DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT.BK.NO. 80/20

QUATERNARY VOLCANISM IN SOUTH-EASTERN SOUTH AUSTRALIA

GEOLOGICAL SURVEY

BY

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Fig. 8 Cross-bedded tuff on the western flank of Mount Muirhead, possibly representing an ash beach deposit. Bar scale 1 m.

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ABSTRACT

Seventeen eruptive centres in south-eastern South Australia constitute a western extension to the Quaternary Newer Volcanics of Central and Western Victoria.

The eruptive centres comprise two distinct groups. The northern group of 15 centres forming the Mt Burr Range near Millicent, ranges from lava flows, scoria domes, composite domes, agglomerate cones, to maars or tuffs rings, and extends northwest along three parallel alignments associated with a basement horst. Their ejecta rest on an erosional surface of the Gambier Limestone and are overlain by Pleistocene aeolianites of the Bridgewater Formation. Drilling of one composite dome revealed a fossil soil, implying a history of eruption interspersed with times of quiescence. Incursions of Pleistocene seas structurally modified many of these volcanic centres.

The southern group consists of Mounts Gambier and Schank whose volcanics overly Pleistocene aeolianites, apparently consolidated prior to eruption. No marine erosion is indicated at either structure. Both are complex maar and cone features, indicating that abundant groundwater was present during eruption.

Palaeomagnetic orientations interpreted for Mounts Gambier and Schank show that they are not contemporaneous. One result of carbon 14 dating of Mount Gambier carried out in the 1950's, 4830 ± 70 y.B.P., agrees with recent palaeomagnetic information. Mount Schank's construction appears to have been continuous, whereas Mount Gambier exhibits a break of at least two or three years in eruptive activity-sufficient time to allow complete crystallisation of two lava sheets.

An extended period of sporadic volcanic activity like that exhibited by the northern group may still be in progress in the area surrounding Mounts Gambier and Schank, as evidenced by the age measurements, and recent seismic activity, however, future eruptions are expected to be rare events and on a small scale.

INTRODUCTION

The Quaternary-Recent volcanic province of South

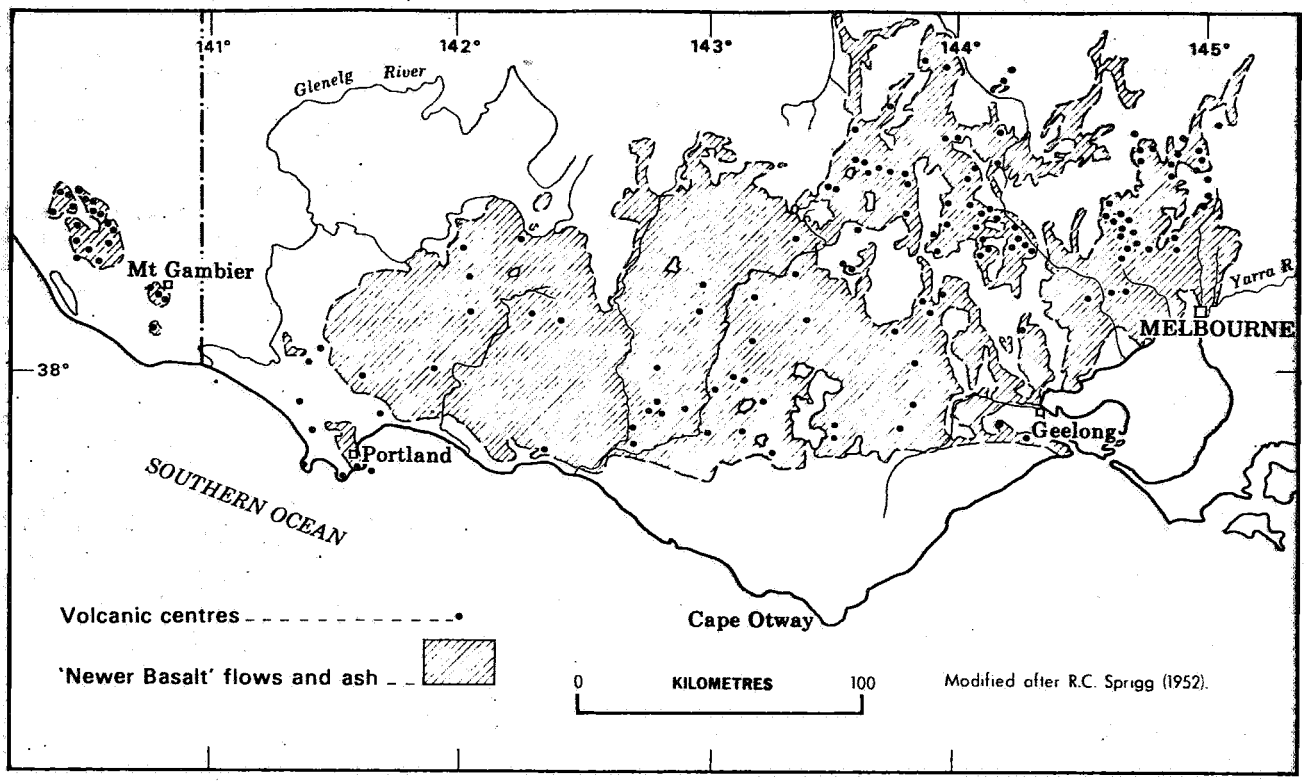

FIG. 1

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED M. J. S.	for C D O 1/4/80 DATE
QUATERNARY VOLCANISM IN SOUTH-EASTERN SOUTH AUSTRALIA	DRAWN J. P. V.	SCALE —
SOUTH-EASTERN SOUTH AUSTRALIA & SOUTH-WESTERN VICTORIA	DATE 5-3-80	PLAN NUMBER
TERTIARY TO QUATERNARY VOLCANIC DEPOSITS	CHECKED	S 14690

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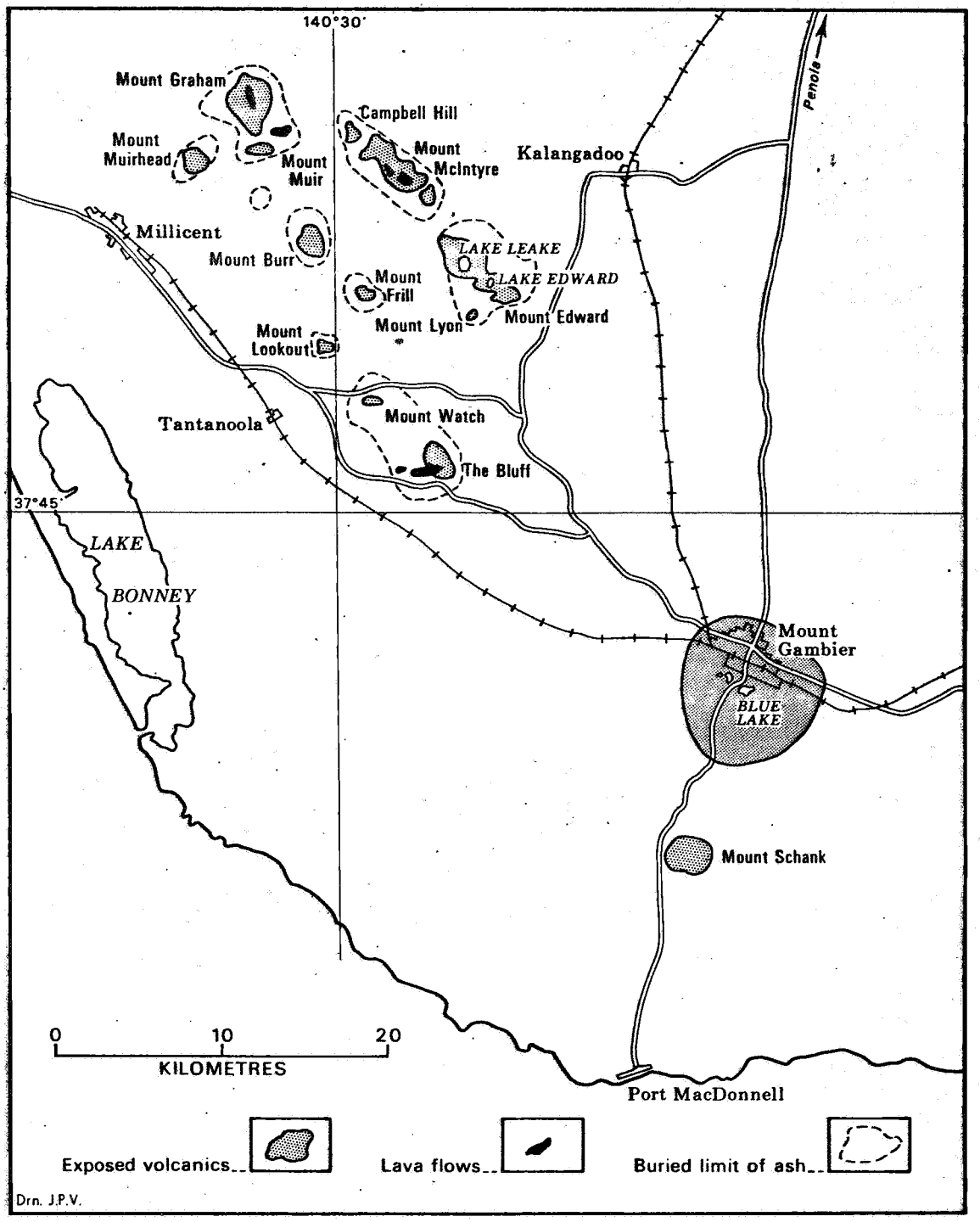


FIG. 2

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED M. J. S.	C D O	1/4/80 DATE
QUATERNARY VOLCANISM IN SOUTH-EASTERN SOUTH AUSTRALIA	DRAWN J. P. V.	SCALE	—
MOUNT GAMBIER AND MOUNT BURR REGIONS	DATE 5-3-80	PLAN NUMBER	
QUATERNARY VOLCANIC CENTRES	CHECKED	S 14691	

1733

Australia occupies a small portion of the State's south-eastern corner, and constitutes a western extension to the Quaternary Newer Volcanics of Central and Western Victoria (Fig. 1). This extension contains some 17 main eruptive centres - many of these have experienced multiple eruptions.

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 from one group, while the more isolated Mounts Gambier and Schank form the second (Fig. 2).

MOUNT BURR RANGE

In the Mt Burr Range, northeast of Millicent, are some 15 major volcanic centres. Most are associated with fissure eruptions, aligned along three main linear trends that parallel the Burr/Gambier Lineament and the Burr Platform or peninsula (Fig. 3) described by Sprigg (1952) and Marker (1975). A basement high, possibly an up thrown block (horst structure) as indicated by seismic profiles, underlies the Burr peninsula. It is via the faults associated with the horst that basaltic magma approached the surface.

Volcanic structures are varied ranging from lava flows, scoria domes, composite domes, agglomerate cones to maars or tuff rings. Volcanic products associated with each structure are indicated in Table 1 (modified after Walker, 1967), an example of a lava bomb is displayed in Figure 4. The ejecta rests on the erosional surface of the Gambier Limestone and is overlain by the Pleistocene fossil beach sand drift up to 50 m thick - known as the Bridgewater Formation (Fig. 6).

TABLE I

VOLCANIC CENTRES IN SOUTHEAST SOUTH AUSTRALIA (MODIFIED AFTER WALKER, 1967)

Name of Volcano	Latitude	Longitude	Height*above m.s.l.(m)	Edifice height* above plain(m)	Type of volcano	Volcanic products. +olivine bombs present
MT.GRAHAM	37°31½'	140°27'	181.6	132	Composite	Lava, ash and agglomerate.
MT. MUIR	37°33'	140°28'	172	122	Ash-cone	Ash, lapilli and agglomerate.
CAMPBELL HILL	37°33'	140°31'	111	50	Ash-dome	Ash and agglomerate.
MT.McINTYRE	37°34'	140°33'	188.7	128	Composite	Lava, scoria and ash (well bedded).
BOYCE HILL	37°35'	140°33½'	139	69	Ash-cone	Lapilli and agglomerate.
LAKE LEAKE HILL	37°37'	140°35½'	127	57	Maar	Well bedded ash and agglomerate.
MT. EDWARD	37°37½'	140°36'	160	80	Maar	+Bedded agglomerate.
MT. LYON	37°38'	140°38'	150	80	Ash-cone	+Bedded lapilli and agglomerate.
THE BLUFF	37°44½'	140°34½'	201.5	168	Composite	Lava, scoria, agglomerate & ash.
MT. WATCH	37°44½'	140°31½'	181.5	121	Scoria-dome	+Bedded scoria and lava bombs.
MT. LOOKOUT	37°40'	140°29'	96	66	Ash-cone	Agglomerate in soil below dune sands.
MT. FRILL	37°40'	140°31'	181	101	Ash-dome	Lapilli and agglomerate.
MT. BURR	37°36'	140°29'	240.5	158	Composite	Lava, scoria and agglomerate.
MT. MUIRHEAD	37°33½'	140°24'	149.7	122	Maar & Cones	Bedded agglomerate overlying buried lava, flow.
Submarine Flow near Beachport	37°35'	139°35'	-64 (approx.)**	5 (approx.)**	Flow	Lava? (No samples collected to date).
MT.GAMBIER	37°50'	140°45'	189.3	152	Maars	+Stratified tuffs, agglomerate, scoria, lava.
MT. SCHANK	37°56½'	140°44'	122.2	82	Maar & cones	Lava, scoria and agglomerate.

* Taken from Dept. of Lands S. Aust. 1:50 000 scale Topographic Maps: Kalangadoo, Millicent.

** Taken from Sprigg (1959).

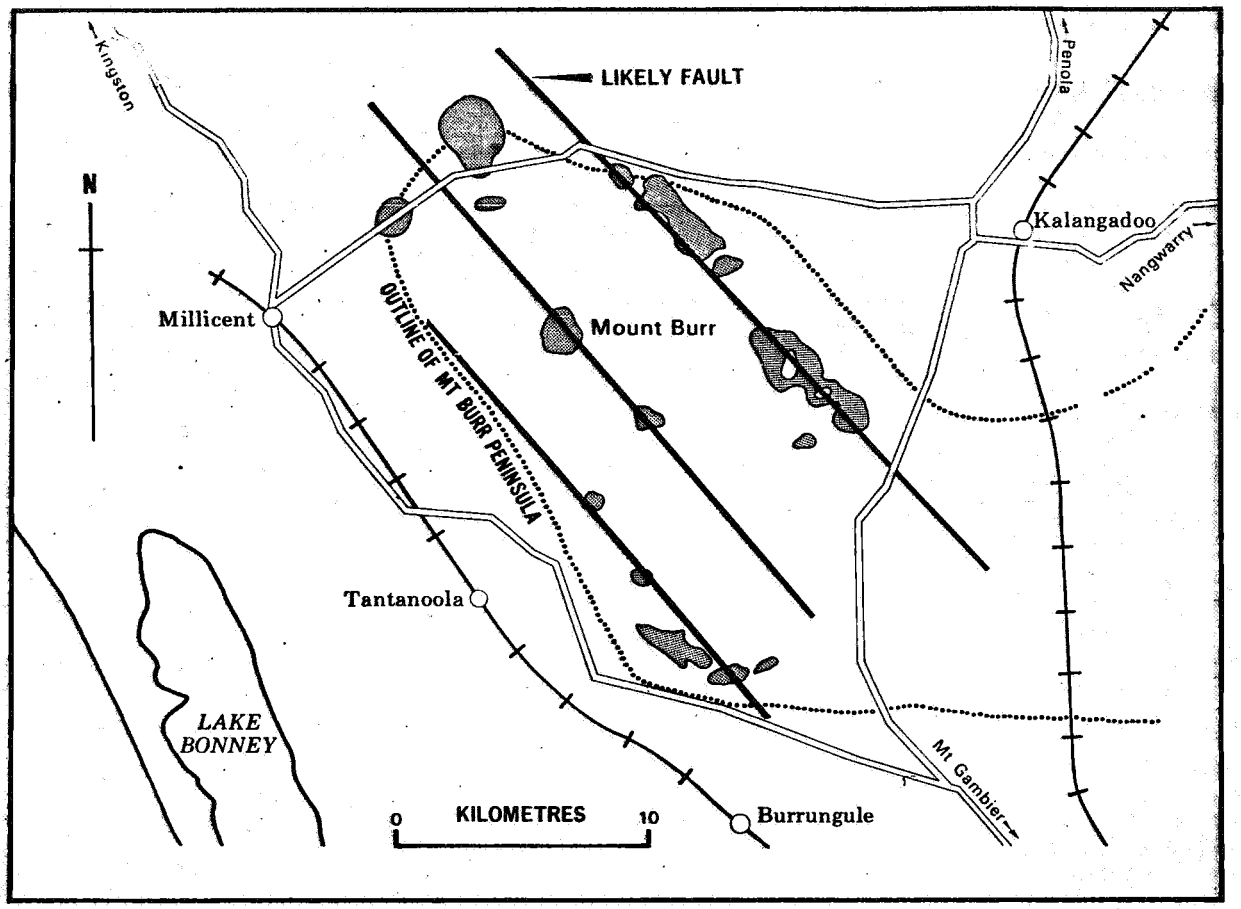


FIG. 3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED M. J. S.	for C D O 1/4/80 DATE
QUATERNARY VOLCANISM IN SOUTH-EASTERN SOUTH AUSTRALIA	DRAWN J. P. V.	SCALE —
THE OLDER MOUNT BURR VOLCANICS	DATE 5-3-80	PLAN NUMBER
POSITIONS OF INFERRED BASEMENT FAULTS SHOWING RELATIONSHIP TO OUTLINE OF MOUNT BURR PENINSULA	CHECKED	S 14692

1733

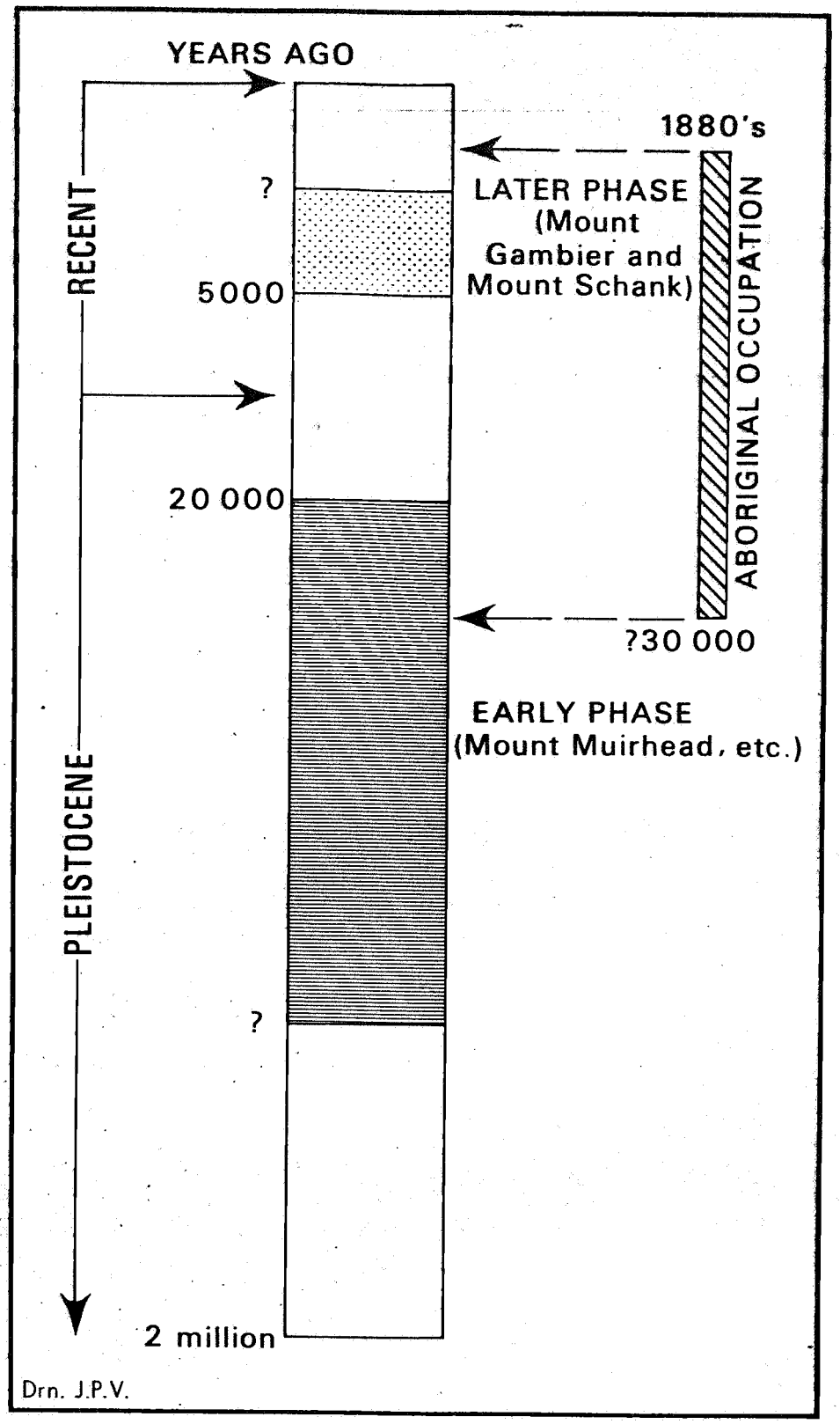


FIG. 5

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED M. J. S.	CDO	1/4/80 DATE
QUATERNARY VOLCANISM IN SOUTH-EASTERN SOUTH AUSTRALIA PHASES OF VOLCANIC ACTIVITY IN RELATION TO ABORIGINAL OCCUPATION AND THE GEOLOGICAL TIME SCALE (Taken from SELBY and SHEARD, 1979, Fig. 2)	DRAWN J. P. V.	SCALE	—
	DATE 5-3-80	PLAN NUMBER	S 14693
	CHECKED		

Mantled by these sands their full extent is only revealed by drilling. Present data indicates that the field covers an area of 110 km^2 (Fig. 2). Diamond drilling at The Bluff revealed an alternating sequence of scoria, lava flows, and ash containing a fossil soil 30 m below its apex - indicating a major time break in its eruptive history.

Irving & Green (1976) presented possible sources and the geochemistry of several volcanic rocks from the Mt Burr Range. No pattern is apparent, however, some chemical similarities and relationships between nearby centres seem to exist.

Pleistocene marine activity has had a marked effect on the structural shape of the volcanic edifices and ash distribution. Mt Muirhead and The Bluff are asymmetrical due to the action of onshore winds and coastal erosion by the sea (Fig. 7). Cross bedding with high angle set, slumping, and ripple marks are common features of the volcanic layering on the lower seaward flanks of Mt Muirhead (Fig. 8), indicating that coastal eruptions took place producing ash-based beach deposits.

Ages for the Mt Burr Range volcanics based on rock relationships, depth of weathering, and pollen fossils from present deposits, range from two million to 20 000 years before present (Dodson, 1974, Marker, 1975). It is possible that local aborigines witnessed volcanic activity in this area (Fig. 5). Tribal legends from the Booandik Tribe describe Mt Muirhead as being the oven of a giant called Craitbul, which is filled with ash that can be seen under the soil today (Smith, 1880).

SOUTHERN VOLCANIC GROUP

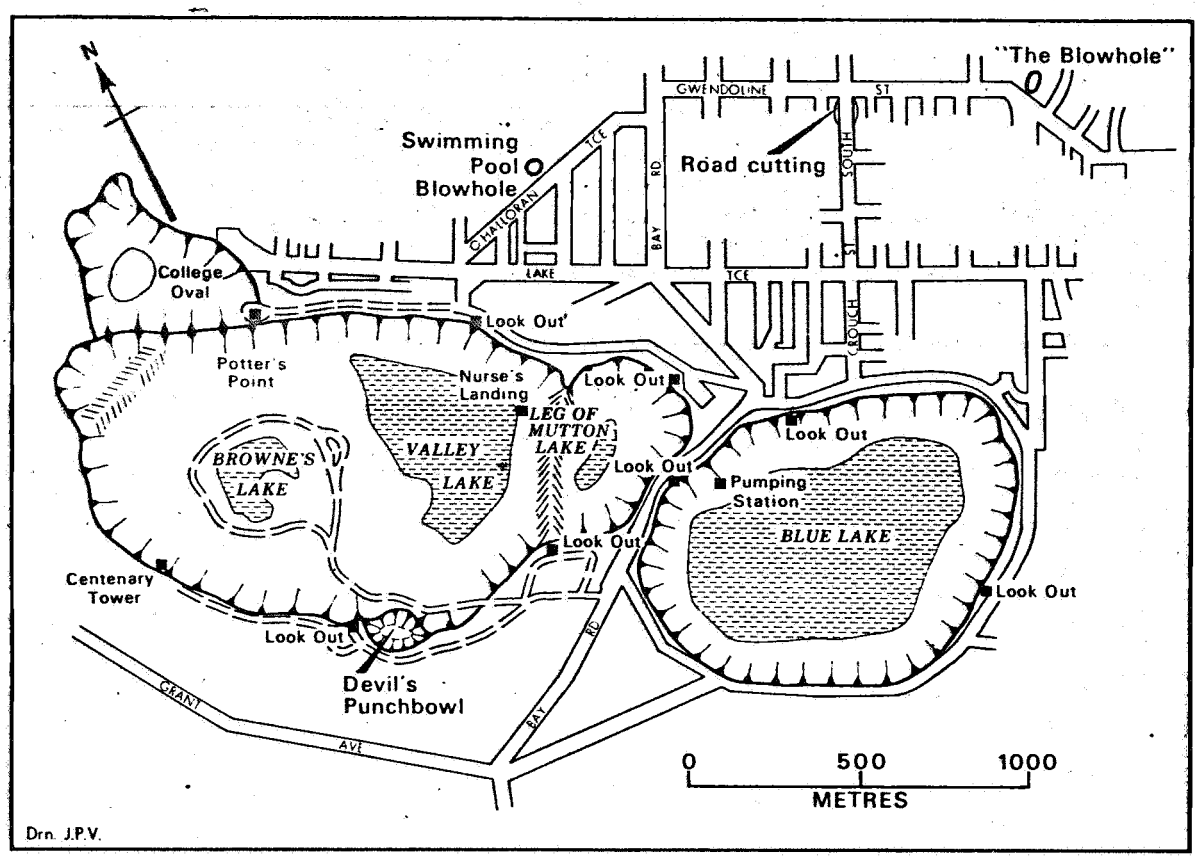
The southern volcanic group (Fig. 2) consists of the Mt Gambier Volcanic Complex and Mt Schank (Figs. 9, 10). Both

structures rest on the Bridgewater Formation drift sands which appear to have stabilised at each site prior to eruption (Fig. 5). Hence these volcanic structures are younger than those of the Mt Burr Range. Neither structure displays marine erosion, however, Solomon (1951) described quench textures at Mt Schank, indicating the presence of surface water - possibly a swamp.

Mounts Gambier and Schank are both complex maar-cone structures, they are dominantly constructive features formed by volcanic explosions (Ollier, 1967; Sheard, 1978). There is no evidence for large scale collapse, as a mode of formation, proposed by earlier workers. Large open craters, especially at Mt Gambier are features of steam-induced volcanic explosions - caused by the influx of abundant near surface groundwater into the active vents and conduits.

Mt Gambier

A detailed geological history of Mt Gambier is set out in Sheard (1978). Briefly, Mt Gambier has undergone two closely spaced periods of eruption, each with a distinctive style. Two carbon 14 dates for Mt Gambier are: 4830 $\pm$ 70 years B.P. (Ferguson & Rafter, 1957), and 1410 $\pm$ 90 years B.P. (Blackburn, 1966a). Both dates are consistent with recent palaeomagnetic information, and there is no measurable difference in magnetic orientation between the earliest and latest eruptive materials. This indicates the gap between eruptive periods is probably small and less than two or three centuries (Barbetti & Sheard, in prep.). The younger carbon 14 date may not be related to a volcanic event according to Blackburn (1966b), because the material dated may represent a tree root penetrating the ash and subsequently burnt by a local bush fire.



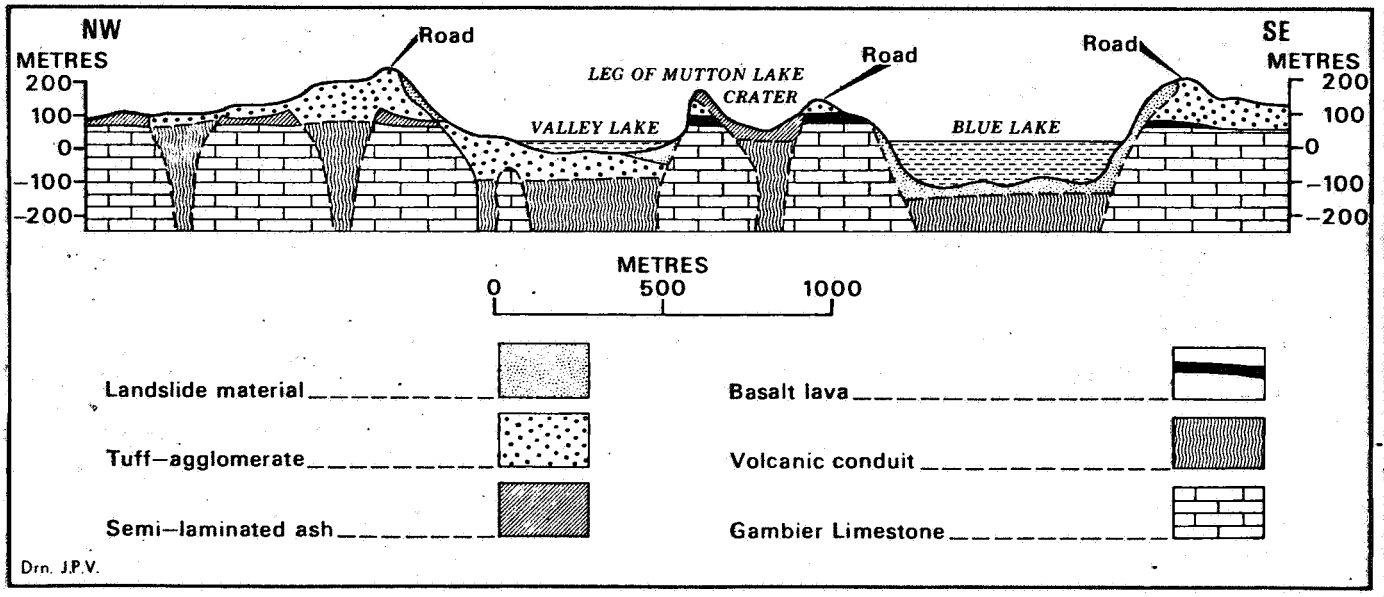


FIG. 11

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA		COMPILED M. J. S.	for C D O 1/4/80 DATE
QUATERNARY VOLCANISM IN SOUTH-EASTERN SOUTH AUSTRALIA		DRAWN J. P. V.	SCALE —
THE MOUNT GAMBIER CRATERS		DATE 5-3-80	PLAN NUMBER
PLAN AND DIAGRAMMATIC CROSS SECTION		CHECKED	S 14694

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Initial eruptions occurred at the present sites of the Tenison College oval (western end of the Complex, Fig. 11 taken from Selby & Sheard, 1979) and the Leg of Mutton Lake crater. Small, low, open explosion craters called maars were produced, covering the surrounding countryside with ash and lapilli. Next, lava flowed from fissures near the present day Brownes Lake and from a vent in the centre of the complex near the present day Leg of Mutton Lake. A scoria cone now partly exposed in the crater walls west of the Brownes Lake, completed period one eruptions. Activity ceased for some time, allowing the lava flows to cool and crystallize, a process that may have taken up to two years.

The second period eruptions were on a much larger scale than those of the first. During the time between the two periods of eruption, groundwater percolated down the existing volcanic conduits to mix with hot and/or molten rocks at depth. The resultant explosive volcanism produced the large craters we see today (Figs. 9, 11). Many small vents close together eventually combined to form the large craters now containing the Blue, Valley, and Brownes Lakes. During these eruptions many large blocks some weighing many tonnes were thrown out of the craters (Fig. 12). The Leg of Mutton Lake crater as it now appears, is a late-stage feature that formed as activity was waning. Lava fountaining in the Brownes Lake crater was the last magmatic event, and produced lava spatter and ropey lava. Activity ended with steam venting through blow holes such as the Devils Punch Bowl and several others inside and outside the main craters (Fig. 11).

Mt Schank

The volcanic pile at Mt Schank has not been dated, but fragments of charcoal collected from the underlying dune

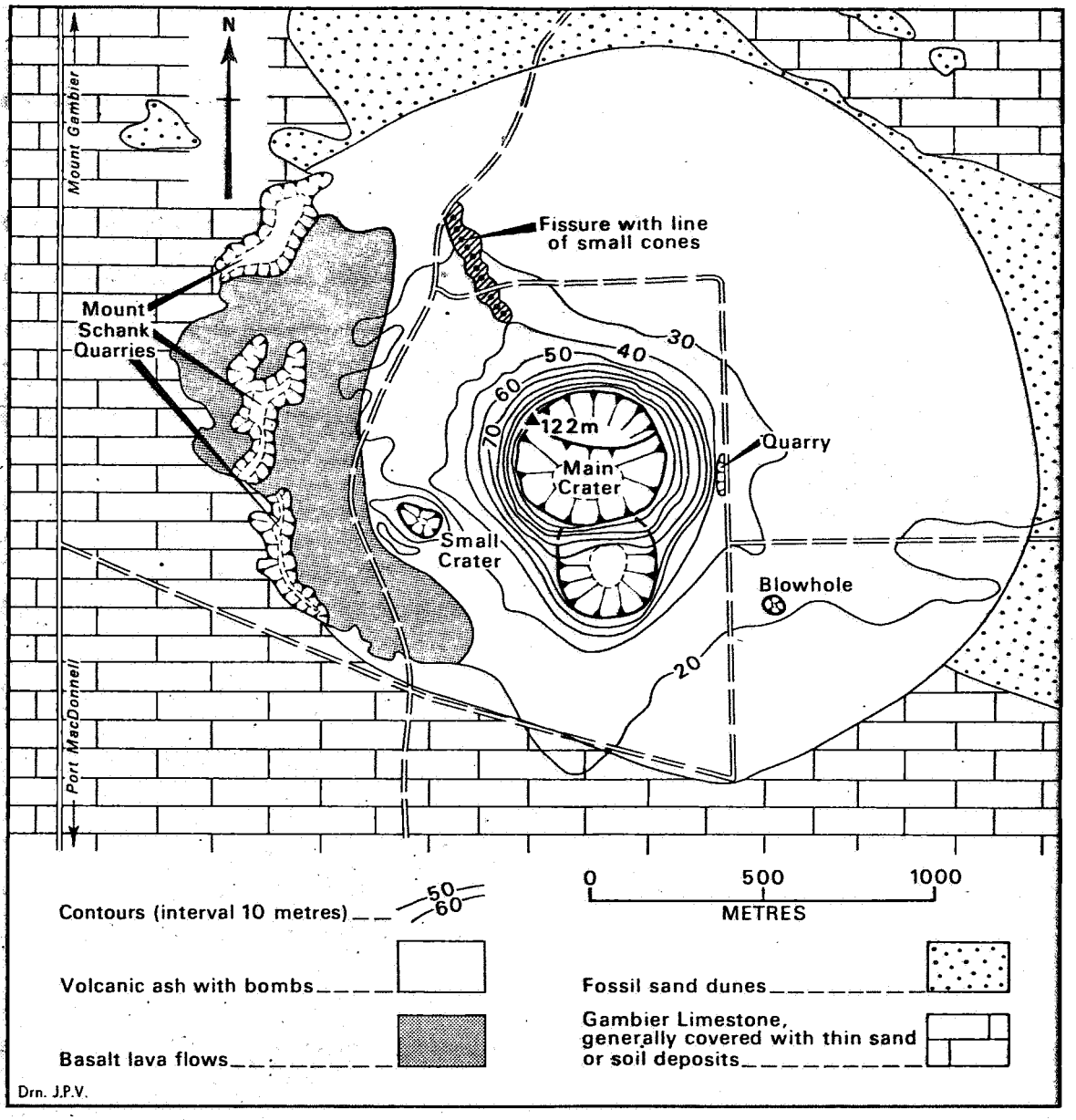

FIG. 13

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED M. J. S.	for C D O	1/4/80 DATE
QUATERNARY VOLCANISM IN SOUTH-EASTERN SOUTH AUSTRALIA	DRAWN J. P. V.	SCALE	—
VOLCANIC CONES FORMING MOUNT SCHANK (Taken from SELBY and SHEARD, 1979, Fig. 5)	DATE 5-3-80	PLAN NUMBER	S 14695
	CHECKED		

sands have an age of 18 100 ± 350 years B.P. (Polach et al., p. 365), so the volcanics are younger than this. Palaeomagnetic data from Mt Schank differs significantly from that obtained for Mt Gambier (Barbetti & Sheard, in prep.). Thus the two structures are not contemporaneous; it is not possible from present data to determine which structure is older.

There appears to have been no break in eruption at Mt Schank as is evident at Mt Gambier. However, exposure of the whole volcanic pile near the craters is incomplete, thus, obscuring any evidence to the contrary.

Initially lava flowed westward from a northwest-trending fissure - now marked by a line of small scoria cones (Fig. 13). Explosive activity followed with the development of a large ash-scoria cone at the centre of the fissure and a small maar crater at the southern end. Straddling the small maar and almost obliterating the large cone is a larger hybrid maar-cone structure composed mainly of lapilli and agglomerate (Fig. 14) which completed the eruption at this site.

Strong southwesterly winds have influenced the ash distribution during eruption and the effects of this are displayed in Figure 13.

OBSERVED ACTIVITY IN THE PROVINCE

The possibility that aboriginal people witnessed volcanic activity at Mt Muirhead was mentioned earlier. It is even more likely that they saw eruptions from Mt Schank and/or Mt Gambier: evidence for this is recorded in the Booandik Tribe legend of the giant Craitbul which also tells of him digging ovens at Mt Gambier, four times he dug his oven and lit a fire but each time the underground water rose and put it out (Smith, 1880).

Since European settlement commenced 150 years ago tectonic activity in this volcanic province has been restricted to earthquakes. Two of the State's largest earthquakes have occurred near Robe and Beachport (May 1897, August 1948), just to the northwest of the province. Sutton et al., (1977) have demonstrated that these were most likely due to regional tensional releases related to crustal plate tectonics. Sprigg (1959) postulated a link between these two earthquakes and the existance of three possible submarine lava flows some 17 km WSW of Beachport, Table 1. So far no samples have been collected from these supposed flows, or detailed magnetic surveys over them made, hence, their volcanic origin remains a point of conjecture.

More recently a series of small earth tremors have shaken areas closer to Mt Gambier. These tremors occurred between 1975 and late 1976, (Sutton et al., 1977; McCue & Sutton, 1979). The distance from the nearest recording stations precluded calculation of the exact epicentre, but a local seismic network currently being set up by the Adelaide University Physics Department will provide more accurate data in the future. Sutton et al. (1977) have indicated that the close association of the volcanic province with recent earthquake activity cannot be ignored.

On present indications, future volcanicity cannot be ruled out, but future eruptions are expected to be on a small scale and relatively rare events - at least in terms of the human lifespan.

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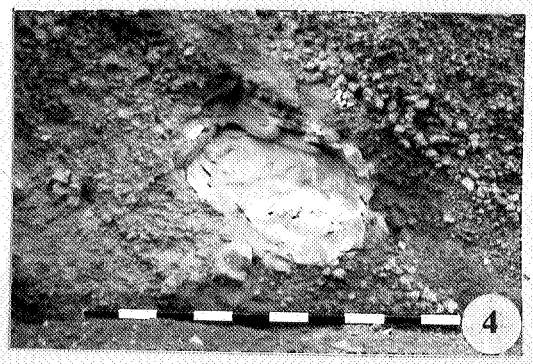
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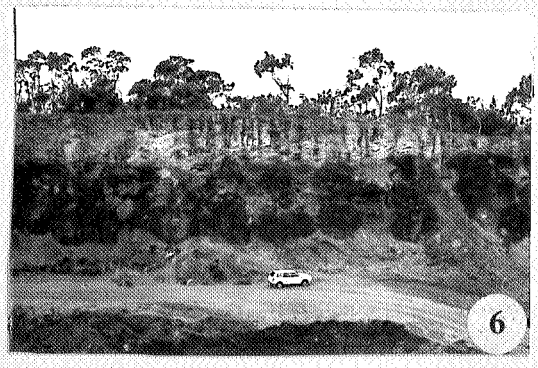
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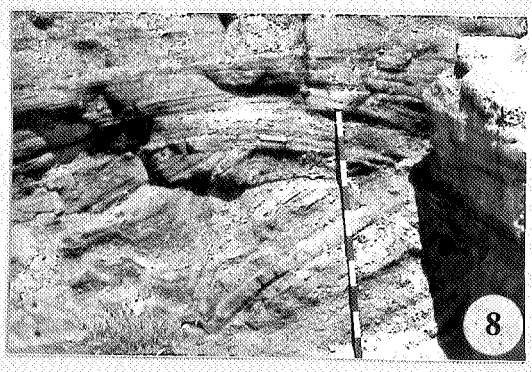
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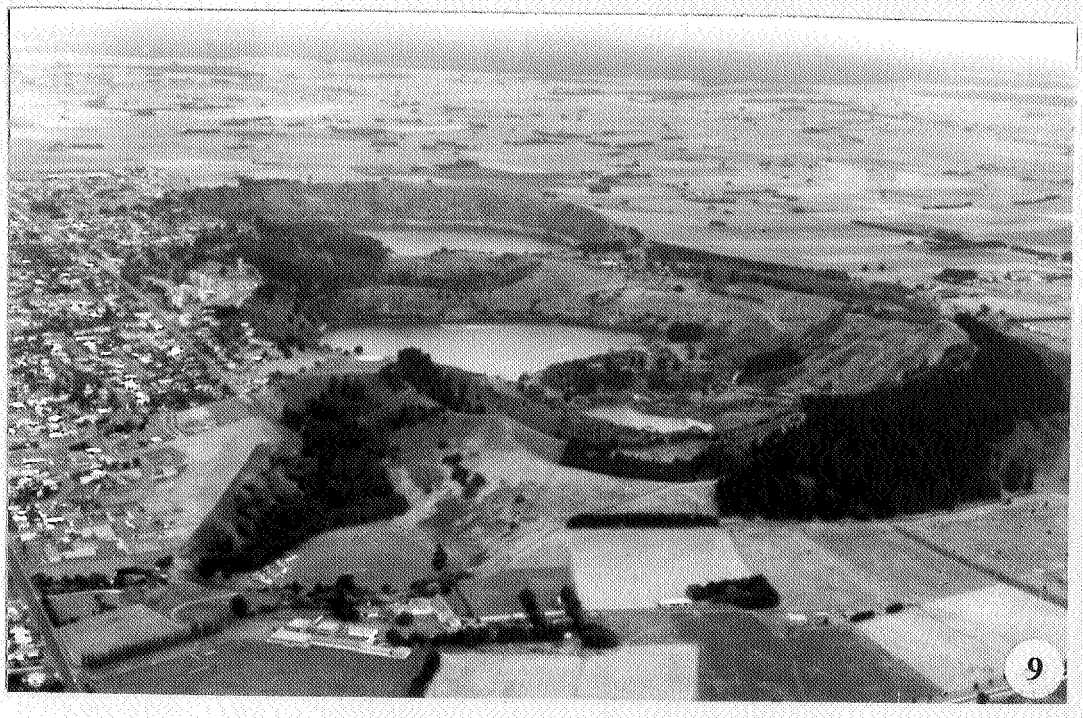
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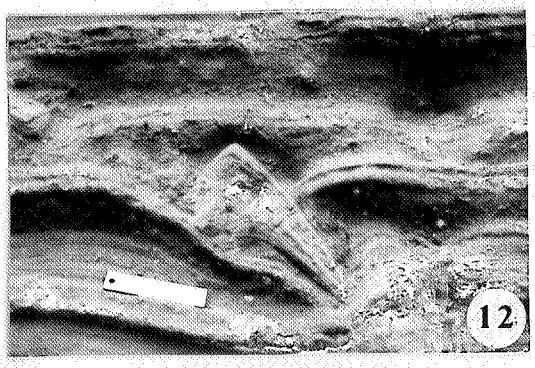
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