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# PLEISTOCENE TO HOLOCENE VOLCANIC ACTIVITY IN SOUTH AUSTRALIA: A REVIEW

# REVUE DE L'ACTIVITE VOLCANIQUE EN AUSTRALIE MERIDIONALE DU PLEISTOCENE A L'HOLOCENE

GEOLOGICAL SURVEY

by

M.J. SHEARD
GEOLOGIST

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## ABSTRACT

Quaternary basaltic volcanoes of southeastern South Australia comprise two distinct groups that constitute a western extension to the late Tertiary to Quaternary newer Volcanics of Western Victoria.

The older (northern) Mt Burr Range group includes 14 fissure controlled centres with lava flows, composite domes and cones, and tuff rings or maars. Their ejecta lie stratigraphically between the Pliocene erosional surface on the Miocene Gambier Limestone, and the Pleistocene Bridgewater Formation aeolianites. Many volcanoes in this group exhibit erosional modification by Pleistocene interglacial high sealevels. Radiometric dating of this group has been unsuccessful due to rock alteration.

Mounts Gambier and Schank form a younger (southern) group. Both are maar-cone complexes, which are a consequence of eruption through abundant groundwater. Their ejecta rest on top of the Pleistocene aeolianites.

Thermoluminescent dating of baked sands at Mt Schank has yielded a tentative age of 8 700 ± 10% years B.P. which agrees with palaeomagnetic results. Carbon-14 dates from charcoal in ash at Mt Gambier yield ages between 4 000 and 4 300 years B.P. which agree with palaeomagnetic results. This makes Mt Gambier the youngest volcanic feature on the Australian mainland.

These dates together with recent seismicity and a possible offshore submarine lava flow may indicate that the province is still active.

# REVUE DE L'ACTIVITE VOLCANIQUE EN AUSTRALIE MERIDIONALE DU PLEISTOCENE A L'HOLOCENE

## RÉSUMÉ

Les volcans basaltiques de l'ère quaternaire du Sud-Est de l'Australie Méridionale comprennent deux groupes distincts qui constituent une extension occidentale aux volcans plus récents (fin Tertiaire à Quaternaire) du Victoria occidental.

Plus au Nord, le groupe plus ancien de la chaîne du Mont Burr comprend quatorze centres fissurés avec coulées de lave, dômes et cônes composites et anneaux de tufs ou maars. Stratigraphiquement leurs retombées se situent entre la surface d'érosion Pliocène du calcaire Miocène du Gambier et la formation éolienne Pléistocène de Bridgewater. On peut remarquer que de nombreux volcans appartenant à ce groupe ont subi des modifications dûes à l'érosion causée par les hauts niveaux de la mer au temps du Pléistocène interglaciaire. La datation radiométrique de ce groupe reste sans succès vu l'altération des roches en question.

Plus au Sud, les Monts Gambier et Schank constituent un groupe plus jeune. Tous deux sont des complexes maar-cônes, conséquence d'éruptions à travers d'une eau souterraine abondante. Leurs retombées reposent au dessus des formations éoliennes Pléistocènes.

Une approximation de l'âge des sables cuits du Mont Schank nous est donnée par datation thermoluminescente : 8700 ± 10% d'années B.P. Ceci est en accord avec les résultats paléomagnétiques.

Une estimation de l'âge du Mont Gambier nous est donnée par datation du carbone 14 contenu dans le charbon de bois de ses cendres : 4000 a 4300 ans B.P. Ceci aussi est en accord avec les résultats paléomagnétiques. D'après ceci, Mont Gambier serait l'événement volcanique le plus récent sur le continent Australien.

Ces âges, ainsi qu'une séismicité recente et une coulée de lave sous-marine possible au large pourraient indiquer une activité encore acteulle.

## INTRODUCTION

The Quarternary volcanic province of South Australia occupies a small portion of the State's southeastern corner, constituting a western extension to the Quarternary Newer Volcanics of central and western Victoria. This extension contains 16 eruptive centres.

A karstic terrain of low profile with poorly developed surface drainage and abundant groundwater underlies and surrounds the volcanic structures. Two distinct groups of volcanics are evident: the northern Mount Burr Range form one group, while the more isolated Mounts Schank and Gambier form the second.

## MOUNT BURR RANGE GROUP

In the Mt Burr area near Millicent there are 14 major volcanic centres. Most are associated with fissure eruptions they are aligned along three main linear trends parallel to the Burr/Gambier Lineament and the Burr Platform or peninsular described by Sprigg (1952) and Marker (1975). A basement high, possibly a horst structure as indicated by seismic profiles, underlies the Burr platform. It is via the faults associated with the horst that basaltic melts approached the surface.

Volcanic structures are varied, ranging from lava flows, scoria domes, composite domes, agglomerate cones to maars or tuff rings. The ejecta rests on the Pliocene erosional surface of the Miocene Gambier Limestone and is mantled by up to 50 metres of the Pleistocene aeolianites of the Bridgewater Formation, so the full extent of the volcanics is revealed only by drilling. Present data indicate that the volcanic detritus covers an area of 110 square kilometres. Three areas of ash may represent either small subaqueous eruptions or falls of wind blown ash.

Diamond drilling on two volcanoes has revealed fossil soils within alternating scoria, lava, and ash, indicating major breaks in their eruptive histories.

Irving & Green (1976) presented the petrogenesis and geochemistry of some alkali basalts in the Mt Burr Range. No pattern is apparent; however, melt fractionation between eruptive sites may have occurred within the alkali basalt field.

Pleistocene marine activity has had a marked effect on the structural shape of the volcanic edifices and ash distribution. Mts Muirhead and Bluff are asymmetrical structures due to the action of onshore winds and coastal erosion by the sea. Highangle crossbedding and slump structures are common on the lower seaward flanks of Mt Muirhead.

Ages for the Mt Burr Range volcanics based on stratigraphic and palynological evidence range from $2 \times 10^6$ to $2 \times 10^4$ years B.P.

## SOUTHERN VOLCANIC GROUP

The southern volcanic group consists of Mt Schank and the Mt Gambier Volcanic Complex. Both structures rest on Pleistocene aeolianites which appear to have stabilised at each site prior to eruption. Hence these volcanics are stratigraphically younger than the volcanics of the Mt Burr Range. Neither structure displays marine erosion, however, Mt Schank may have erupted close to an ephemeral swamp because Solomon (1951) described spinifex textures at the extremities of its lava flow.

Mts Schank and Gambier are both complex maar-cone-agglomerate structures, which are the consequence of eruption through abundant groundwater in the proximate country rocks.

Mt Schank

Initially lava flowed westward from a northwest-trending fissure which is marked by a line of scoria cones. More explosive activity followed with the development of a small maar and two cones. Irving & Green (1976) classified the basalt at this site as K-rich nepheline hawaiite.

Carbon-14 dating of charcoal fragments in sands underlying the tuff deposit has yielded an age of 18,100 ± 350 years B.P. (Polach et al., 1978). Palaeomagnetic data obtained by Barbetti & Sheard (1981) indicate Mt Schank is not contemporaneous with Mt Gambier; and that it erupted either prior to 7,000 years B.P. or between 5000 to 1000 years B.P. Thermoluminescent data obtained from lava-baked sands have given a tentative age of 8,700 ± 900 years B.P. according to B. Smith (pers. comm., Physics Dept, University of Adelaide, South Australia).

Mt Gambier

Sheard (1978) provides a detailed geological history for the Mt Gambier Volcanic Complex. Mt Gambier has undergone two major periods of eruption, each with a distinctive style. The first began explosively and ended passively with lava extrusion. A second more explosive period followed, producing an elongated complex of overlapping maars.

The time gap between the two periods is at present under review. Palaeomagnetic orientations are identical from the base and the top of the volcanic pile. According to Barbetti & Sheard (1981) this indicates the break could be no more than a few centuries. Field evidence shows that a lava sheet solidified prior to the second period of eruption, hence the time gap need be only a few years.

Irving & Green (1976) classified the basalts at Mt Gambier as nepheline hawaiite.

Carbon-14 dating of charcoal fragments within the basal tuff has recently refined the age of Mt Gambier. Blackburn et al., 1982, indicate the eruptions occurred 4000 to 4300 years B.P. This evidence agrees with the palaeomagnetic results of Barbetti & Sheard (1981). Hence, Mt Gambier is the youngest volcanic feature on the Australian mainland.

## RECENT ACTIVITY IN THE PROVINCE

Since settlement commenced about 150 years ago, only earthquake activity has occurred in South Australia. Two of the State's largest earth tremors have occurred near Kingston (1897) and Robe (1948) just to the northwest of the volcanic province. Sutton et al. (1977) demonstrated that these were most likely regional tensional releases related to plate movement.

Sprigg (1959) postulated a link between these earthquakes and possible submarine lava flows some 17 kilometres west-southwest of Beachport. So far no sampling or magnetic surveys have been made of these features, hence their existence remains conjectural.

A succession of small earthquakes in the Southeast of South Australia from 1975 to late 1976 had Richter magnitudes from 2.5 to 4.5, with epicentres, according to Sutton et al. (1977), within the Otway Basin rift zone. Two of the smaller tremors had epicentres that plot within the volcanic province itself. Sutton et al. (1977) state that the general coincidence of the seismic and volcanic belts cannot be neglected.

## CONCLUSIONS

The Mt Burr Range provides evidence of an extended period of interrupted volcanic activity of many styles, with ash fallout over an area of 110 square kilometres.

The younger southerly volcanic group on present indications may be following a similar pattern of development.

Recent seismic activity in the province is probably associated with regional tectonics as suggested by Sutton et al. (1977), but may also be a precursor to further volcanic activity. Two seismic stations have been added to the South Australian seismic network in this area, one in the Mt Burr Range and one at Willalooka, 140 kilometres to the north, to provide more detailed measurements.

On present indications, future volcanicity cannot be ruled out, but eruptions are expected to be rare and small.

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M.J. SHEARD

GEOLOGIST

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