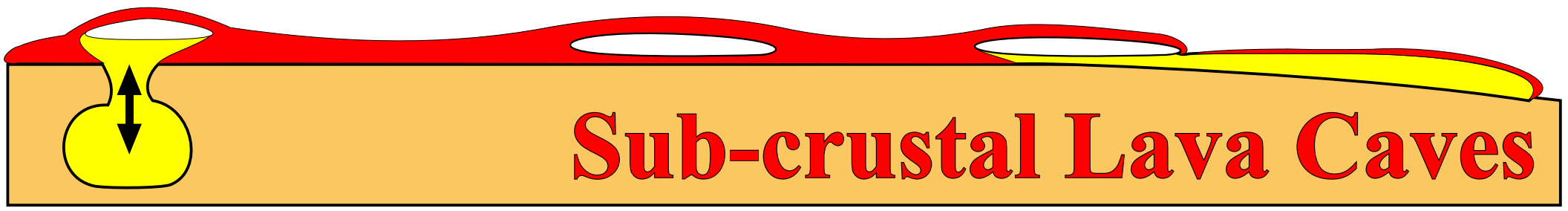


Sub-crustal Lava Caves

The Process of sub-crustal Drainage

Sub-crustal Lava Caves

A newly-formed lava flow quickly develops a crust, which may be inflated upwards.

Later drainage of liquid lava from beneath the crust can form small shallow caves.

As the flow expands, complex sub-crustal drainage systems can form.

Overview of lava cave formation

Observations of active lava flows has shown that there are two distinct ways in which lava tubes or caves form:

Roofing of surface lava channels (e.g. Peterson et al, 1994) - not discussed here.

Sub-crustal drainage within thin lava lobes. (e.g. Hon et al, 1994) - the subject of this poster.

Development of sub-crustal caves

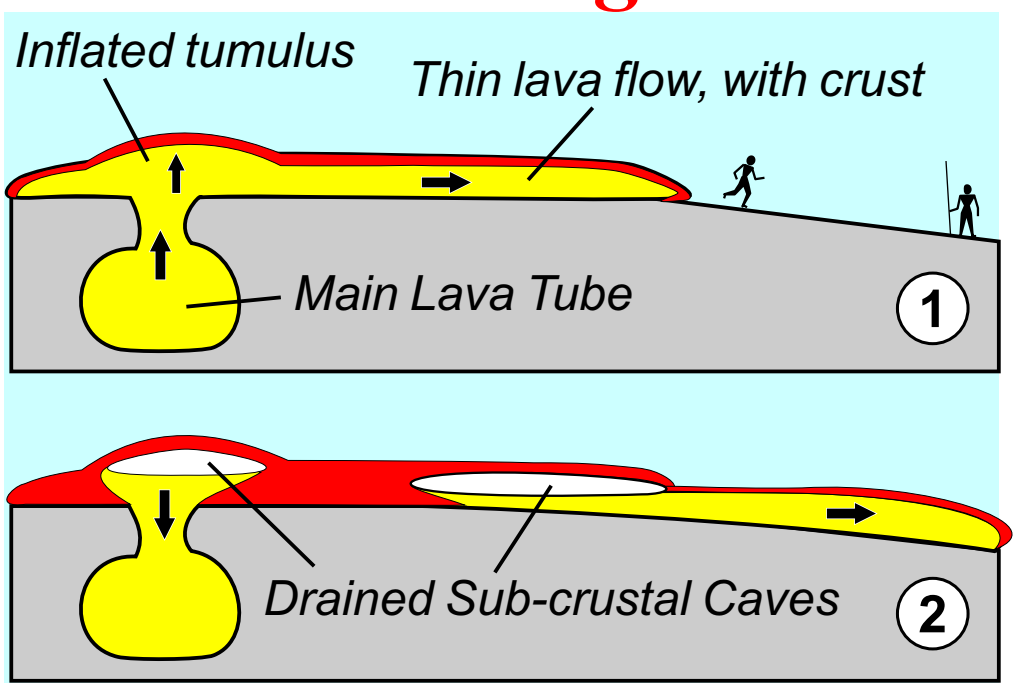
➤ Lava spreads from a skylight above a tube, or by overflow from a crater or a lava channel.

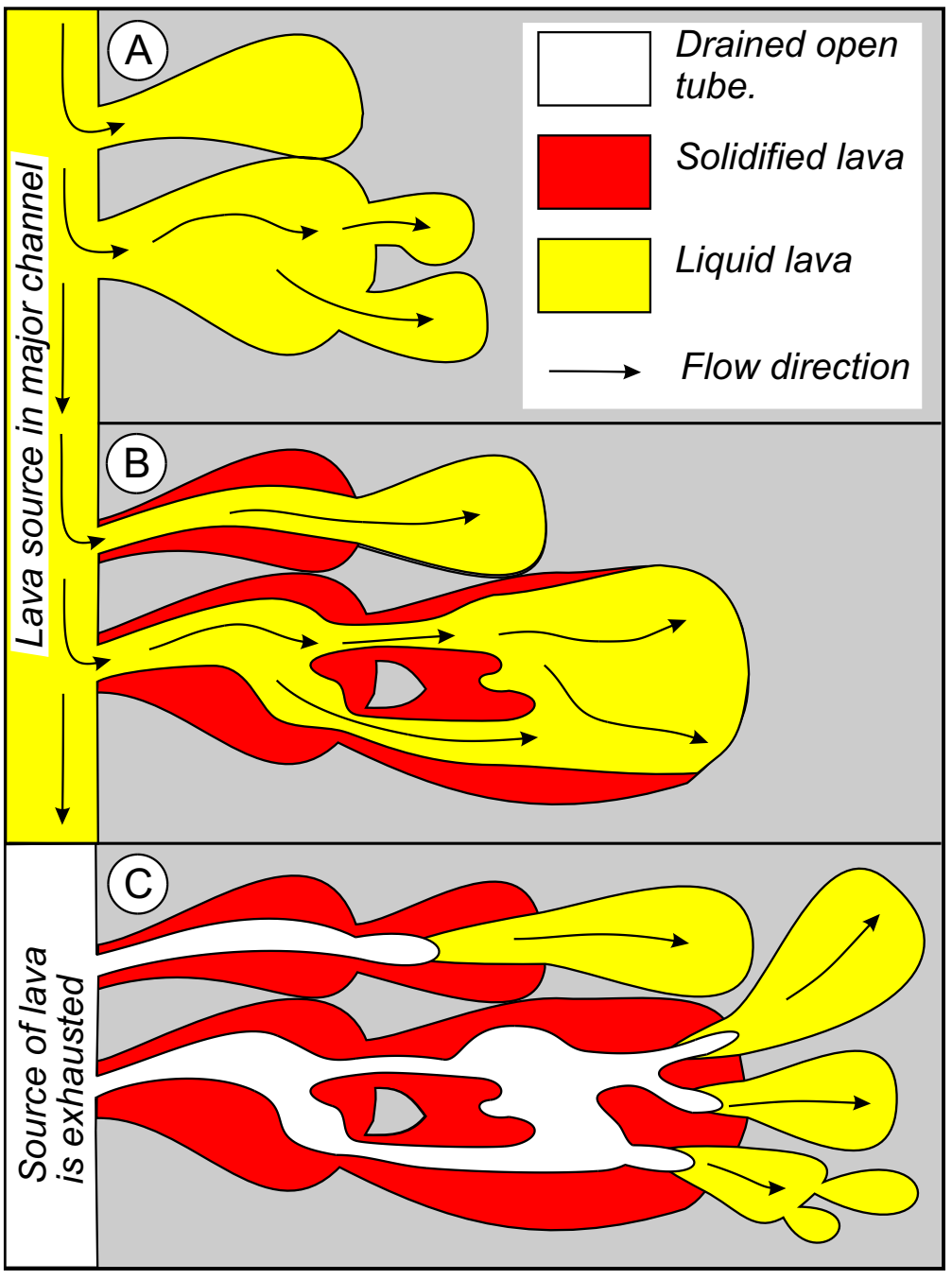
➤ The spreading lobes grow by a process of 'budding' in which a small lobe develops a skin, and is inflated by the lava pressure until the skin ruptures in one or more places.

➤ Lava escaping through the rupture develops new lobes and so on.

➤ If the supply of fresh lava is cut off, the liquid parts of a lobe may be drained to form a broad but low-roofed chamber.

➤ However, if fresh hot lava continues to be delivered from the volcano it may become concentrated into linear tubes that feed the advancing lobes, while the surrounding stagnant areas slowly solidify.





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Hon, K., Kauahikaua, J., Denlinger, R., & Mackay K., 1994: Emplacement and inflation of pahoehoe sheet flows: Observations and measurements of active lava flows on Kilauea Volcano, Hawaii. *Geological Society of America Bulletin.* **106:** 351-370.

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. *Bull. Volcanol.* **56:** 343-360.

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Sub-crustal Lava Caves

Small sub-crustal lava caves

Small isolated caves

Small isolated chambers occur scattered through the undulating lava fields.

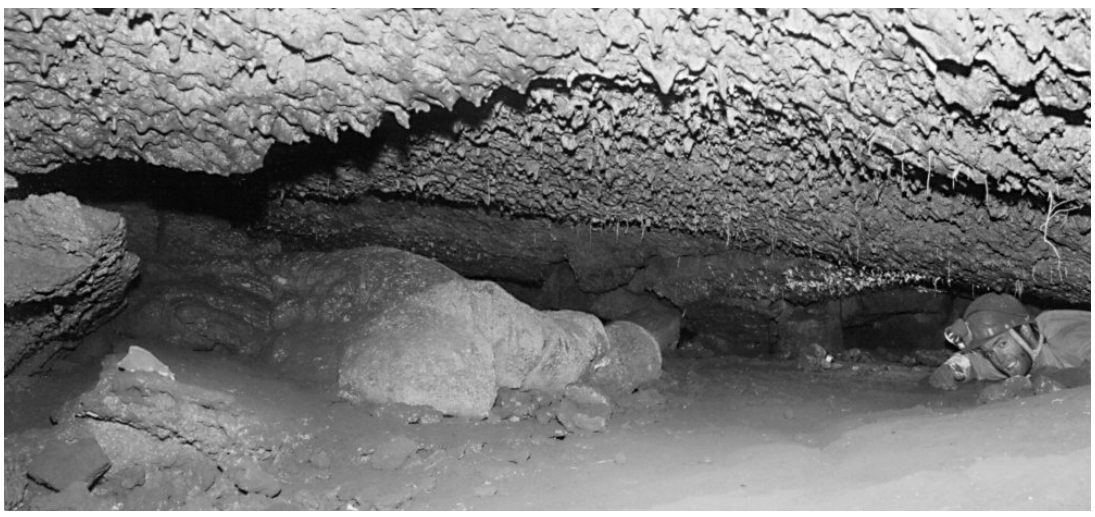
➤ The simplest caves are small chambers (typically only 1m high with a roof about 1m or less thick) which occur scattered through the lava fields. These have been called "blister caves" in Victoria. They generally are found beneath low rises, though some have no surface relief at all.

➤ They can be circular, elongate or irregular in plan; up to 20m or more across but grading down to small cavities only suitable for rabbits.

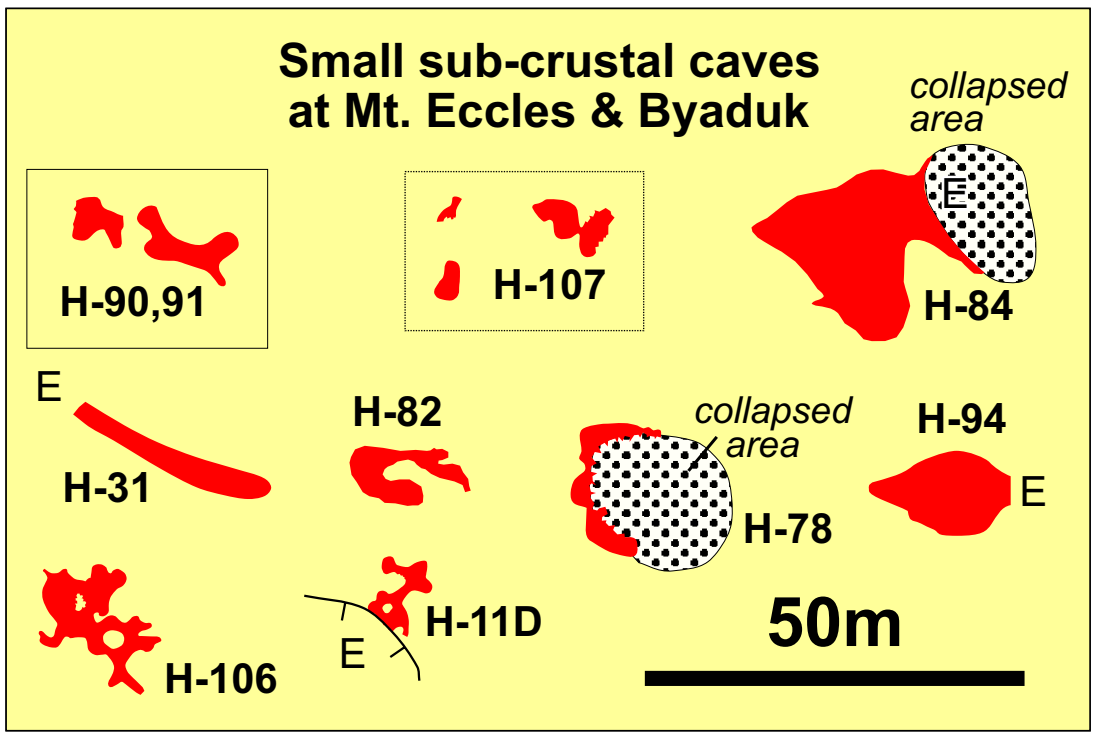
➤ In cross-section, the outer edges of the chamber may be smoothly rounded or form a sharp angle with a flat lava floor.

➤ The ceiling may be arched or nearly flat, and can have a central "soft" sag that would have formed while the crust was still plastic. Alternatively, the thin central part of the roof has collapsed and we find only a peripheral remnant around the edge of a shallow collapse doline (e.g. H-78).

➤The more elongate versions grade into small "tubes" (e.g. H-31).

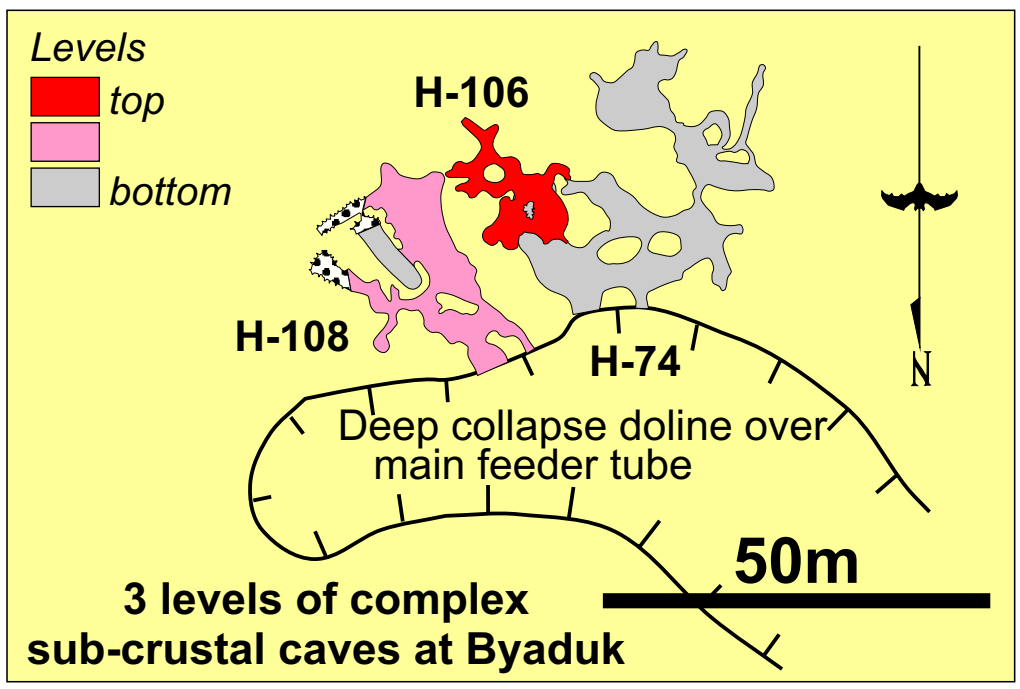


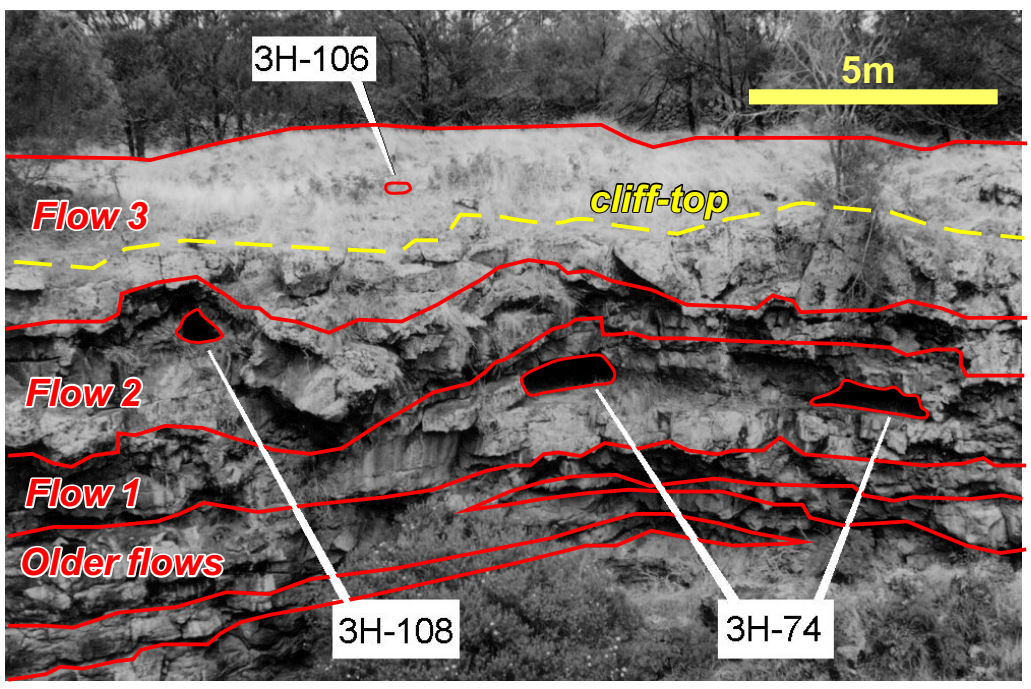
Broad low chamber in H-106. A mound of invasive lava lobes enters from the left.

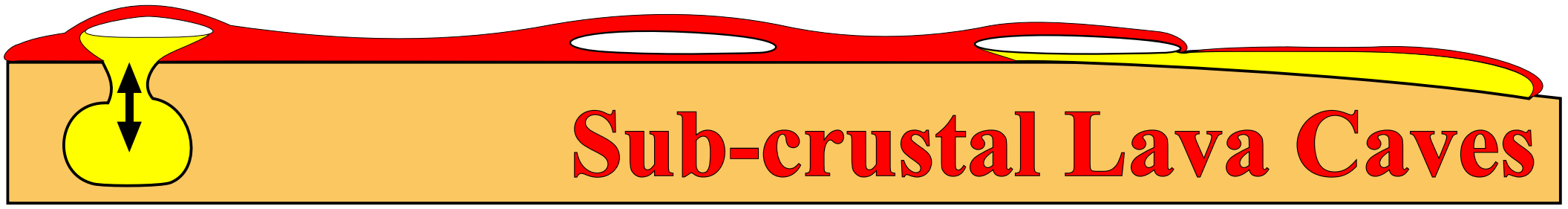


A stacked system at Byaduk, Victoria.

Three distinct sub-crustal caves have developed; each in a separate lava flow, 1-3 m thick. The flows and cave entrances are exposed in the cliff of a collapse doline developed over a large feeder tube at greater depth. The thin lava flows may have been fed by overflow from this major tube - either through a skylight, or when it was an open channel





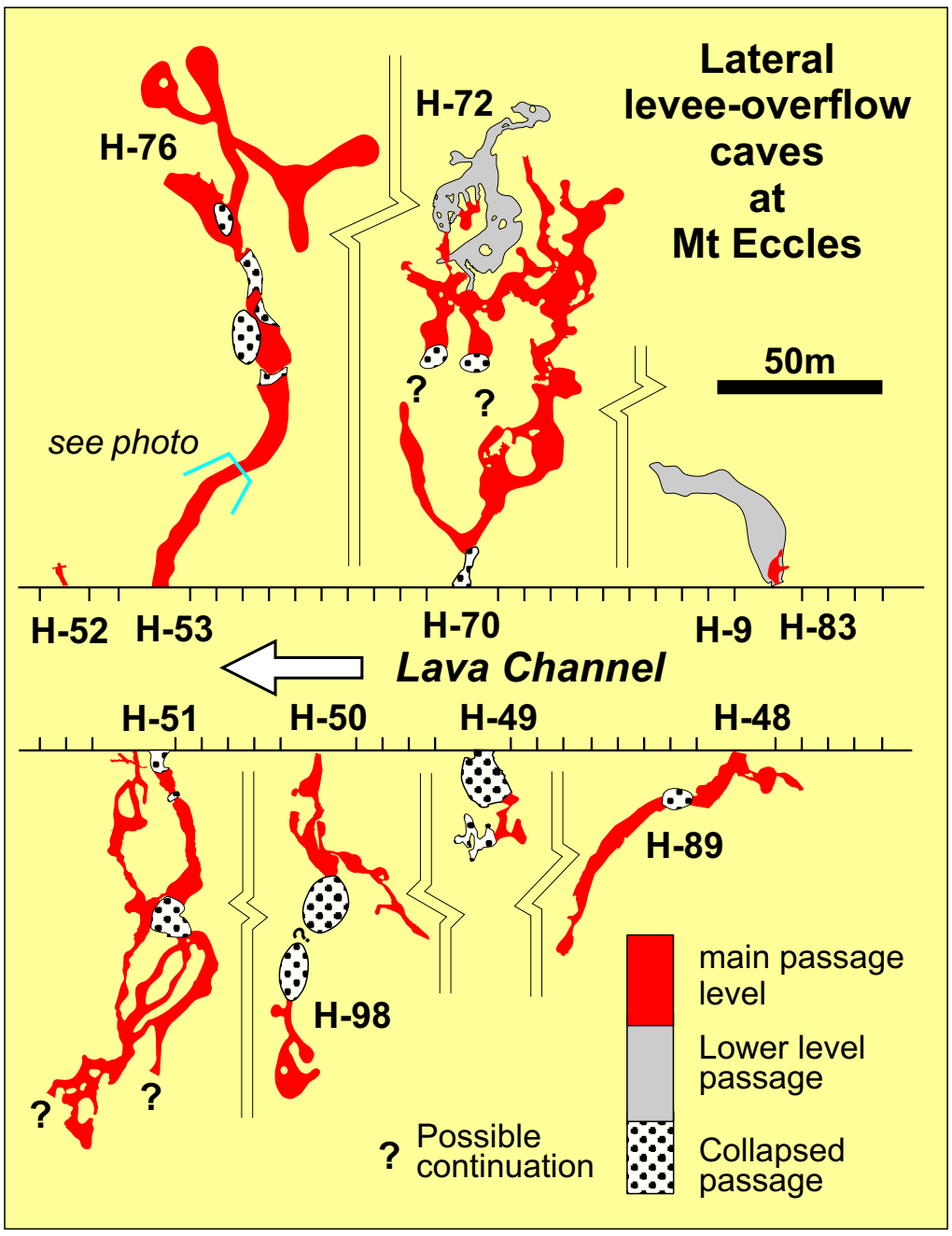


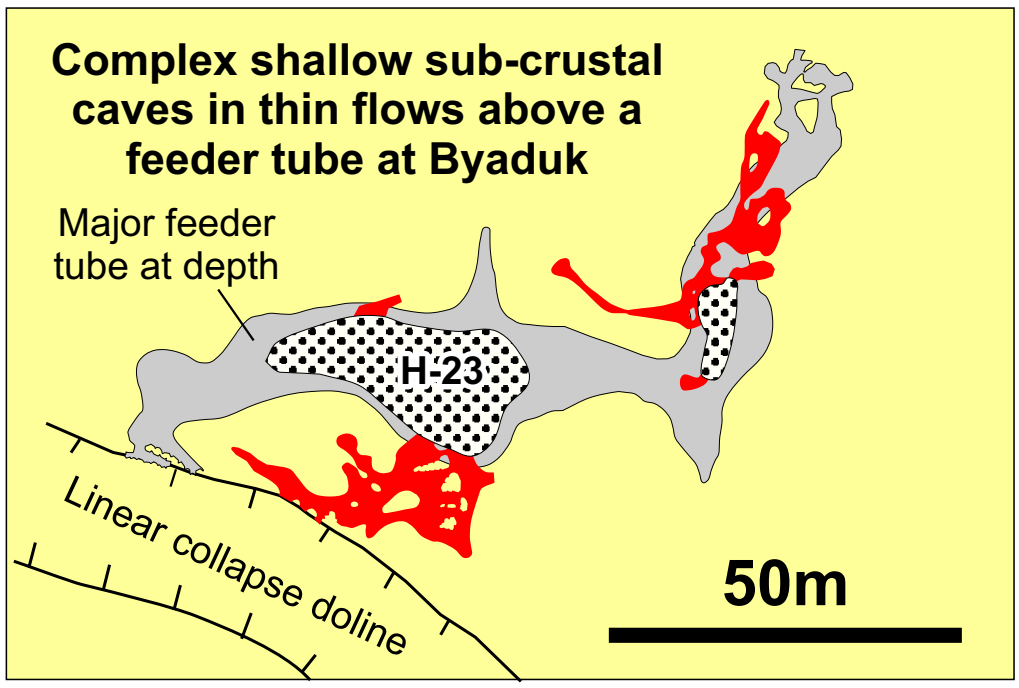
Sub-crustal Lava Caves

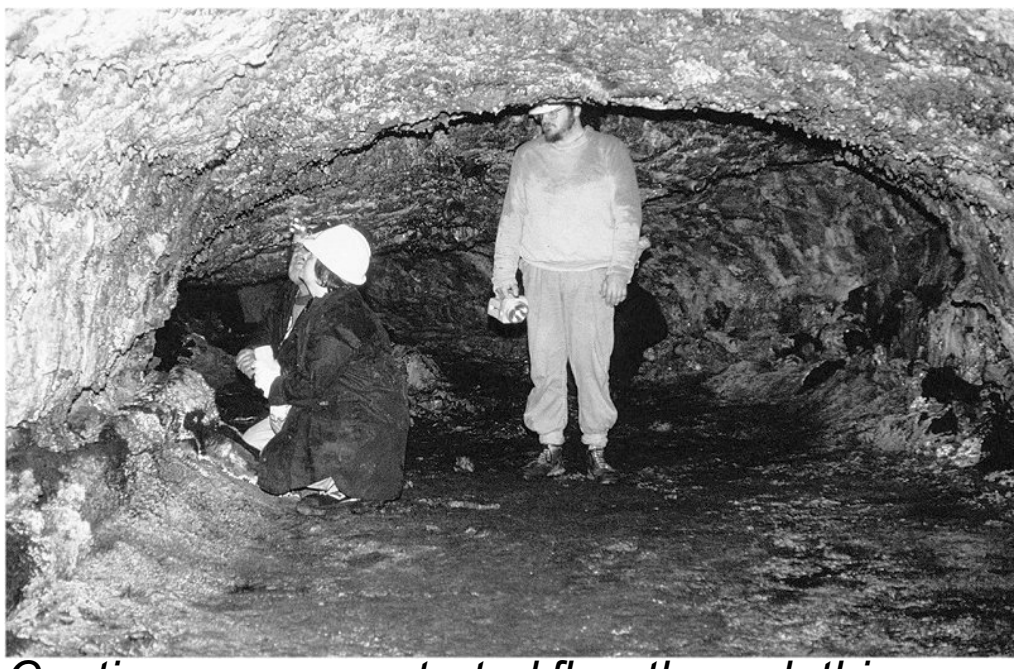
Complex sub-crustal lava caves

Complex Caves

In larger flow systems the original simple "drained-lobe" forms evolve into branching systems of low passages that bifurcate and rejoin, or open out into broad, low chambers.







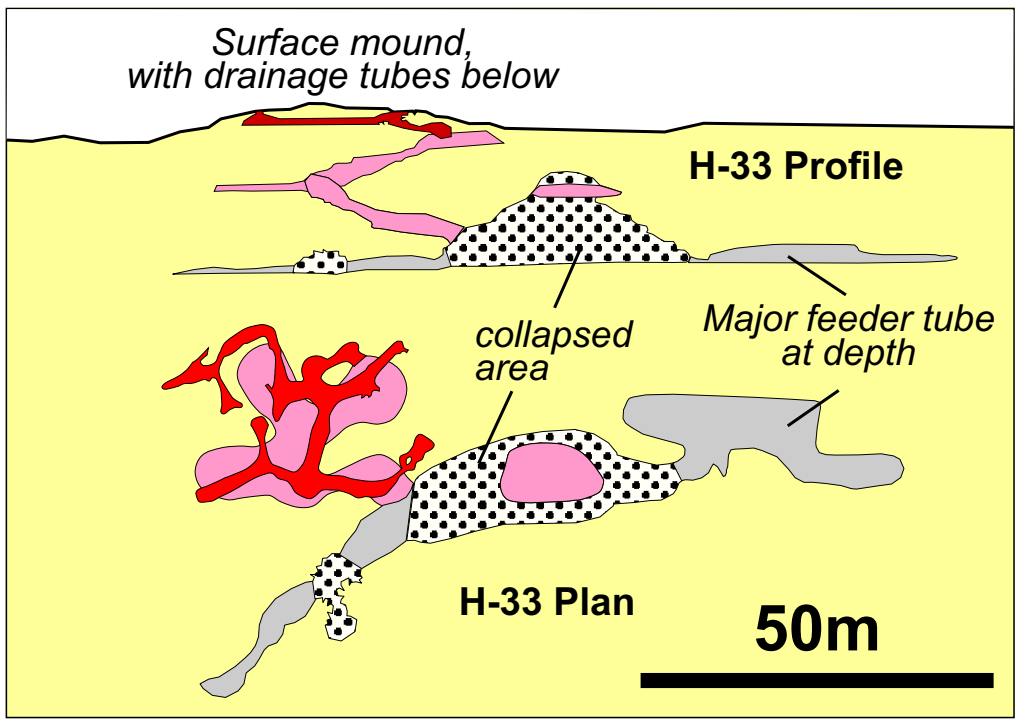
Continuous concentrated flow through this section of H-53 has produced a linear cylindrical form typical of major feeder tubes.

Developed Systems

More complex systems evolve where lava continues to flow beneath the crust for an extended time and over a greater distance.

Complex networks can evolve, with cylindrical "Feeder" tubes being maintained in areas of rapid flow, while slow moving areas solidify.

These linear tubes may extend radially from a central source (e.g. the upper level of H-33, see map to right) or laterally from the breached levee of a lava channel (maps above). At the downflow end the feeder tubes may split into a maze of smaller tubes and chambers.



Overflow to the surface from a major feeder tube formed a domed mound with a branching tube pattern. Draining back to the lower level left several low-roofed chambers and tubes.

Sub-crustal Lava Caves

Example: Carmichael Cave, 3H-70, Mt. Eccles

A complex sub-crustal cave

H-70 comprises alternating linear tubes, mazes and broad low-roofed chambers. It was formed by over-flow from a lava channel. The lower level may be an earlier system invaded by the later one.

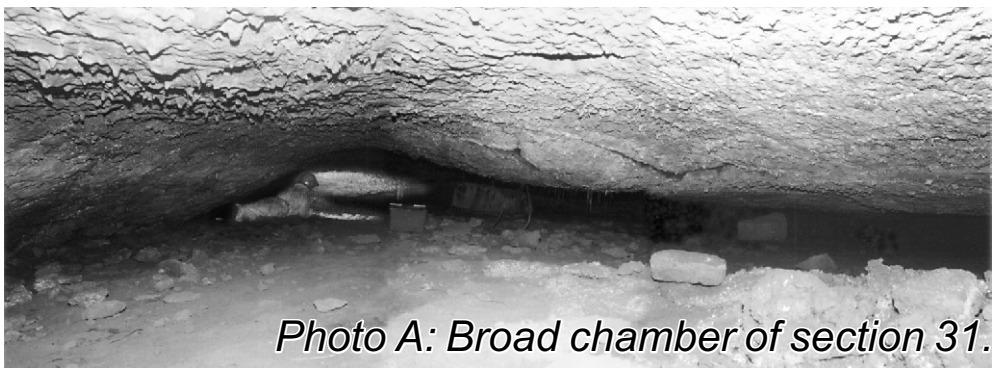
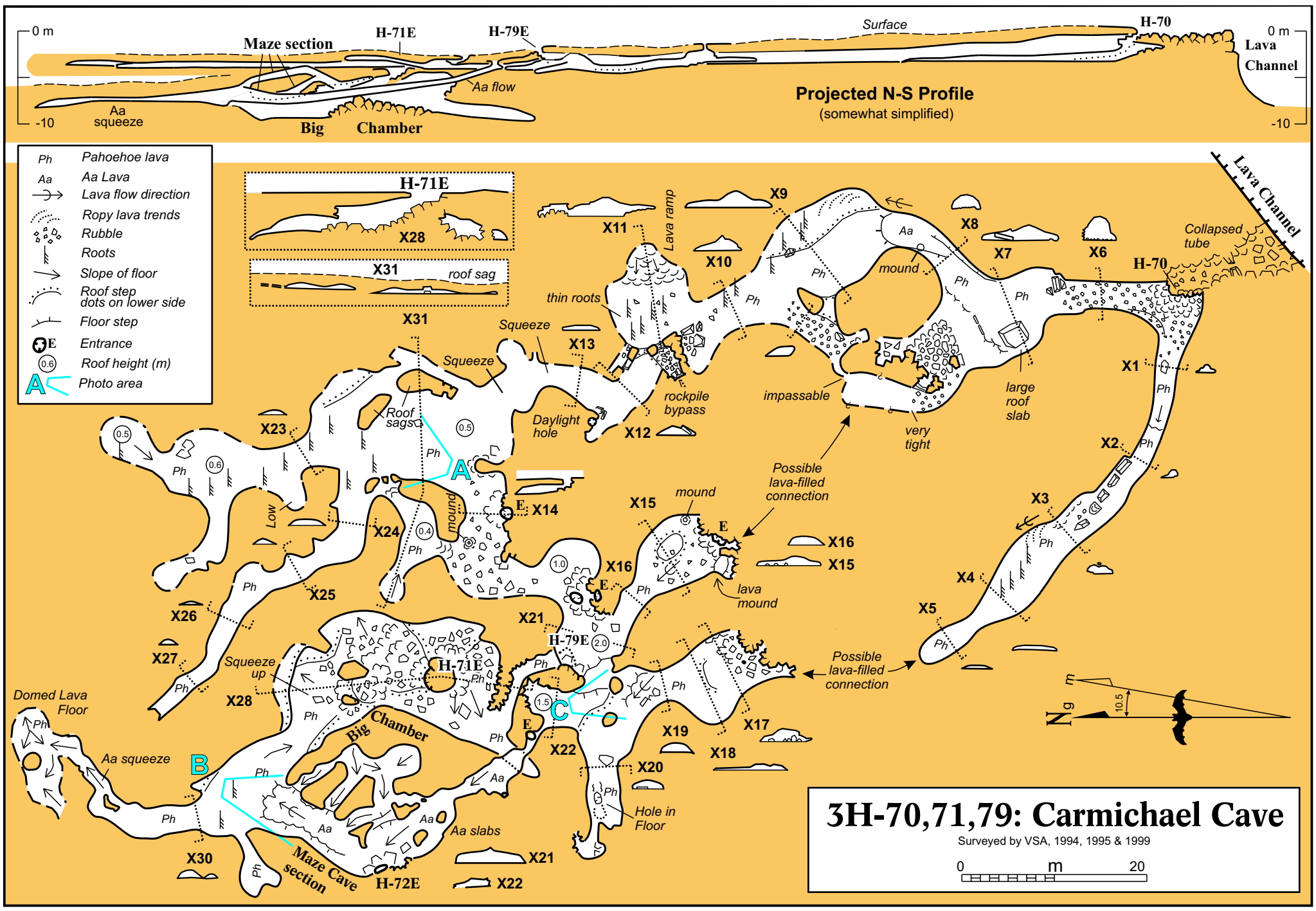


Photo A: Broad chamber of section 31.



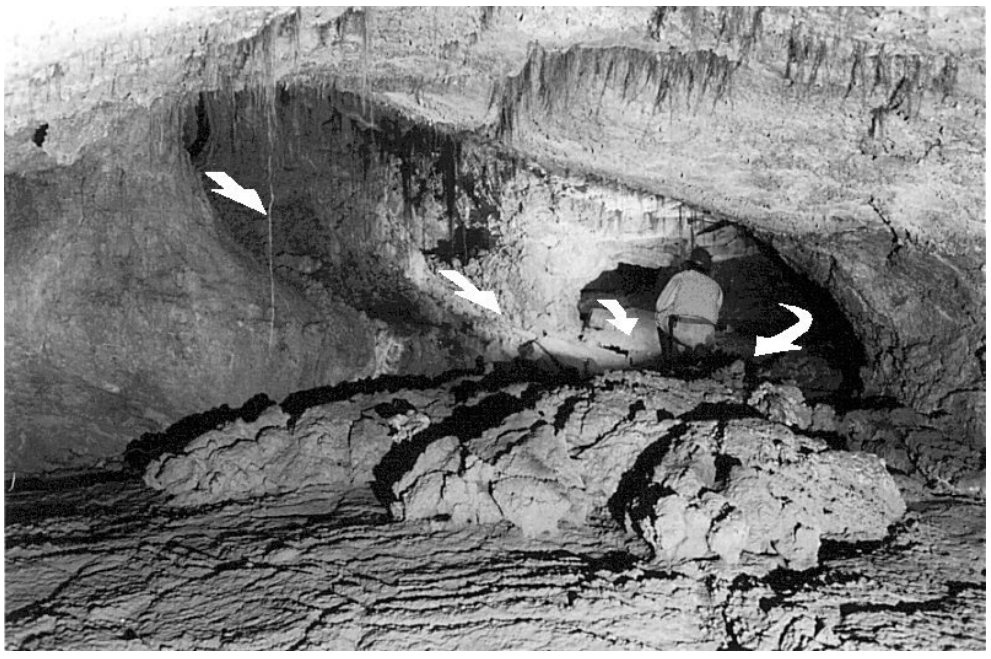


Photo B: Maze section: Aa flow invading from higher levels (arrows)

Photo C: Mound at left separates two chambers - is this a "partition" between two lobes?

Ken Grimes 8-2002