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AN HYPOTHESIS RELATIVE TO THE AGE OF SOME WESTERN DISTRICT VOLCANOES, VICTORIA

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Abstract

Volcanoes of proved Holocene age have ash spreads related directly to the present prevailing winds. A number of Western District volcanoes have ash spreads chiefly to the east, and this cannot be explained by the direction of present winds. It is hypothecated that during the Pleistocene the strong westerly winds now blowing over Tasmania (the 'Roaring Forties') would blow over Victoria, and so account for the ash spreads to the east. If this hypothesis be correct, then the volcanoes with easterly ash spreads are Pleistocene in age.

Introduction

Most of the Western District of Victoria is occupied by a great basaltic plain, some 9,000 sq. miles in area, which Grayson and Mahony (1910) claim to be the third largest in the world. Numerous vents occur over its surface, and the work of distinguishing the many basalt flows and ash spreads, and determinining their ages, has been but begun (e.g., Hills, 1939). The problem is a complicated one. Flows have coalesced, and ash spreads often screen lava flows. The present hypothesis is put forward as a possible means of determining the age of some of the ash spreads.

Tower Hill

The Tower Hill nested caldera (Fig. 1 and Plate XX) is situated about 10 miles NW of Warrnambool. It consists of a high rim of thinly-bedded tuff* and lapilli some 300 feet thick in its thickest part. The caldera owes its origin to collapse as there is not around it the heavy ejectamenta which would be present if it were of explosive origin. There is a number of nested cones consisting chiefly of heavy and light scoria. The scarp to the north of Tower Hill marsh (see Fig. 1) is believed to be a former coastline. It continues NE under the high bank of tuff beds west of the Lake, round the northern rim of the caldera (where the Miocene limestone bedrock outcrops), and then in a long sweep round behind the city of Warrnambool which is built on Pleistocene aeolianite standing on a sloping former sea-floor (Gill, 1943). The contours in Fig. 1 show the highest beds to be on the NE of the caldera. The level of the terrain has been built up through the highest vertical distance on this side, moreover, because built in front of the former coastal cliffs. This indicates that the majority of the ash has been distributed to the NE of the vent, a direction related to the present prevailing SW winds (see wind rose on Fig. 1).

As the ejectamenta from a volcano are lifted into the air by the up-sweep of hot gases and by explosion, their spread is determined by the degree to which winds modify their original trajectory. When accounting for the ash spread of a volcano, the direction of the prevailing winds is primary, and their strength secondary. The strength of the wind will influence the distance to which a certain type of ejectamenta will be distributed, but not the direction of the spread. Ash spread is mainly a function of prevailing wind direction.

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* Tuff in this paper means consolidated volcanic ash.

Thus in studying the ash spreads of Western District volcanoes, a wind rose was constructed representing average wind direction and not strength. The readings used were made twice daily over a period of two years. However, it may be noted that in the Tower Hill area, the SW are not only the prevailing winds, but they also include the strongest.

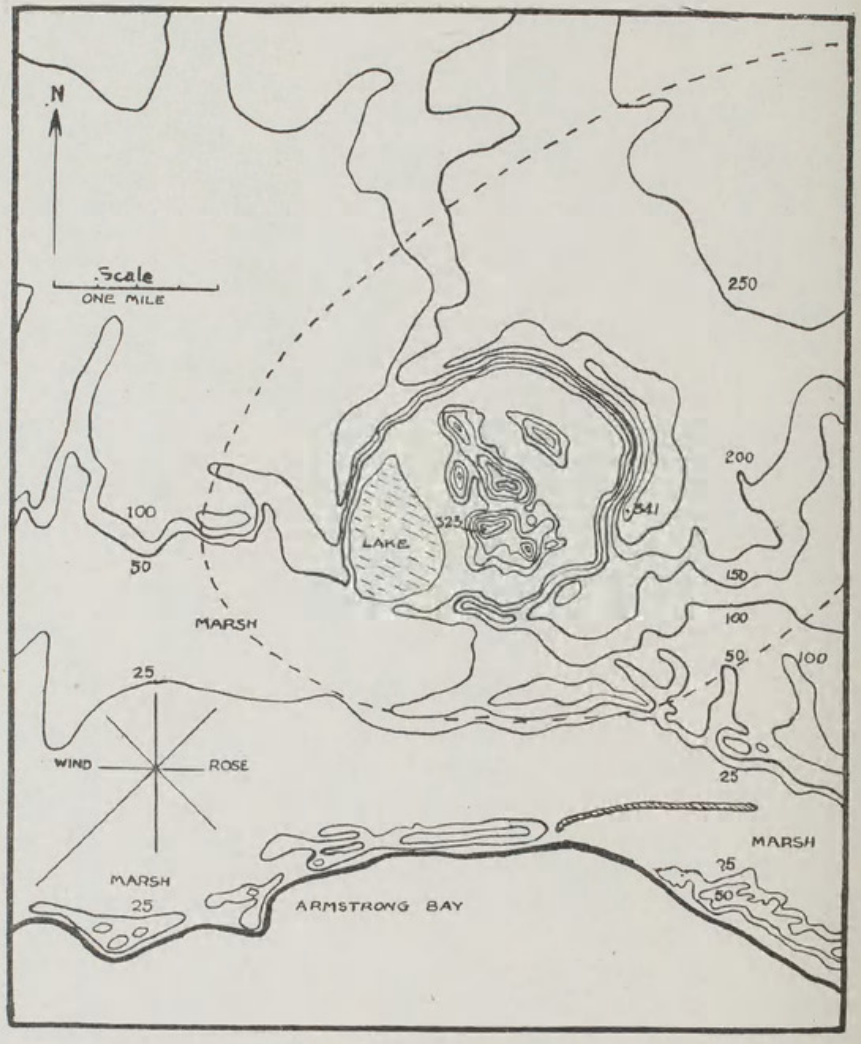

Fig. 1. Tower Hill nested caldera. The broken line represents approximately the limits of continuous ash cover. It extends eastward as far as Yangery Creek.

Age of Tower Hill Tuff

The age of the Tower Hill caldera is shown by the geological structures on which its ejectamenta are spread. They lie upon a soil layer developed on the Pleistocene aeolianite of Warrnambool and Dennington. Tuff occurs also on top of beds of Holocene shells associated with the latest emergence of fifteen-twenty feet (Gill, 1943, 1947a). An even closer dating can be made by a study of the disposition of the tuff at Warrnambool in relation to an old sea cliff cut by the 15-20 ft. sea (Fig. 2a, b).

The fact that the ash piled up against the old sea cliff but was not washed away, although material so easily eroded, indicates that the sea had receded to approximately its present level when Tower Hill erupted, i.e., the last emergence was practically completed. This is a very recent event.

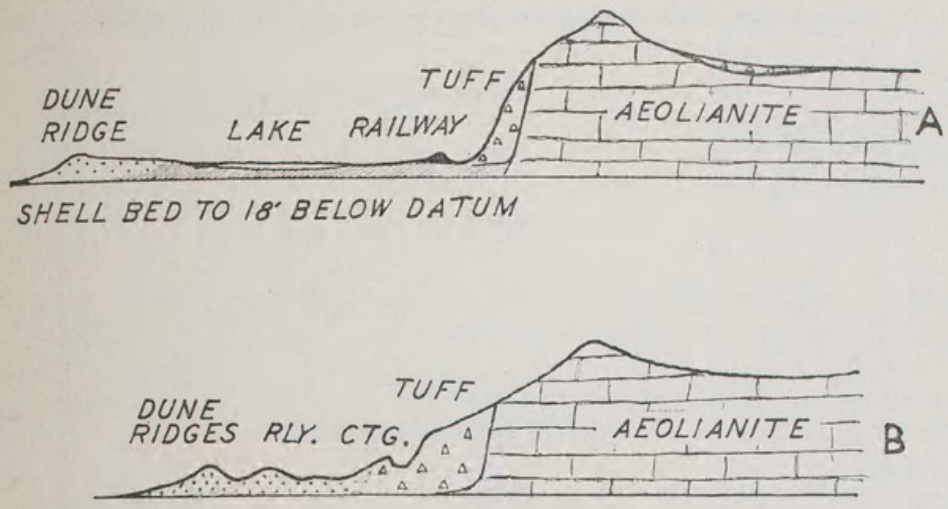

Fig. 2. Semi-diagrammatic cross-sections of former sea-cliff at Warrnambool showing the relationship of the Tower Hill tuff to it and to present sea-level. The base line in each case is Admiralty datum.
Horizontal scale : 1″=660′. Vertical scale : 1″=100′
A. Section through Cannon Hill, railway embankment, edge of Lake Pertobe, and foreshore dune ridge to beach, on west side of the Pertobe Rd. railway bridge.
B. Section similar to A, but east of railway bridge, through railway cutting below the lighthouse.

Volcanoes With Easterly Ash Spread

Mount Warrnambool

Sixteen miles ENE of Warrnambool, near Panmure, is the nested caldera of Mt. Warrnambool (Fig. 3), not previously recognized as such. It is another collapse caldera with a very steep inner edge to the surrounding tuff rim, and an outer edge of moderate slope. The rim is of thinly bedded tuff and lapilli as can be well seen in a quarry marked on the map (Fig. 3). The strata slope out from the centre at angles of from five to ten degrees. Marshy flats occupy the space between the tuff rim and the central scoria cone.

The central cone is notable for its height of nearly 400 feet above the caldera floor and the fact that it has two craters in the summit. The ash spread of this volcano is chiefly to the east, as shown in Fig. 3. The rim on the east side rises well above the 400 ft. contour shown.

The following two volcanoes are other examples of vents with easterly ash spreads.

Wangoom Hill

This volcano is 8 miles NE of Warrnambool, and its easterly ash spread is most marked, there being but a low mound in other directions (Fig. 4). At the base of the high easterly ridge can be seen some scoriaceous volcanic agglomerate and a small amount of dense basalt. Most of the ejectamenta above this appear to be tuff and lapilli, but there is also some finely divided scoria. A windmill bore put down on the outer side of the ridge traversed a considerable thickness of what the workmen called ' slate,' i.e., finely bedded tuff. The hundreds, or rather thousands, of layers of tuff seen in each of the volcanoes described in this paper show that they are not maars, and the piling of material to the east of their vents was not the result of a sudden volcanic paroxysm. There was ejection of ash intermittently over a not inconsiderable period, and the ash spread is an indication of the prevailing direction of the winds which blew through that period.

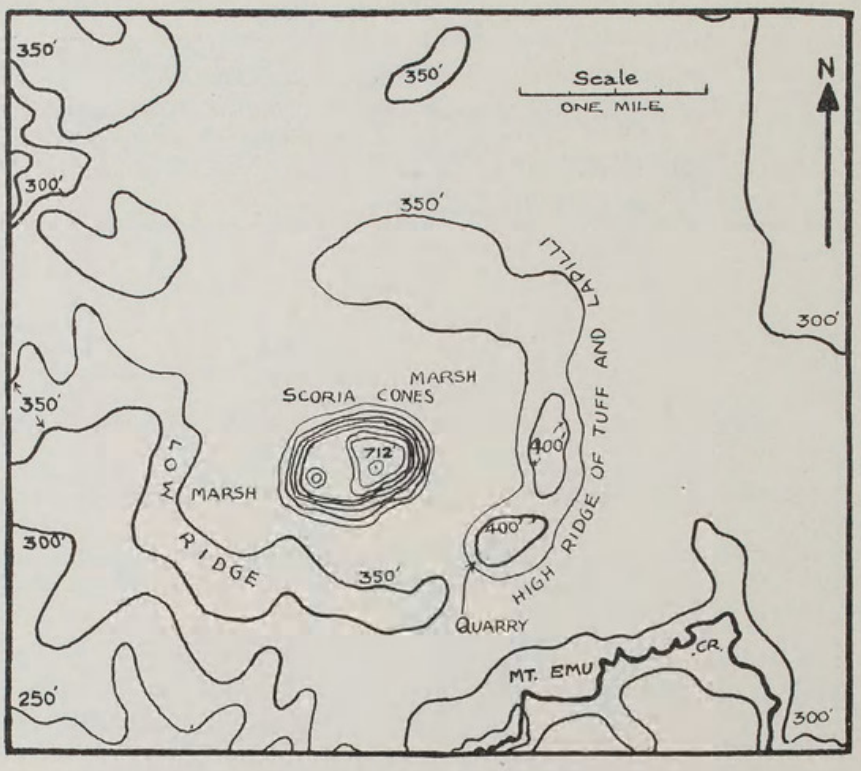

Fig. 3. Mt. Warrnambool nested caldera.

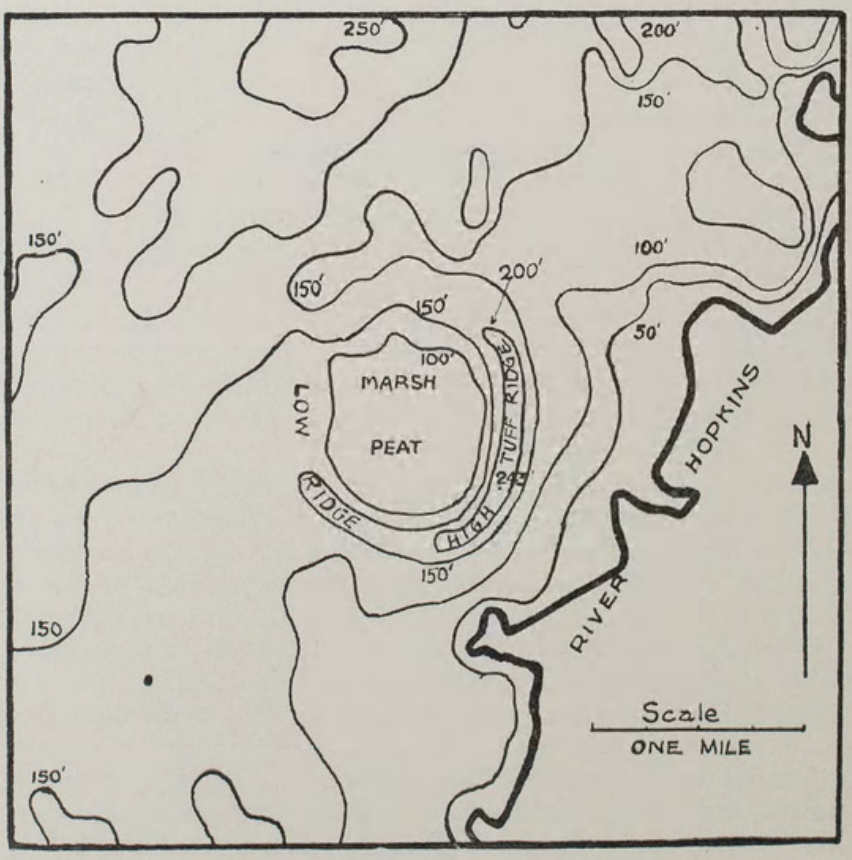

Fig. 4. Wangoom Hill volcano.

Wangoom Hill and Ecklin Hill are not calderas like Tower Hill and Mt. Warrnambool, but they are vents of the negative type (Stearns and MacDonald, 1946), i.e., they have been enlarged by collapsing. This accounts for the steep inner walls of the tuff rings of these volcanoes. They are really calderas on a small scale. Collapse features are very common in the Western District volcanic structures, and this suggests a weakness in the marine limestone bedrock common to them all.

Ecklin Hill

This volcano is situated 24 miles east of Warrnambool and 9 miles south of Terang; it has been previously described (Gill, 1947b). Its form is very similar to that of Wangoom Hill.

Thus examples are given of one caldera and two other volcanoes whose ash spreads are very markedly to the east. Such spreads could not have been caused by winds such as blow today. Nor could they have been caused by a combination of the NW and SW winds which blow at the present time because, firstly, the north-westerly winds are negligible, and secondly, a different geomorphology would be expected, viz., a tendency towards highest points to the NE and SE. Again, if the easterly ash spread were found with only one volcano, it might be explained as a phenomenon of that particular event, but the easterly spread is common.

Hypothesis and Conclusions

It is assumed that during the periods of glaciation in the Pleistocene, the weather moved northwards in front of the advancing Antarctic ice-cap. The strong westerly winds known as the 'Roaring Forties' which now blow over Tasmania, would then in all probability blow over Victoria. If so, these could account for the easterly ash spread of the volcanoes described.

If this hypothesis be correct, then the volcanoes with easterly ash spreads are Pleistocene in age.

The volcanoes with easterly ash spreads are still well preserved, although the Mt. Warrnambool caldera, for instance, is obviously more eroded than the Tower Hill caldera. Valleys are beginning to appear in the high easterly tuff ridge at Mt. Warrnambool. However, volcanic ash readily absorbs water, and observers have pointed out that such structures may remain intact for a long time on this account, but that once erosion gets started, it is often very rapid. From old records it appears that the tuff deposits were covered with forest until cleared by early settlers. The vegetative cover would reduce the power of the subaerial agents to erode the tuff rings. In view of the shortness of the Holocene period, it is possible for Pleistocene physiographic structures to be quite well preserved. However, as the volcanoes with the easterly ash spreads are still comparatively well preserved, they may tentatively be regarded as Upper Pleistocene in age.

Acknowledgments

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Explanation of Plate

PLATE XX

Aerial photograph looking E.S.E. over the Tower Hill nested caldera. Note the high caldera wall of tuff to the N.E. (top left of photo.) and how it gradually dies out towards the south.

(A. Wilkins photograph.)

Gill, Edmund Dwen. 1950. "An hypothesis relative to the age of some Western district volcanoes, Victoria." *Proceedings of the Royal Society of Victoria. New series* 60, 189–194.

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