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DISCUSSION: Major geomorphic features of the Kosciusko–Bega region

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Ollier & Taylor (1988) are correct when they write that the Kosciusko–Bega region has long been of interest to geomorphologists. They also point out that there has been debate over its geomorphic evolution since the early 1900s and, after reviewing some of this, develop a hypothesis of landscape evolution for the area. We wish to examine the data underlying their hypothesis, and comment on other aspects of their paper.

The geomorphic arguments of Ollier & Taylor suppose (1) that the pre-basaltic drainage of the Monaro was to the north, and (2) that the basalts derive from a single large shield volcano centred on Brown Mountain. There is little evidence for either idea.

We know of no data which show that the major pre-basaltic drainage of the Monaro was northwards. Taylor & others (1985) showed that the pre-basaltic drainage north of the present Great Divide between Berridale and Nimmitabel was to the north. They also argued, however, that the divide has not shifted since the early Eocene, because they could show southwards drainage into Wullwye Creek then. No published data confirm pre-basaltic drainage directions further south. Ollier & Taylor's evidence for north-flowing pre-basaltic rivers is that, south of their postulated shield volcano, the present drainage is northwards. Veitch (1986) showed palaeodrainage on the highlands above the Towamba River to the southeast, in line with the present Towamba valley. We suggest that the palaeo-Towamba was a major drainage outlet for the southern Monaro, because here the basalts are at their lowest elevation. Recent field mapping of the Bombala 1:100 000 sheet area, by staff and students of the Geology group at the Canberra College of Advanced Education, has revealed palaeocurrent directions in pre-basaltic sediments, which show palaeoslopes to the north, west, west-northwest and south.

The only evidence in Ollier & Taylor for the existence of a large shield volcano, their 'Monaro volcano', is a radial drainage pattern around Brown Mountain. While we recognise the radial pattern, it might have other causes. Brown Mountain has a basalt capping and is the highest point on the escarpment in the region. It is not surprising that some streams drain off this feature. Most of the major drainage around Brown Mountain is in basement rock, and drainage to the north and south largely follows a north–south structural grain. Drainage to the east runs generally east, off the existing escarpment and mostly through massive granites. It is also partly controlled by northwest-trending fracture zones in the basement. To the west, drainage is west, mostly off basalts on the broad, west-sloping Monaro plateau. Ollier & Taylor argue that the drainage might be superimposed, but any earlier drainage pattern would need to be inherited through a considerable amount of basement erosion (>750 m, east of the escarpment). It should also be noted that, in the northwestern part of the Monaro, there is a major drainage system which does not conform to a radial pattern related to Brown Mountain (e.g. Wullwye, Cooma Back, Slack's and Bridle Creeks).

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Field observations at Brown Mountain show a sequence (<240 m thick) of horizontal basalt flows. This thin sequence of flows is inconsistent with nearness to the centre of a shield volcano 80–100 km wide (by Ollier & Taylor's reckoning). At the trig station there is a small area (150 m across) of basalt containing crustal xenoliths which might be part of a small volcanic plug, like the many others we have found across the southern Monaro. There is certainly no surface evidence for a major volcanic plug or central intrusive complex which is usually developed in large shield volcanoes, such as Tweed Volcano, Barrington, and others, (Wellman, 1986), and Mt Dromedary (Eggleton, 1987). No significant magnetic or gravity anomalies suggest a hidden feeder or central complex in the area (Department of National Development, 1978; Bureau of Mineral Resources, 1976).

In contrast with this lack of evidence for a large shield volcano, there is good field evidence that the Monaro basalts erupted from many vents over a wide area of the southern Monaro (Brown & others, 1988). We have located 23 plugs and eruption points, scattered basaltic tuffs and a maar structure (Fig. 1). Evidence for flow directions, including

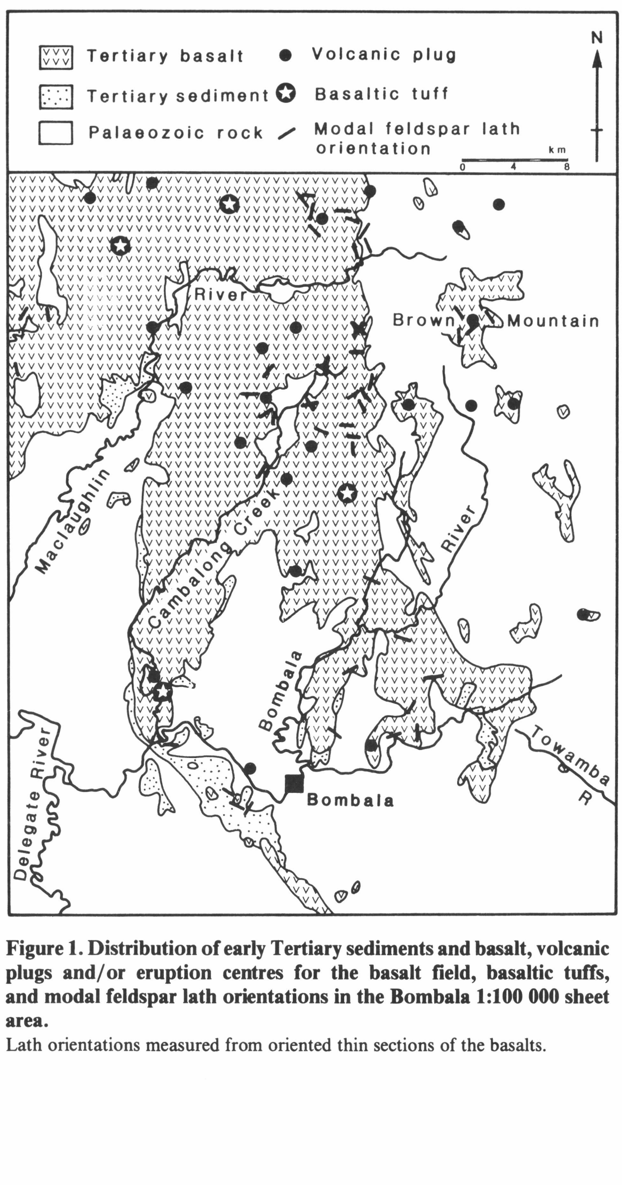

Figure 1. Distribution of early Tertiary sediments and basalt, volcanic plugs and/or eruption centres for the basalt field, basaltic tuffs, and modal feldspar lath orientations in the Bombala 1:100 000 sheet area.
Lath orientations measured from oriented thin sections of the basalts.

plagioclase lath orientations, directions of vesicle alignment and palaeoslope information, is consistent with basalt eruption from many vents into predominently north–south trending major valley systems. We therefore believe that the Monaro basalts are the remnants of a lava field rather than a shield volcano (see also Wellman & McDougall, 1974), and we propose the term Monaro Lava Field to describe more accurately the volcanic province.

Since there is no unequivocal evidence for the former existence of a large shield volcano, and even less evidence for its shape and extent, it is hard to see how Ollier & Taylor can claim that about half of it has been eroded away. If the 'Monaro volcano' did not exist as a circular or sub-circular pile, then Ollier & Taylor's arguments on the age of uplift and hence the Great Escarpment are not supported. Their argument that most of the uplift (and the escarpment) post-dates 50 Ma is based on removal of the eastern part of the hypothetical volcano and their view that the present regional relief is much greater than that of the pre-basalt surface (about 10 times, on their Fig. 3). Near the Towamba River, the pre-basaltic relief was at least 400 m and perhaps as much as 800 m (Veitch, 1986), which is half to all the present relief. In other areas of the Monaro, the sub-basaltic relief is up to 300 m. Some palaeovalleys are deeply incised, and have very steep sides (from 50° to near vertical). Such relief suggests substantial enough pre-basaltic uplift for the development of an escarpment.

In arguing against an early Tertiary escarpment, Ollier & Taylor draw an analogy with an area near Innisfail, where basalt 2 Ma old drapes the escarpment, showing that the scarp was there before 2 Ma ago. They then claim that, because this situation cannot be found on the Monaro, a scarp did not exist 'near' its present position before basalt eruption. Since the basalts of the Monaro date from the Paleocene, and have been subjected to at least 30 Ma of erosion, we suggest that the analogy with Innisfail is inappropriate and misleading.

Some major geomorphic features in the Kosciusko-Bega region have not been covered by Ollier & Taylor. Notable among these is Mt Dromedary, a large mid-Cretaceous volcano (Eggleton, 1987; Smith & others, 1988), which must have been a significant geomorphic feature during the late Mesozoic and probably also the early Tertiary. Remnants of its volcanic pile crop out near sea level, suggesting that it erupted east of any existing escarpment and/or highlands, or that the base of the volcano has subsided (relative to the highlands) since the Late Mesozoic.

We also point out the following errors and/or drafting mistakes in the paper of Ollier & Taylor. The average elevation of the Monaro is about 850 m, and not 2000 m as they state. On Ollier & Taylor's Figure 2, the Bago Plateau has been labelled the Bega Plateau and the Coolumbooka River the Bombala River. Their Figure 5 shows the lower Murrumbidgee River draining south, implying that Lake Bunyan was the centre of an internal drainage system. This was never implied by Taylor & Walker (1986).

Much work is needed to resolve the geomorphic history of the Kosciusko–Bega region. We make a strong plea for more detailed field studies, rather than the erection of hypothetical models based on inadequate or erroneous data.

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REPLY

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Taylor & others correctly state that we envisage a large volcano, centred on Brown Mountain.

They mistakenly conclude that the presence of many eruption points shows that there was no major volcano with radial drainage. In fact, many large volcanoes with radial drainage have numerous parasitic cones on their flanks. Well known examples are Mt Etna (Romano, 1982), shown in Figure 1, and Tristan da Cunha (Baker & others, 1964; Ollier, 1988, fig. 3.0).

In analysing drainage patterns around volcanoes one looks for radial drainage on the volcano, pre-volcanic drainage lines and their possible continuations, and drainage flowing around the volcano or otherwise diverted. All these we have described from the postulated Monaro Volcano. Radial drainage is a major indicator of volcanic drainage, even when much of the original volcano has been removed. This is described, with examples from New South Wales, by Ollier (1985). A particularly fine example is that of the Ebor Volcano (Ollier, 1982), where about half the original volcano has been destroyed by erosion. The radial drainage, however, is reserved, even though the valleys are now superimposed on underlying bedrock with structural directions different from the drainage lines.Napak Volcano in Uganda retains a radial drainage pattern even though only an estimated 3% of the original volcano is preserved (King, 1949).

Interpretation of buried and diverted drainage may be illustrated by using the modern Mt Etna as an analogue (Fig. 1). Pre-volcanic rivers there flowed southeast, but after being blocked by the volcano, the drainage is now via the River Alcantara in the north and the River Simeto in the south. Details of the blocking and the interaction of fluvial and volcanic features over the past 300 000 years are given by Chester & Duncan (1932). Our interpretation of the original northerly direction of rivers in the Monaro region is not based on Taylor & others (1985), but on an analysis by D. Taylor of Cretaceous drainage of this and a larger region. A map of this drainage will be published in Ollier and Wyborn (in press).

The evidence of Veitch is a matter of detail. In the case of Mt Etna, some younger lava flows occupy valleys formed long after the original valleys were buried, and follow prior courses of the Alcantara and Simeto rivers (Fig. 1), but they do not affect the large scale interpretation of earlier events.

Detailed mapping of the whole Monaro area will eventually lead to a fuller understanding of the landscape history of the region, but the few points of detail provided by Taylor & others do not persuade us that our general view is incorrect.

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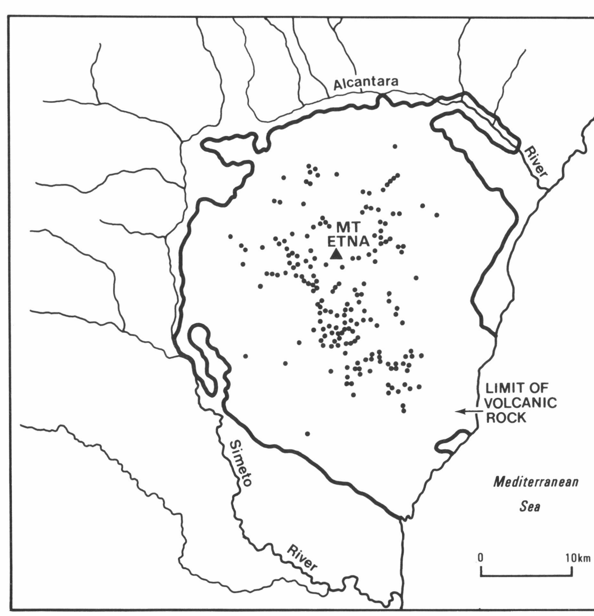

Figure 1. Drainage diversion around Mt Etna, Sicily, and the distribution of points of eruption.