VOLCANIC CAVES AND RELATED FEATURES

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The Western District Volcanic Province

The Western District Volcanic Province of western Victoria (previously known as the Newer Volcanics Province) is one of the world's larger volcanic plains, and has formed by a succession of eruptions and basaltic lava flows over the last five million years. The isolated volcanoes at Mount Gambier are a western outlier of the Province (Figure 2.1). Eruptions have continued up to quite recent times and further eruptions could occur in the geological future. Current dating suggests that the youngest volcano may be Mount Schank, south of Mount Gambier, which erupted 5,000 years ago. The flows associated with these younger eruptions show better lava caves and surface features than those of the older volcanics. None-the-less, a few 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 – Mt Eccles and Mt Napier (Webb & others, 1982, Grimes & Watson, 1995, Grimes, in press). See chapter 5 for cave descriptions.

Surface landforms

The volcanics are dominantly built up from basalt lava flows, but there are numerous small volcanic cones built by explosive activity, as well as larger maar lakes formed by major explosions (Price & others, 2003; Joyce & Webb, 2003).

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 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 by 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 (eg. Tower Hill), which are large but shallow craters formed by major steam-driven explosions where rising magma intersected water-saturated limestone. At Mount Eccles a line of scoria cones running southeast from the main crater could have formed along a fissure eruption (Figure 5.2).

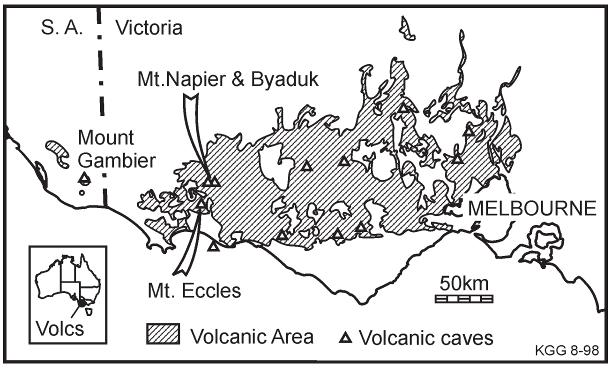

Figure 2.1: Western District Volcanic Province & caves.

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 2.3).

As pahoehoe loses gas and cools it becomes frothy and stiffer. 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 channels builds up *levee* banks of thin sheets or spatter. Larger flows across a 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 5.2). A number of shallow lava tubes are known in flows that have run off to the sides from these channels (Grimes, 1995 & in press).

Lava tubes provide good insulation for the hot lava flowing within them. This allows the formation of very

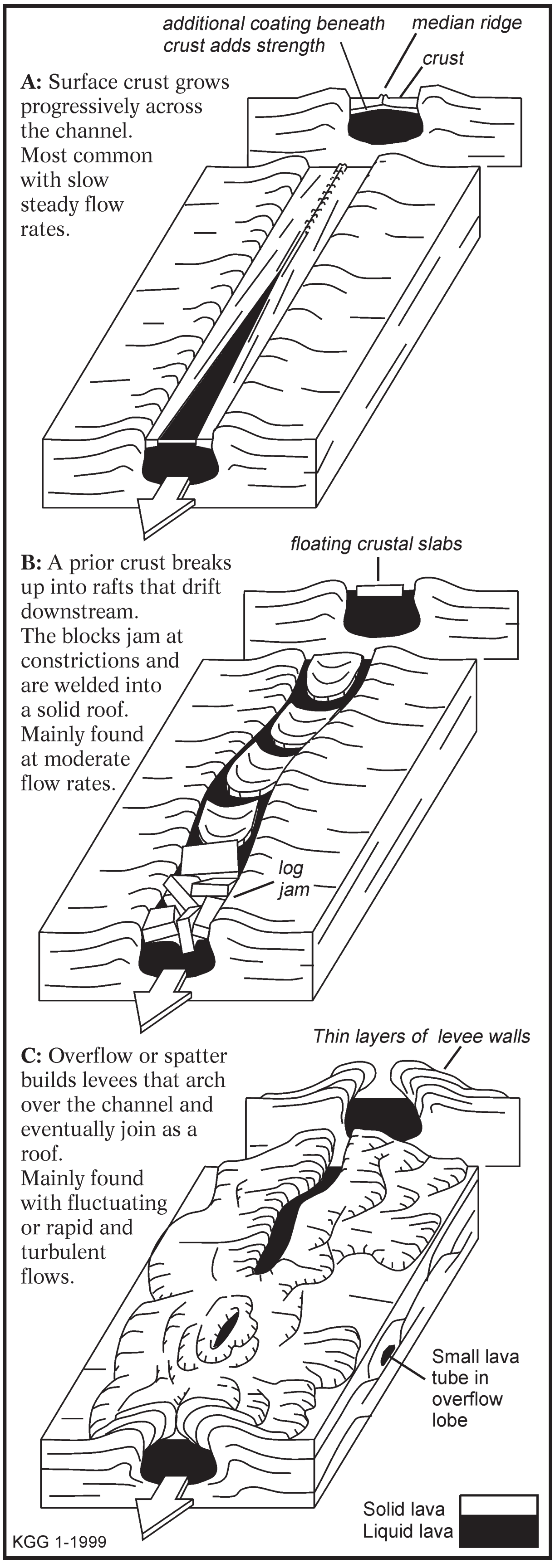

Figure 2.2: Three ways to make a lava tube by roofing a lava channel.

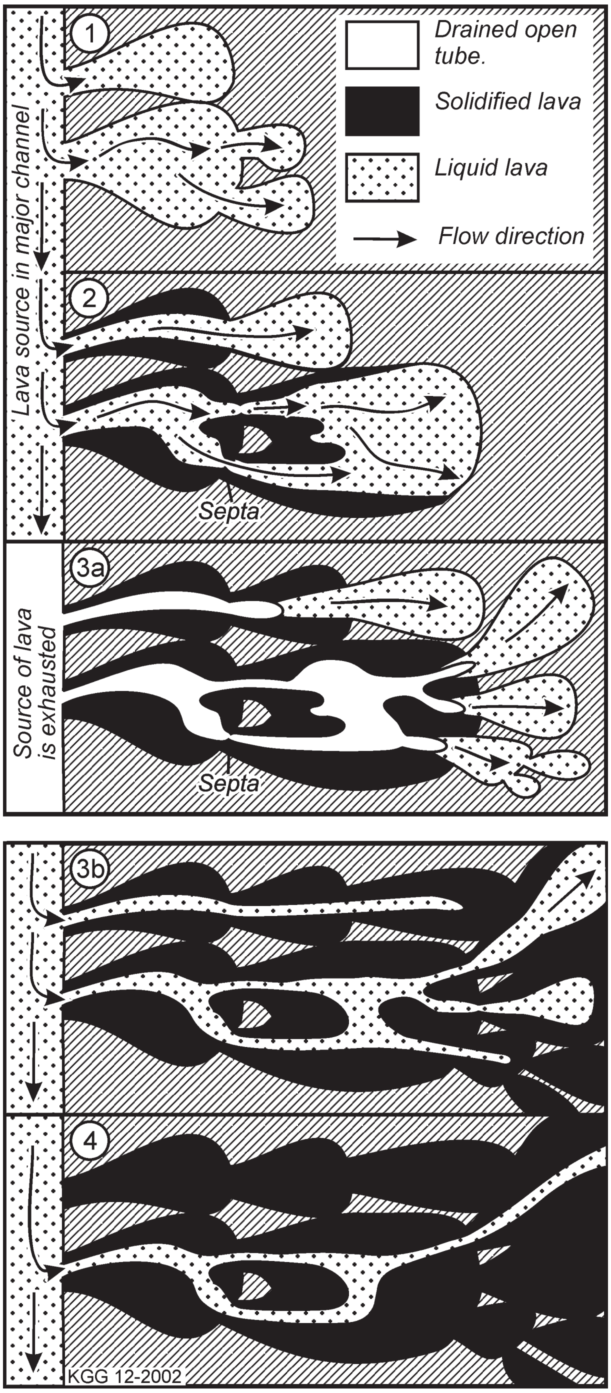

Figure 2.3: Stages in the formation of lava tubes by draining of lava lobes.

Step 1: Thinly crusted lobes of lava expand by breakouts through ruptures and budding of further lobes.

Step 2: Stagnant areas of the older lobes solidify, but flow from the source keeps the feeder conduits liquid.

Step 3a: If the source flow ceases some of the conduits may drain to form air-filled cavities.

Steps 3b and 4 indicate the further evolution into more linear feeder tubes as lava continues to flow through the system.

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 (Figure 5.1).

When a lava flow follows a valley, as in the Harman Valley flow from Mt. Napier and 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 (Peterson & others, 1994; Halliday, 2004): first by the roofing over of surface lava channels in several ways (Figure 2.2); and second by the draining of still molten material from beneath the solidified crust of a flow (Figure 2.3).

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. 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 these need not have drained at the end of the eruption to form open caves.

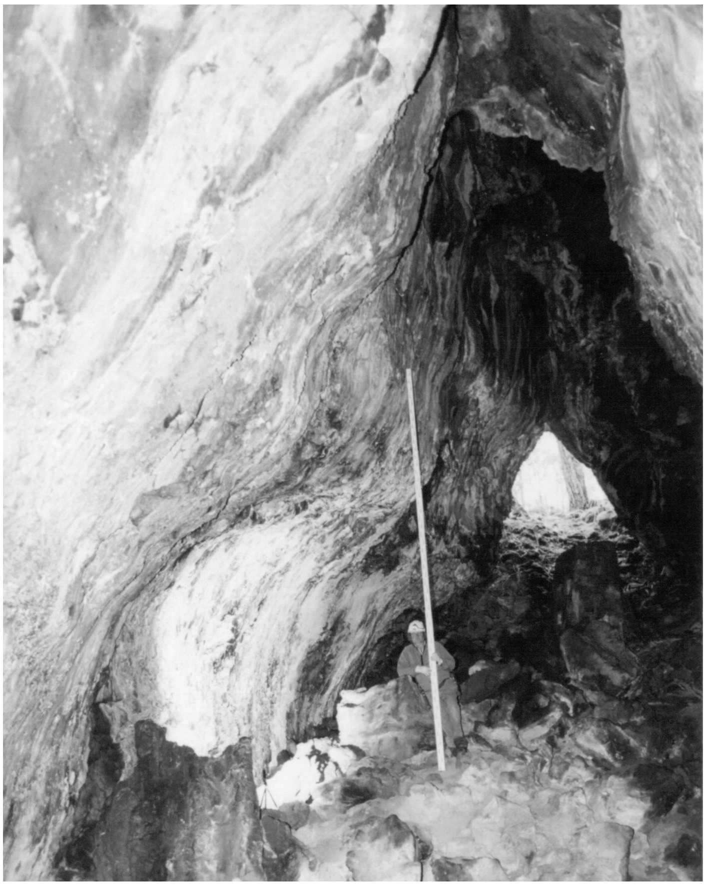

Figure 2.4: The ceiling of Natural Bridge (3H-10), Mt. Eccles has a "Gothic" shape that suggests it formed by levee overgrowth, as shown in Figure 2.2c, [KGG]
See also Figure 5.7.

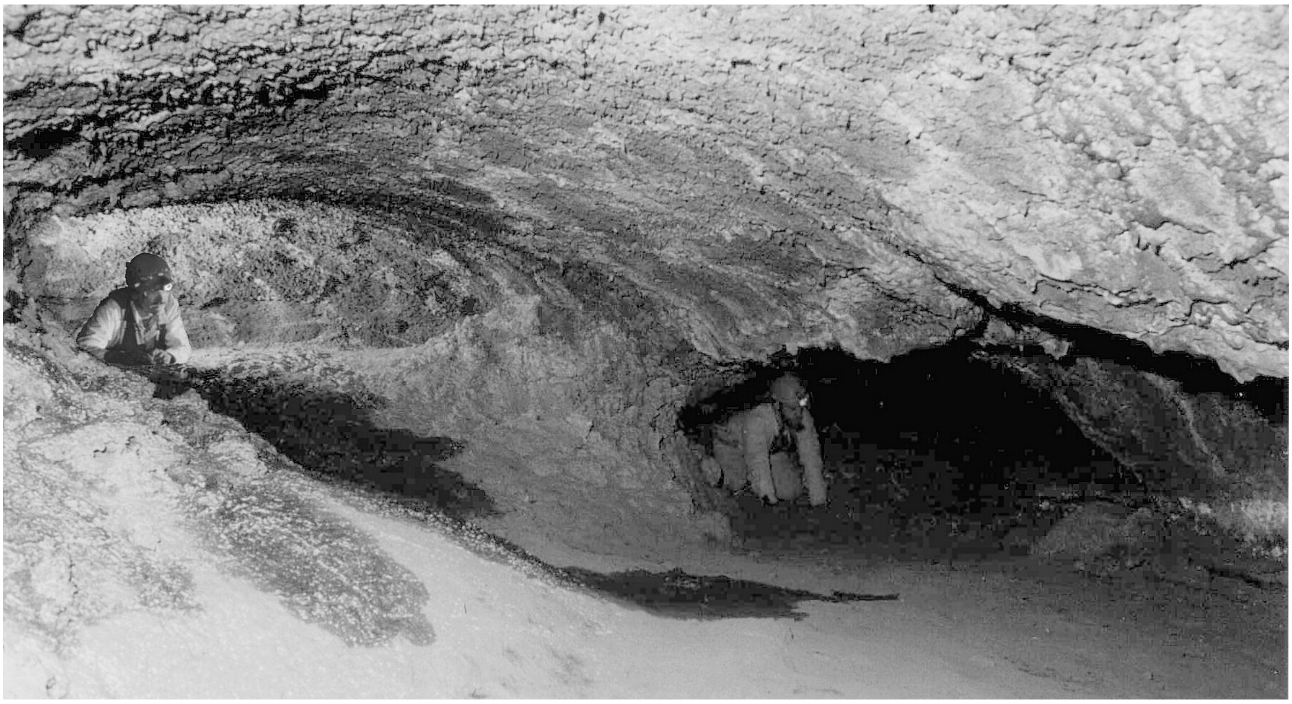

Figure 2.5: Caves formed by draining of lava lobes tend to have low broad chambers and passages (see Figure 2.3). Carmichael Cave, 3H-70. [KGG]

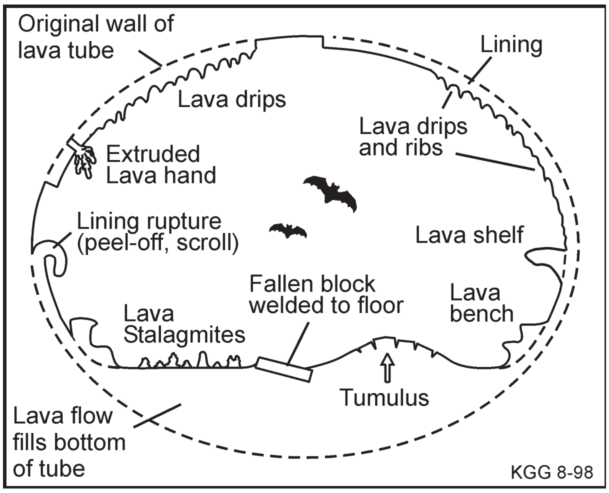

Figure 2.6: Formations found in lava tubes

Features found in Volcanic Caves

The lava caves contain a distinctive suite of lava structures or "decorations", some of which are illustrated in Figure 2.6.

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 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.

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 (Photo 5.14). 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'.

Figure 2.7: Lava drips and a burst section of lining.on the ceiling of 3H-70, Mt Eccles. [KGG]


Figure 2.8: Lava tide-mark on a roof pendant. 3H-33, Byaduk. [KGG]