This is a **pre-print** of an article published in
Proceedings of the 13th Australasian Conference on Cave and Karst Management. pp 148-151 (1999)

VOLCANIC CAVES AND RELATED FEATURES IN WESTERN VICTORIA.

Ken G. Grimes.
Regolith Mapping, PO Box 362, Hamilton, 3300, Australia. (*ken-grimes@h140.aone.net.au*)

ABSTRACT

The basaltic volcanic plains of western Victoria range in age from over five million years ago up to quite recent times. They host a variety of volcanic caves including large lava tubes formed by the roofing of surface lava channels, smaller but more complex lava tubes formed by draining from beneath the crust of lava lobes, and one example of a still-open volcanic vent or hornito. Management problems involve a conflict with quarrying of scoria cones, the demands of a growing tourism industry, and the karst-like problems of the underground drainage of the younger "stony rise" lava flows.

The Newer Volcanics Province

The Newer Volcanic Province of western Victoria is one of the world's larger volcanic plains, and has formed by a succession of eruptions and lava flows over the last five million years. The isolated volcanoes at Mount Gambier are a western outlier of the Province (Figure 1). Eruptions have continued up to quite recent times (as little as 5,000 years ago) and further eruptions could occur in the geological future. Current isotope dating suggests that the youngest volcano may be Mount Schank, south of Mount Gambier, which erupted 5,000 years ago; followed by Mount Napier, south of Hamilton, which probably erupted about 8000 years ago. The flows associated with these younger eruptions show better preserved caves and surface features than those of the older volcanics. None-the-less, several of the caves are in flows several million years old.

Lava tubes and other volcanic caves are scattered across the province, but the majority of them are in the western area where they are associated with two of the younger eruptions in the region (Webb & others, 1982, Grimes, 1995, Grimes & Watson, 1995, Grimes & others, 1999).

Surface landforms

The volcanics are dominantly built up from lava flows, but there are numerous small volcanic cones built by explosive activity, as well as larger maar lakes formed by major explosions.

The older volcanoes of the region have degraded features, and thick lateritised soils, which make their recognition difficult. By contrast, the flows from the younger eruptions have only minimal soil development and rough undulating surfaces known as *stony rises*; isotope dating suggests that these are

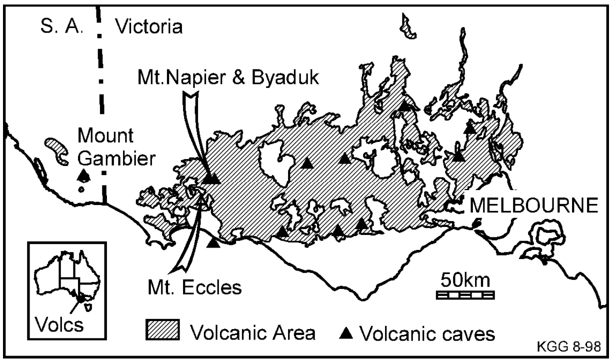


Figure 1: The Newer Volcanics Province and caves.

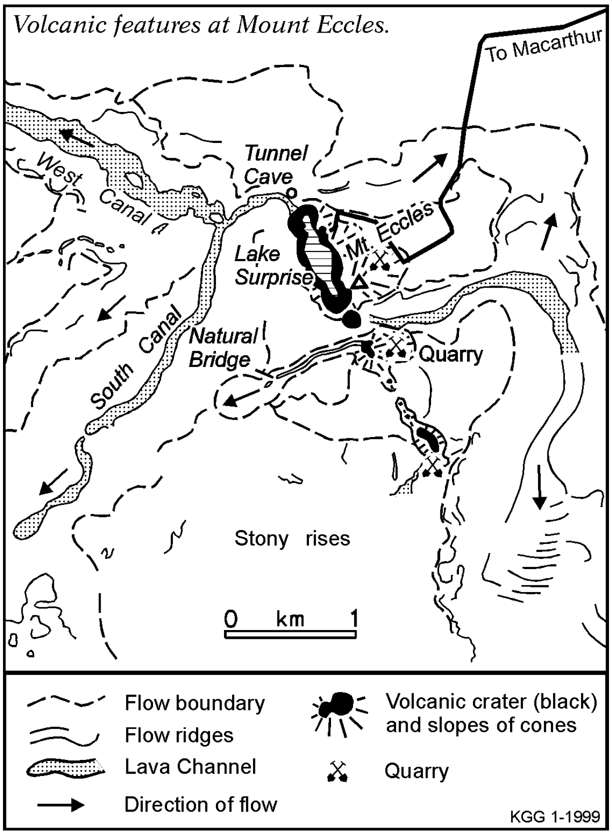


Figure 2: Mount Eccles area, showing lava channels and other features

all less than 500,000 years old.

The best modern model for the nature of vulcanism in this region is provided by the Hawaiian volcanoes. There we see broad lava shields built up by successive flows of very fluid basaltic lava spreading out from a central crater or fissure. In the crater area we see lava pools with fountains jetting into the sky and building local small cones of welded spatter or loose scoria. The long lava flows are seen to be fed either by surface channels, or underground via lava tubes.

Local examples of lava shields are the lower slopes of Mount Napier and the lava fields surrounding Mount Eccles. However, in Victoria we also have slightly more explosive eruptions which build larger scoria cones; and the maar lakes, which are large but shallow craters formed by major steam driven explosions (Orth & King, 1990). At Mount Eccles a line of scoria cones running southeast from the main crater could have formed along a fissure eruption (Figure 2).

Lava flows:

Basaltic lava is a hot (1100°C) liquid that can flow readily. There are two main forms of basaltic lava flow, which grade into each other. *Pahoehoe* lava is the most liquid form - characterised by the formation of thin smooth skins that become wrinkled (hence its alternative name of 'ropy lava'). Pahoehoe lavas advance as a succession of lobes, each of which develops a skin, is inflated by the liquid pressure within, then ruptures at one or more points to release liquid lava to form new lobes (Figure 4).

As pahoehoe loses gas and cools it becomes frothy and more viscous. The surface tends to crack, twist and break into angular, often spiny, blocks to form what is called *aa* or 'blocky' lava.

Behind the advancing lava front solidification of stagnant areas restricts lava movement either to narrow surface *channels*, or internally in *lava tubes* beneath a surface crust. Overflow from the surface channel builds up a *levee* bank of thin sheets or spatter. Larger flows across the levee can feed lateral lava lobes with small internal lava tubes. A major breach of a levee may result in a large side flow, fed by its own channel, and the original channel may be abandoned. Good examples of lava channels (locally referred to as 'canals') occur at Mount Eccles (Figure 2). A number of shallow lava tubes are known in flows that have run off to the sides from these channels (Grimes, 1995, Figure 6).

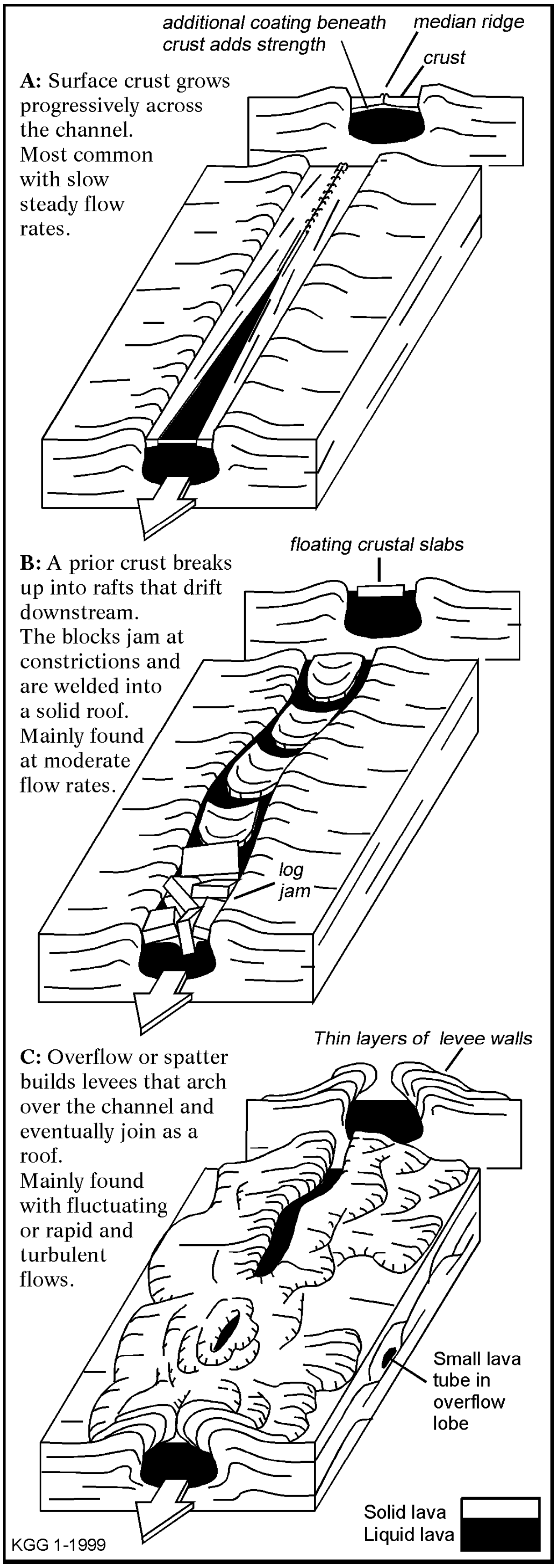


Figure 3: Three ways to make a lava tube by roofing a lava channel. Based on descriptions in Peterson & others, 1994.

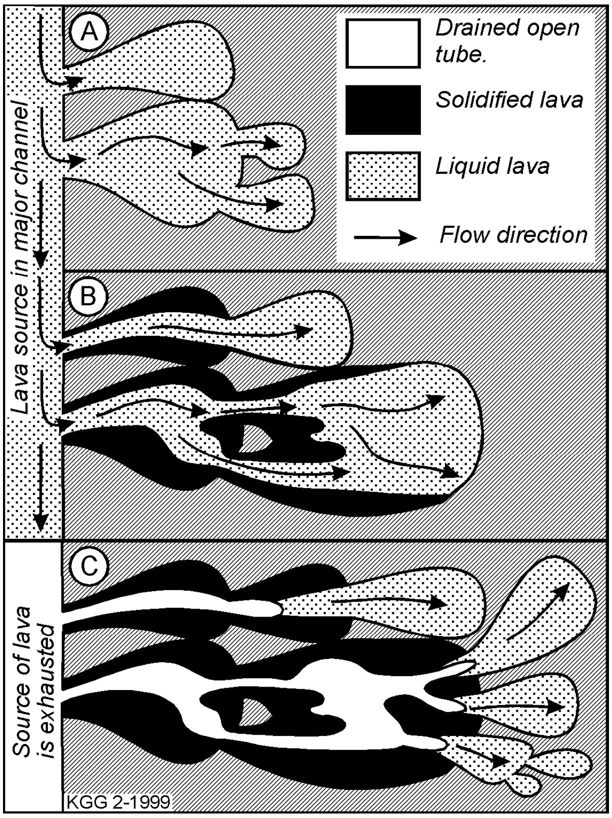


Figure 4: Stages in the formation of lava tubes by draining of lava lobes.
A: Thinly crusted lobes of lava expand by breakouts through ruptures and budding of further lobes.
B: Stagnant areas of the older lobes solidify, but hot flow from the source keeps the feeder conduits liquid.
C: When the source flow ceases some of the conduits may drain to form air-filled cavities.

Lava tubes provide good insulation for the hot lava flowing within them. This allows the formation of very long flows such as the 50km Tyrendarra Flow from Mount Eccles, which extends offshore across the continental shelf (which was dry at the time), and the older 60km flow from Mount Rouse, which may also extend offshore.

When a lava flow follows a valley, as in the Tyrendarra flow from Mount Eccles, it disrupts the drainage. Twin *lateral streams* may run down each side of the original valley. *Swamps or lakes* will form where the flow enters the valley, and where tributary valleys have been dammed by the flow.

Formation of Volcanic Caves

Lava tubes form in basaltic lava flows by two main processes which have been observed in active lava flows in Hawaii (Peterson & others, 1994): first by the roofing over of surface lava channels in several ways (as described in Figures 3 & 5); and second by the draining of still molten material from beneath the solidified crust of a flow (Figures 4 & 6).

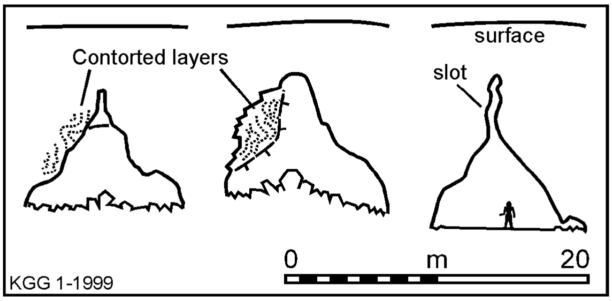


Figure 5: Cross-sections of Natural Bridge at Mount Eccles show the "Gothic" roof and contorted layers associated with roofing of a channel by levee overgrowth (c.f. Fig 3c).

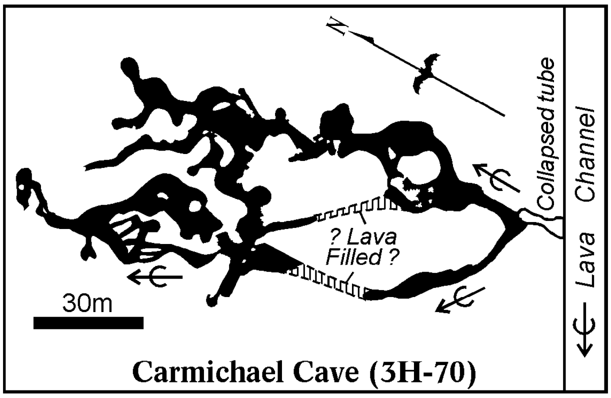


Figure 6: Example of a complex cave formed by draining of lava lobes that overflowed from a lava channel at Mount Eccles. Arrows indicate flow directions.

Tubes formed by draining of crusted lava lobes and flows are generally smaller than those formed by the roofing of a channel, but tend to have more complex forms (Figure 6). Lava lobes can be stacked vertically as well as advance forwards so that a complex three-dimensional pattern of branching tubes can form. The long lava flows in the region would all have been fed by large cylindrical lava tubes; but only a small percentage of the active lava tubes will

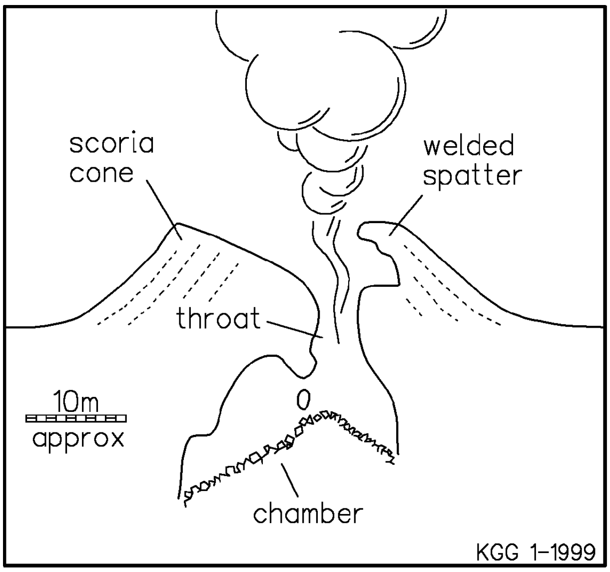


Figure 7: The Shaft is the still-open throat of a volcanic vent or hornito.

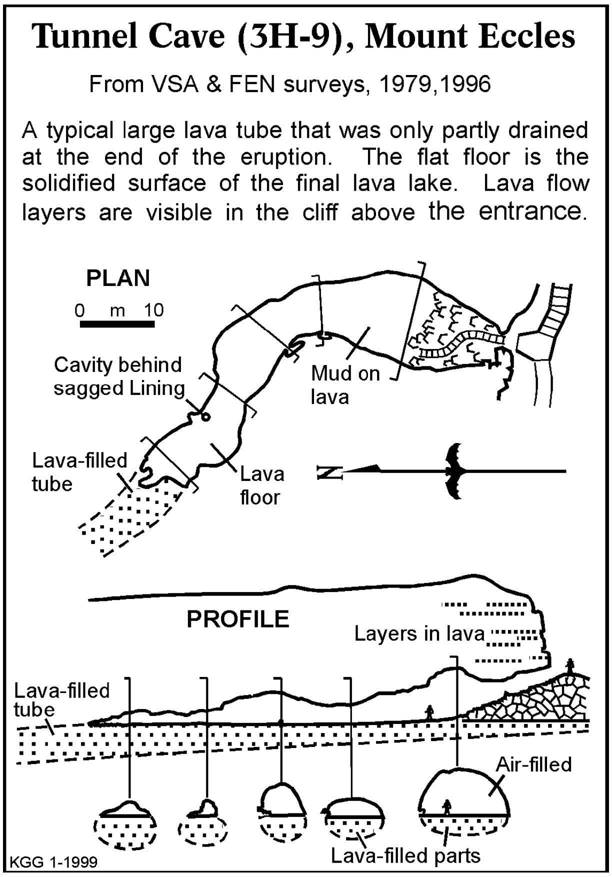


Figure 8: Tunnel Cave at Mount Eccles illustrates a roofed-channel type of tube that was incompletely drained at the end of the eruption.

be drained at the end of the eruption and become accessible to cavers. Tunnel Cave at Mount Eccles illustrates a partly drained tube (Figure 8).

Lava tubes are not the only type of cave that can form in volcanic rocks. **The Shaft** at Mount Eccles is the only Australian example of an explosive cavity and throat within a spatter cone that remained open after the volcanism ceased (Figure 7).

Features found in Volcanic Caves

The lava caves contain a distinctive suite of lava structures or "decorations", some of which are illustrated in Figure 9.

The level of lava within the tubes tends to fluctuate during the course of the eruption, and so we find thin linings plastered onto the walls and roofs, and 'tide-marks' are indicated by solidified benches or shelves on the sides of the tubes. Some shelves can reach right across a passage to form a false floor.

The thin wall linings can rupture, peel back and curve over to form draperies and scrolls. Some linings are smooth, but others have a sharp hackly

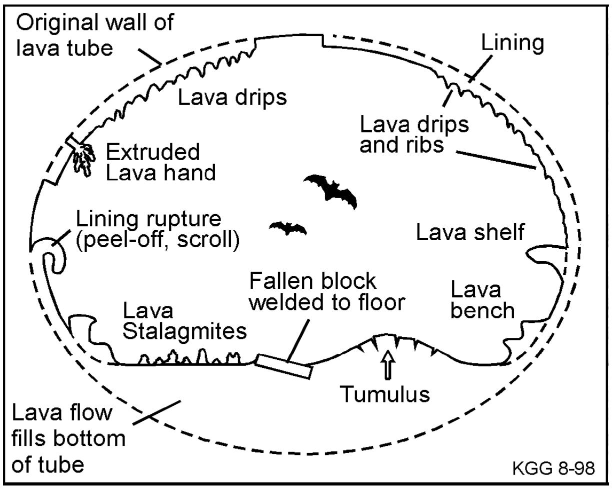


Figure 9: Features found in lava tubes.

surface which may be due to the bursting of many small gas bubbles. Rafted slabs floating on a flow surface may leave grooves and striations on the semi-solid wall linings. Lava "hands" of semi-solid lava can be squeezed out through cracks or holes in the lining.

Small round-tipped lava stalactites, (lavacicles, lava drips) form where molten lava has dripped from the roof. Lava ribs form where lava dribbled down the walls of the cave, or where the whole lining has sagged and wrinkled. If the floor was already solid (unusual) drips of lava from the ceiling can build up lava stalagmites. Stalagmites often have a knobby form in which the original drips can still be seen welded together as a lumpy mass.

The floor of the tube is often flat or slightly arched; being the surface of the last flow of lava through it. If a lava flow within a tube forms a solid crust, and then drains away from beneath it, we get a tube-in-tube effect with a thin false-floor bridging the tunnel. Small lava mounds, or tumuli, may be heaved up by pressure from below. In some caves the crusted floor has buckled and broken into a jumble of heaved up plates, or cracked into a mosaic of jostling plates with rounded or upturned edges. Material falling from the roof may be rafted some distance downstream and may end up welded into the floor, or piled up in 'log jams'.

Management of Volcanic caves

Volcanic caves share many of the problems of limestone caves. The formations found in lava tubes are even less renewable than those in limestone caves. At least a broken calcite stalactite ***might*** regrow in a few thousand years, but a broken lava formation will ***never*** do so; unless someone builds one heck-of-a hot campfire in the cave!

The stony rise country of the recent lava flows has a high permeability via fractures, vesicular zones, and open tubes. Thus the drainage is similar to karst in that surface water goes underground quickly and, if moving in lava tubes, it is unlikely to be filtered of any contaminants.

A major conflict in land use comes from the scenic and geologically interesting volcanic cones being also a source of scoria. Many have been or are still being quarried away. There are several active and abandoned quarries at both Mt Eccles and Mt Napier, and some interesting volcanic features have been destroyed while others are threatened (Guerin, 1992).

The push for tourism development in the region is putting increasing pressure on the lava caves, with the development of access steps and viewing platforms and consequent increases in visitation levels in the better-known caves. There are no show caves in the volcanic region at present, but several lava caves at Mount Eccles are signposted and open to the general public and public access is planned to at least one at Byaduk. The landowner of a lava tube near Skipton, further east, allows school and other groups to enter for a small fee. An attempt to provide a solar-powered visitor-sensing light in the self-guided Tunnel Cave at Mount Eccles was terminated by vandalism and then theft of the components.

REFERENCES

GRIMES, K.G., 1995: Lava caves and channels at Mount Eccles, Victoria. *in* Baddeley, G (*Ed*) *Vulcon Preceedings (20th ASF Conference)*, Victorian Speleological Association Inc., Melbourne., pp 15-22.

GRIMES, K.G., MOTT, K., & WHITE, S., 1999: Field Guidebook to karst and volcanic features in Southeast South Australia and Western Victoria. *Australasian Cave and Karst Management Association, 13th Conference. Mount Gambier.* 34pp.

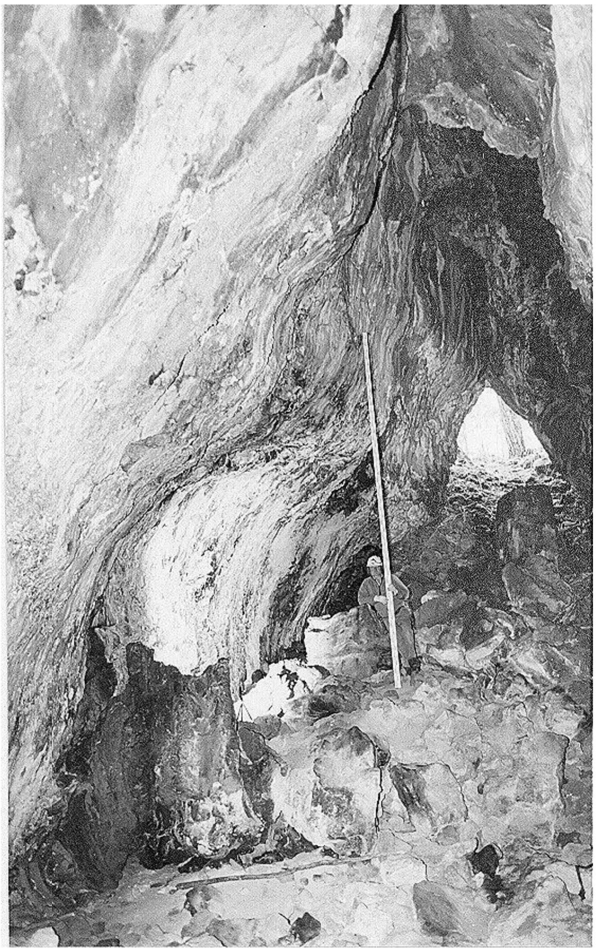
GRIMES, K.G., & WATSON, A, 1995: Volcanic caves of Western Victoria. *in* Baddeley, G (*Ed*) *Vulcon Guidebook (20th ASF Conference)*, Victorian Speleological Association Inc., Melbourne., pp 39-68.

GUERIN, B., 1992: Review of scoria and tuff quarrying in Victoria. *Geological Survey of Victoria report,* **96.**

ORTH, K, & KING, R., 1990: *The geology of Tower Hill*. Geological Survey of Victoria. 17pp.

PETERSON, D.W., HOLCOMB, R.T., TILLING, R.I., & CHRISTIANSEN, R.L., 1994: Development of lava tubes in the light of observations at Mauna Ulu, Kilauea Volcano, Hawaii. *Bulletin of Vulcanology,* **56,** 343-360.

WEBB, J.A., JOYCE, E.B., & STEVENS, N.C., 1982: Lava caves of Australia. *The Proceedings of the Third International Symposium on Vulcanospeleology, Oregon.* pp 74-85.



Gothic roof form in Natural Bridge, Mt. Eccles. 5m staff.