The Geology of the Lorne Basin in the Laurieton Area.

Located on the mid-north coast of New South Wales, the Lorne Basin is a sub-circular basin with Triassic rocks of similar age to those of the much larger Sydney Basin. The Lorne Basin is approximately 35 km in diameter, containing mainly Triassic sedimentary rocks (in excess of 200m thick) and extensive younger intrusions. It is postulated it may have formed as a result of a large meteor impact.

Basin Setting

The Lorne Basin is an isolated sub-circular structural basin, approximately 35 km in diameter, situated in the north coast region of New South Wales between the towns of Coopernook and Wauchope (Figure 1).

Formation of the Lorne Basin.

There are several theories for the formation of the Lorne basin, all of which have been the subject to further research and speculation currently there is no concrete evidence for a definitive formation.

Tonkin (1998), suggested that there is some evidence to suggest that the Lorne Basin may have formed as the result of the impact of a large asteroid or meteorite, which probably measured 2–4 km in diameter. As well as the circular morphology and the presence of a couple of central uplifts thought to be indicative of impacted strata following a major meteorite impact.

Figure 1: Location of the Lorne Basin.

There are a number of intrusive glass dykes in the Carboniferous age 'target' rocks underlying the basin. The glass contains small amounts of nickel-iron, iron-rich hypersthene and abundant spherules and melted fragments, and resembles the glass found at impact sites in other parts of the world. Following basin formation, thick beds of conglomerate, sandstone and shale of predominantly fluvial origin filled the basin, later subsidence possibly triggering the intrusion of a number of granitoids along impact-induced fractures.

A second suggestion is that explanation of the Lorne Basin is an ancient Caldera structure which are large volcanic craters that may form by two different methods: 1) an explosive volcanic eruption; or, 2) collapse of surface rock into an empty magma chamber.

In the case of the Lorne Basin, it has been suggested it is an example of what is known as a Collapse Caldera which can form when a large magma chamber is emptied by a volcanic eruption or by subsurface magma movement. The unsupported rock that forms the roof of the magma chamber then collapses to form a large crater. Crater Lake in the USA and many other calderas are thought to have formed by this process.

The four-step illustration below (Figure 2) explains how the Crater Lake Caldera is thought to have formed.

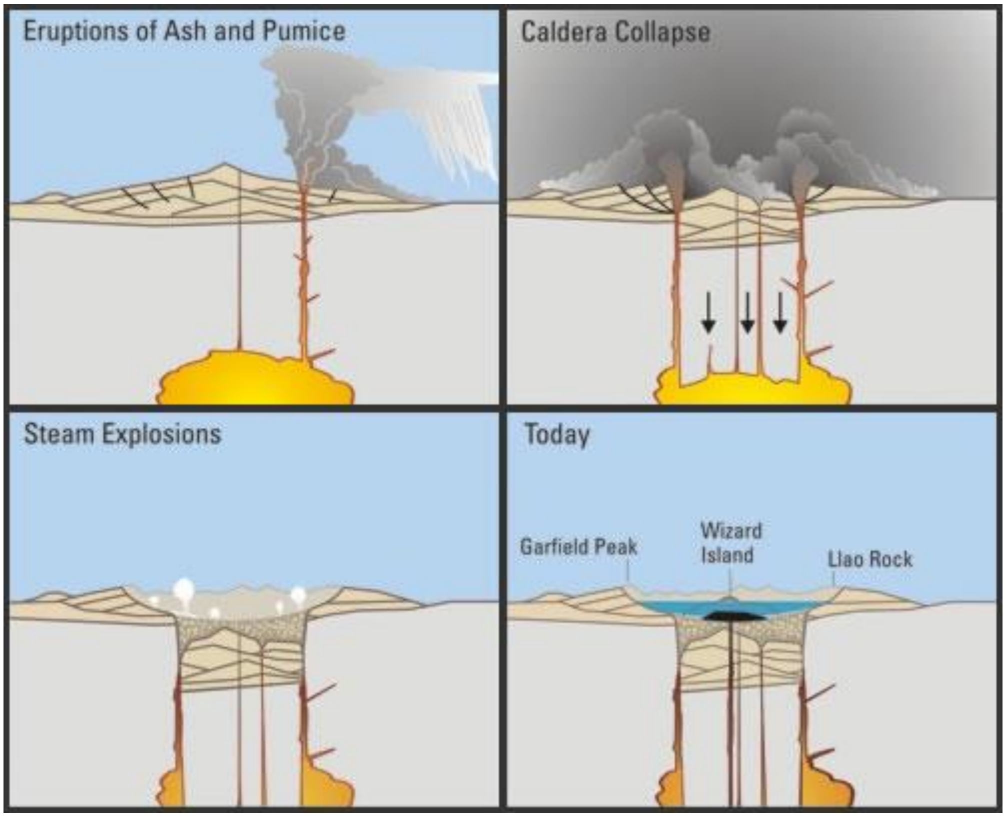

Figure 2: Possible formation of a Caldera Figure modified from diagrams on back of 1988 USGS map "Crater Lake National Park and Vicinity, Oregon." Illustration and caption by the United States Geological Survey.

During the breakup of the ancient Gondwana landform, the eastern edge of the Australian plate was part of a subduction zone whereby continental plates interact with each other due to sea floor spreading. In this case, the eastern (New Zealand) plate is being pushed against the western (Australian Plate) and due to it being composed of a heavier rock mass, is being pushed (or dragged) under or technically "subducted" beneath the Australian Plate. As the eastern plate rocks are pushed deeper, they melt and due to weaknesses in the overlying rock masses can migrate upwards to form molten magma emplacements.

Figure 3, below, schematically represents the subduction of the eastern plate (right hand side) underneath the Australian Plate (left side).

The melting of the eastern (subducted) crustal rocks resulted in some of them rising through the overlying Australian plate rocks close to the margin along zones of weakness resulting in magmatic emplacements, e.g. the Three Brothers.

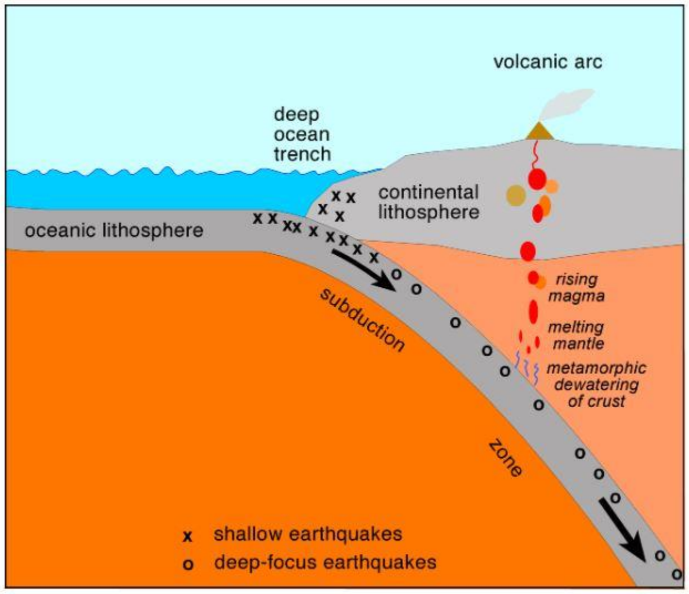

Figure 3: Schematic representation of the subduction of the eastern plate under the western (Australian Plate) during continental drift.

If the molten rock reached surface and erupts, it can form a volcano, but if the molted rock becomes trapped before reaching the surface, it can cool down in situ and form an intrusive plug. Depending on the type of emplacement, it could form a Batholith or a Lopllith as well as several other forms of volcanic "plug"

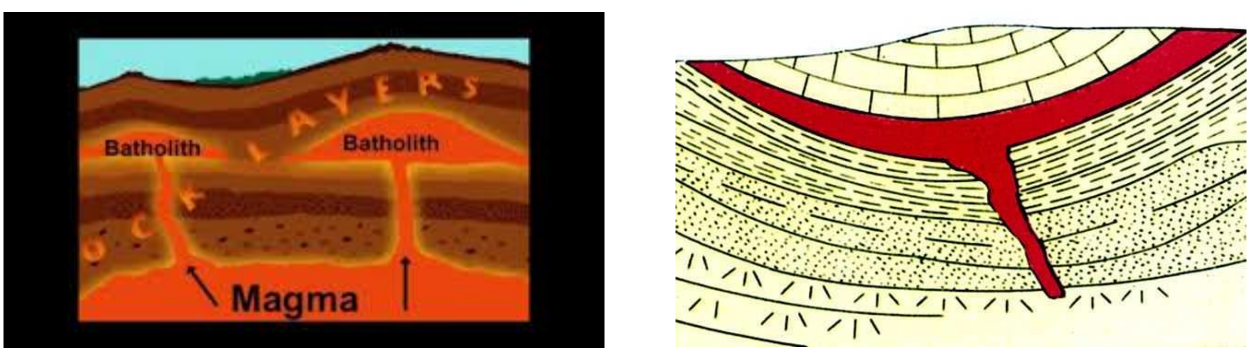

Figure 4: Examples of a Batholith (left) and Lopolith (right).

The batholith usually is deep seated and acts as a conduit for molten rock to migrate upwards to shallower zones in the crust. A Lopolith can be formed as a shallow magma emplacement which over time, due to erosion of the softer rocks surrounding and within the Lopolith structure, can result in a circular structure with upland (more resistant) surrounds. It can also host cores of molten or volcanic glass dykes. This is the third possible explanation for the formation of the Lorne Basin.

However, the actual geological map of the Lorne Basin (Figure 5a & 5B, Pratt 2010) shows that the basin margin is composed of Early Triassic sediments, namely conglomerates of the Laurieton Conglomerate, a unit of the Camden Haven Group.

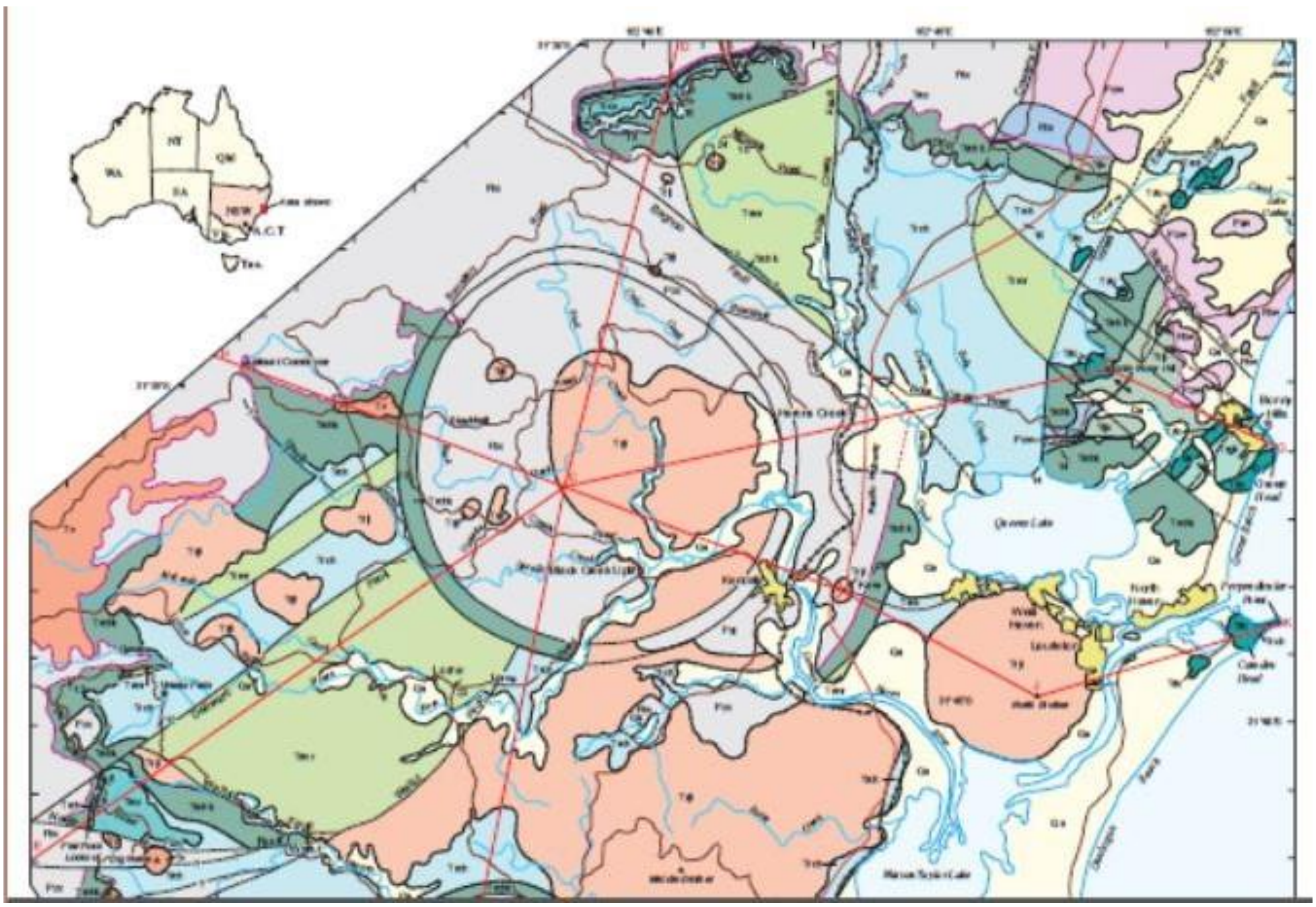

Figure 5a. Geological Map of the Northern Part of the Lorne Basin, from Pratt 2010.

Cross sections shown as Figure 6, clearly show that the resistant margins of the basin are composed of the conglomerate in a basin shaped structural setting. There are numerous intrusive bodies emplaced within the basin, namely the three brothers, as well as numerous smaller igneous bodies such as vertical to sub-vertical dykes.

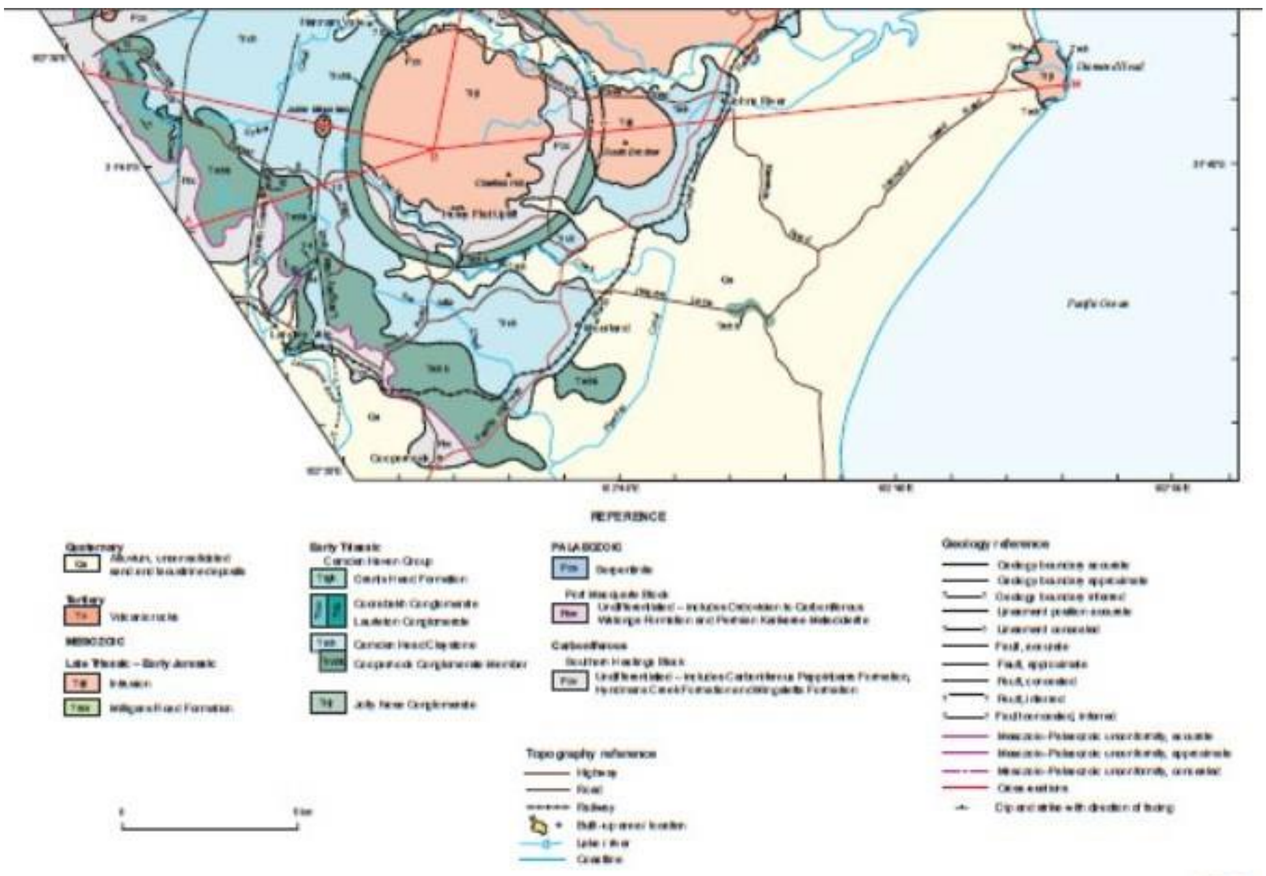

Figure 5b. Geological Plan of the Southern Part of the Lorne Basin, from Pratt 2010.

A further suggestion is that the Lorne Basin is a small, intermountain, Triassic Basin (Geoscience Australia undated) surrounded by the New England Fold Belt. Certainly this explanation can partly go towards understanding the location of the basin, but does no clearly indicate that the basin is essentially circular in shape. An intermountain basin is usually formed between belts of mountains, or mountain ranges and tends to be more elongate in shape rather than circular.

On the evidence of the above, it is most likely that the Lorne Basin was formed in the Triassic era, as a result of structural (Tectonic) movements adjacent to the active New England Fold Belt.

It is purely a sedimentary basin with later igneous intrusions along pre-existing fault zones which were areas of weakness extending into the crust.

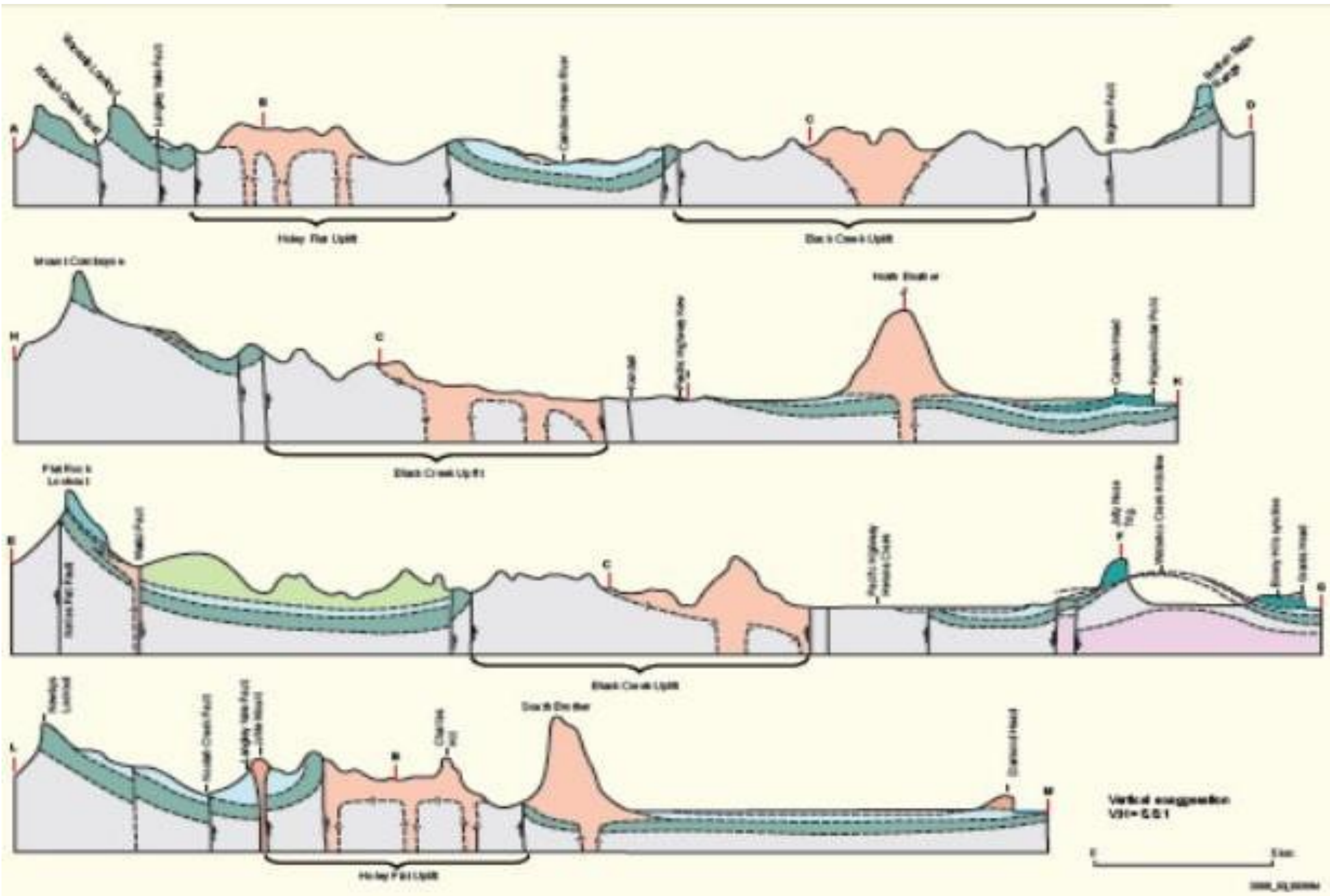

Figure 6. Cross Sections across the Lorne Basin, from Pratt 2010.

References:

Australian Government, Geoscience Australia, (undated) Lorne Basin.

Pratt, G,W,. 2010. A revised Triassic Stratigraphy for the Lorne Basin. NSW Government Industry and Investment Development Quarterly Newsletter, June 2010. No 134.

Tonkin, P. C.,1998. Lorne Basin, New South Wales Evidence for a possible meteor impact? Origin. Australian Journal of Earth Science. Vol 45, Issue 5.

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