of carbonate boulders, nodules, fossils and cement in siltstone and sandstone.

Cracks are created also in the weathering process caused by volume changes and subsequent movement, desiccation and small faults.

Silica spheres once formed are deposited in a regular array in voids from a receding water table forming precious opal. in the available voids or pore space into a variety of host rocks including ironstone, sandstone siltstone and shale.

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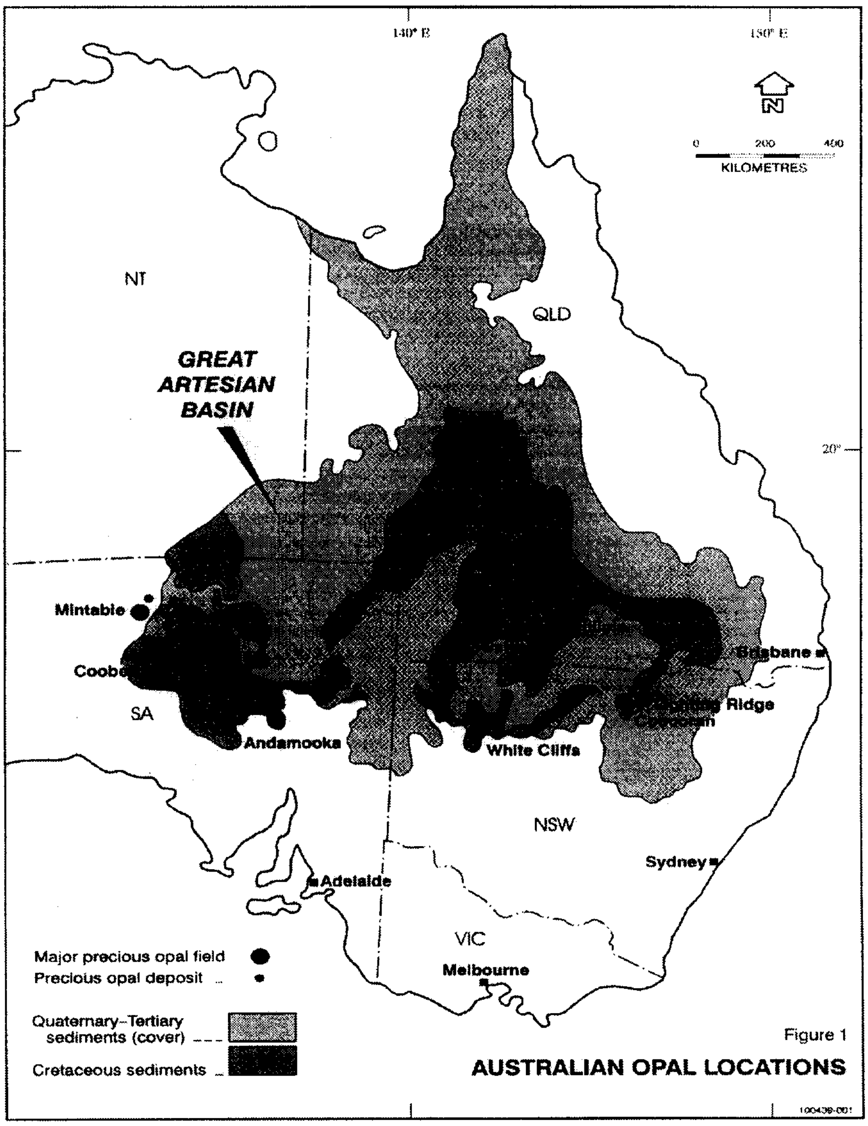

Figure 1. Australian opal location

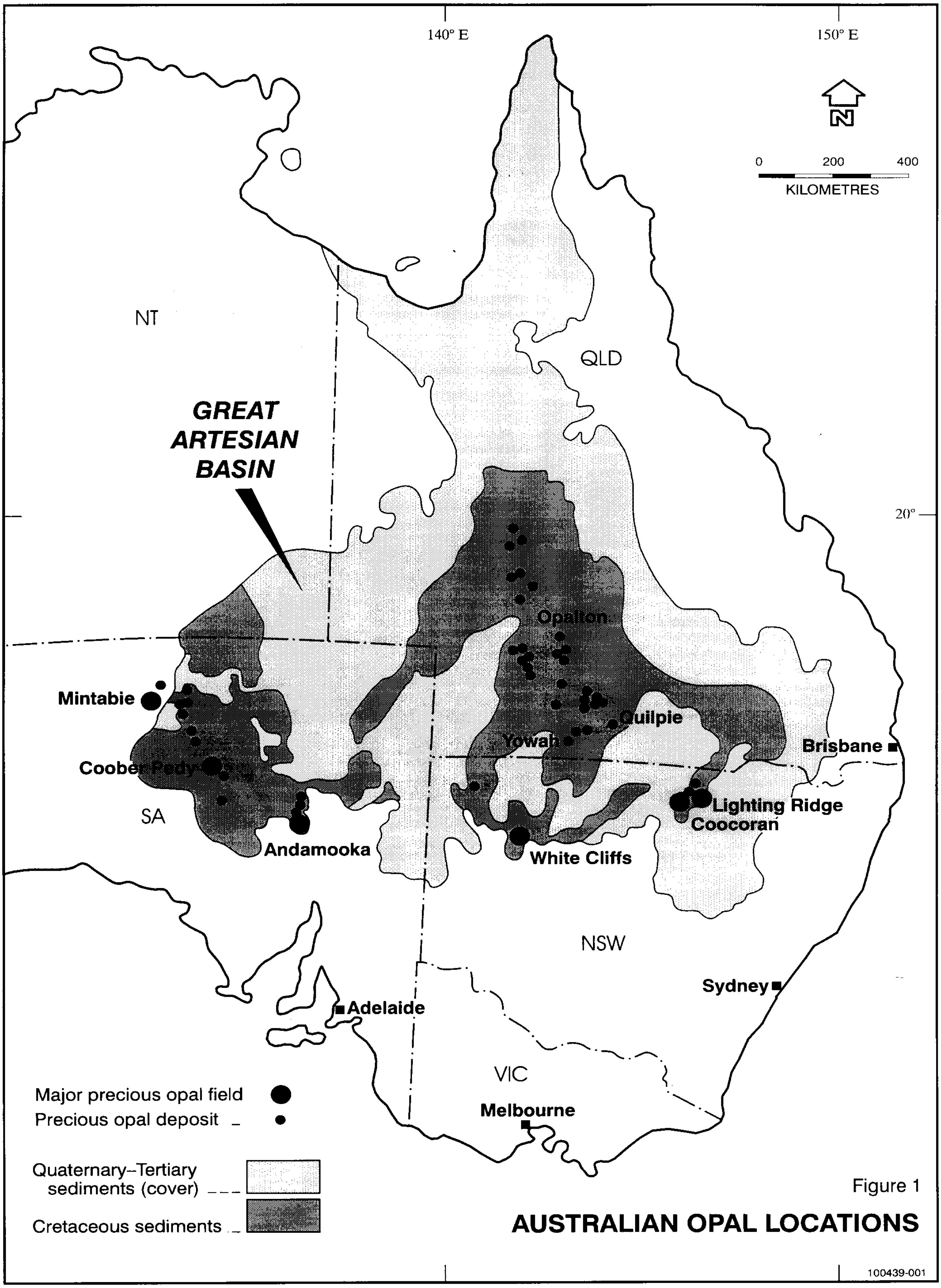

Figure 1

AUSTRALIAN OPAL LOCATIONS