THE UNDARA LAVA TUBES, NORTH QUEENSLAND, AUSTRALIA

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In northern Queensland, within 200 km of the east coast there are several large areas of Pliocene to Pleistocene basalt flows (Fig. 14-1). One of these, the McBride Province, (Twidale, 1956) is about 5,000 km^2 in area, and forms a plateau with an altitude mostly from 600 to 900 m above sea level (Best, Stevens, and Tweedale, 1960). It is broadly domed due to accretion of basalt flows. These appear to have been derived from comparatively few of the many vents present. Small shield volcanoes, pit craters, and scoria cones are present; a total of 109 centres have been located on aerial photographs (Best, 1960) but few have been investigated on the ground. The vents are aligned northeast-southwest, and this is an important structure trend in northern Queensland.

The Undara lava tubes are in the northwest quadrant of the basalt province, close to the largest granite inlier. Two tubes have been recognized, called the Undara West and Undara North Tunnels (Best, 1960). They begin as one tube, close to Undara Crater, then bifurcate and extend westward and northward respectively. Their location is shown on Fig. 14-2 of this paper and on the Einasleigh 1:250,000 geological map (Commonwealth of Australia Bureau of Mineral Resources, 1963) as a series of black dots and irregular areas, representing collapsed parts of the lava tubes. These are easily distinguished on aerial photographs (Fig. 14-3) since the luxuriant vegetation which grows in the depressions is of the "rain forest" or closed forest type usually associated with the coast and nearby ranges, and is quite different from the open forest of the surrounding country (Fig. 14-4).

The linear arrangement of the collapsed areas indicates that there are two continuous tubes. These are not necessarily open tubes where the roof has not fallen in; some parts may be partly

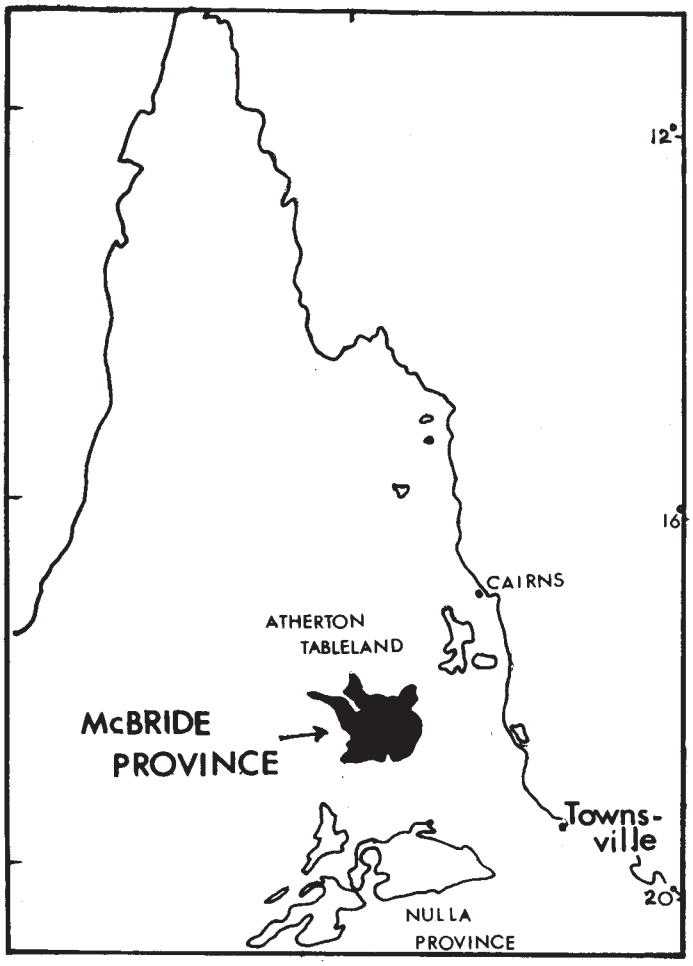

Figure 14-1: Major basalt flows of northern Queensland.

Figure 14-3: Vertical aerial photo of segmental collapse in Undara System.

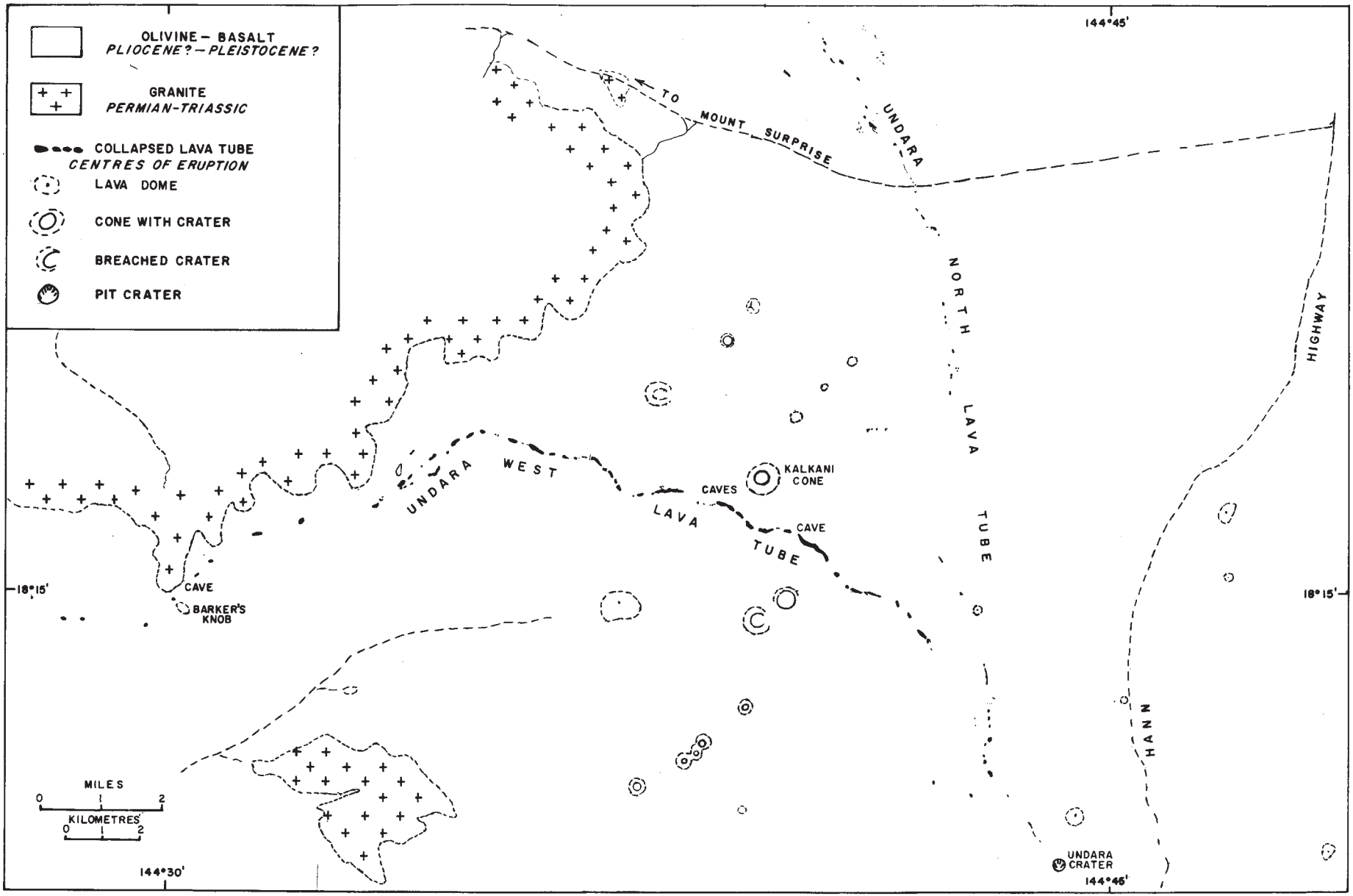

Figure 14-2: Map of Undara Lava Tubes System.

or entirely filled with solidified lava. The total length of the Undara West tube (assuming it emanates from Undara Crater) is over 35 km, that of Undara North Tube is 19 km (from the junction) plus 4 km in common with the Undara West Tube. Near the western end of the Undara West Tube, the tube approaches and is diverted southwesterly by a large area of hilly granite country, and passes between the granite of Barker's Knob and the main granitic inlier (Fig. 14-5).

THE BASALT AND ITS AGE

Best (1960) distinguished four basalt formations and ages: the Older and Newer McBride Basalt, overlain by the Undara Basalt, overlain in turn by the Kinrara Basalt. He considered the latter to be recent, because of the perfect preservation of the cone, crater, and lava structures. The Undara Basalt, in which the tubes occur, was thought to be Pleistocene. No age determinations have yet been made on the basalt of the McBride Province, but the basalts of the Nulla Province, to the south, have been dated at 4.0 - 4.5 m.y., 2.3 m.y., 1.3 m.y., 1.1 m.y., and 0.04 - 0.08 m.y. (Wyatt and Webb, 1970). The youngest of these, the Toomba Basalt, is similar in geomorphological and surface features to the Kinrara Basalt, and is probably of similar age. The Undara Basalt is probably similar in age to the next youngest flows, slightly more than 1 m.y., and thus Pleistocene. All of these basalts are alkali olivine basalts (Morgan, 1968; Wyatt and Webb, 1970).

UNDARA CRATER

When approached from any direction, only a slight rise indicates the proximity of the crater, but once the rim is reached a most impressive, almost vertical-sided unbreached pit crater is found. Although the wall appears to be almost entirely of rough, angular blocks of basalt, varying in size up to 0.6m^3, there is sufficient soil to support closed forest vegetation.

Descending into the crater, several indistinct levels are noticed which may have been former levels of a lava lake. However they are not nearly as distinct as the high-lava mark of Kinrara Crater, a younger crater of the same province. The floor of the crater, approximately 100 m below the rim, is covered with fine red soil, with fragments of scoriaceous basalt, some with the characteristic twist of volcanic bombs. Gravity measurements (Langron, 1969) indicate a high density lava plug beneath this site. It is probable that the lava which drained out through the tubes came from Undara Crater, but no sign of a tunnel entrance is visible. Perhaps lava fragments from a final explosive eruption cover any which may have been present.

LAVA CAVES

To date, five lava caves (non-collapsed parts of the Undara West Tube) have been entered by one of us (F.A.A.) but only two have been mapped. The entrances to all of these are marked only by slight depressions and entry is made over blocks from the collapsed roof.

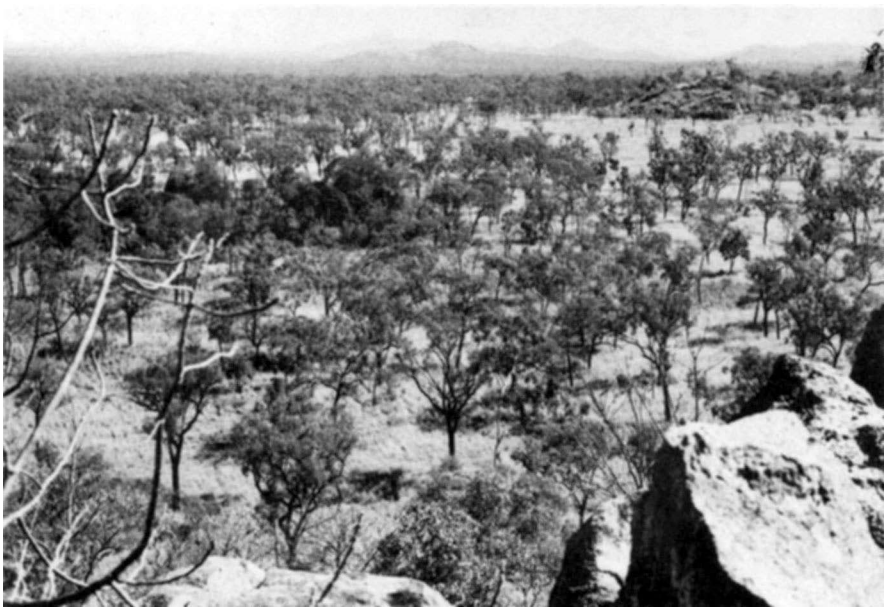

Figure 14-4: Surface of flow near Barker's Cave. Darker vegetation at left center is in collapse sink.

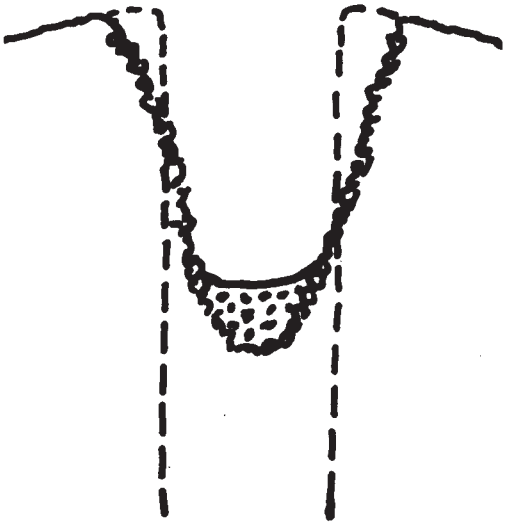

Figure 14-5: Theoretical vertical section of Undara Crater.

Pinwill's Cave. The location of Pinwill's Cave is about half-way between Kalkani Cone and an unnamed crater to the south (Fig.). Its length is 50 m; average height: 6 m, maximum width 21 m. The western end is blocked by a rock fall; here the width is 5 m. The basalt varies from massive to highly vesicular. The vesicles vary from almost microscopic to several cm in length. Elongation of vesicles gives evidence of flow; a flow line on the north wall has a dip of about one-half degree westward. The floor is covered by soil and bat guano, but approximately 30 m from the entrance is a good example of ropy lava. Lava drips are seen on blocks fallen from the walls and roof.

The most unusual feature of this cave is a table-like structure near the entrance. It consists of a curved layer of lava, fairly uniform in thickness (15 cm) which extends 6 m along the wall at a height of 2.4 m above the floor. It is 1.7 m wide for most of its length (Fig. 14-7). The structure is presumed to be a remnant of a former flow level.

Traves' Cave. This cave is approximately 2.4 km west of Pinwill's Cave (Fig. 14-9). It is 67 m long, has an average height of 6 m, maximum height of 10.6 m, and average width of 10.6 m. Rockfall prevents further penetration. Interior surface features of the basalt include lava drips and "runs" (lava dribble).

Atkinson's Cave. This cave adjoins Traves' Cave to the west. The collapsed entrance is similarly marked by dense vegetation of "rain forest" trees and vines. Its length is 100 m, the

Figure 14-6: Cross section of Pinwill's Cave.

Figure 14-7:
"Pancake" lava stalagmite
in Atkinson's Cave.

Figure 14-9: Lava "runs" (drips) near entrance of Barker's Cave.

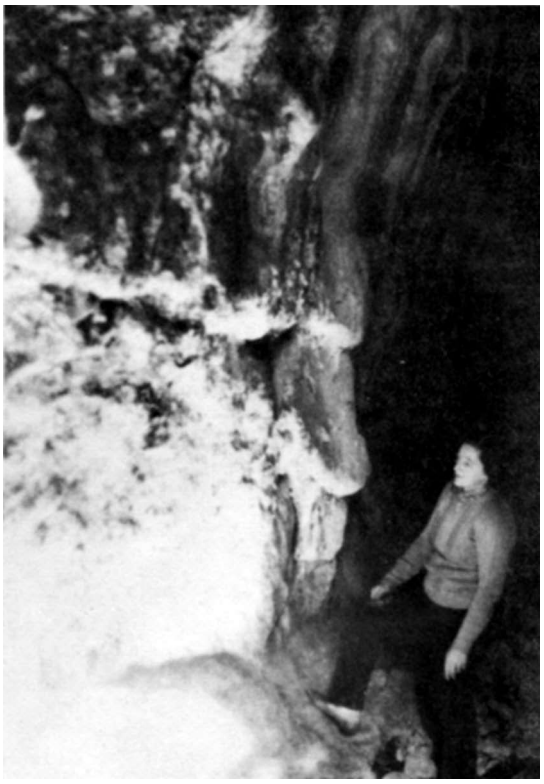

Figure 14-10: Wall of Barker's Cave near entrance.

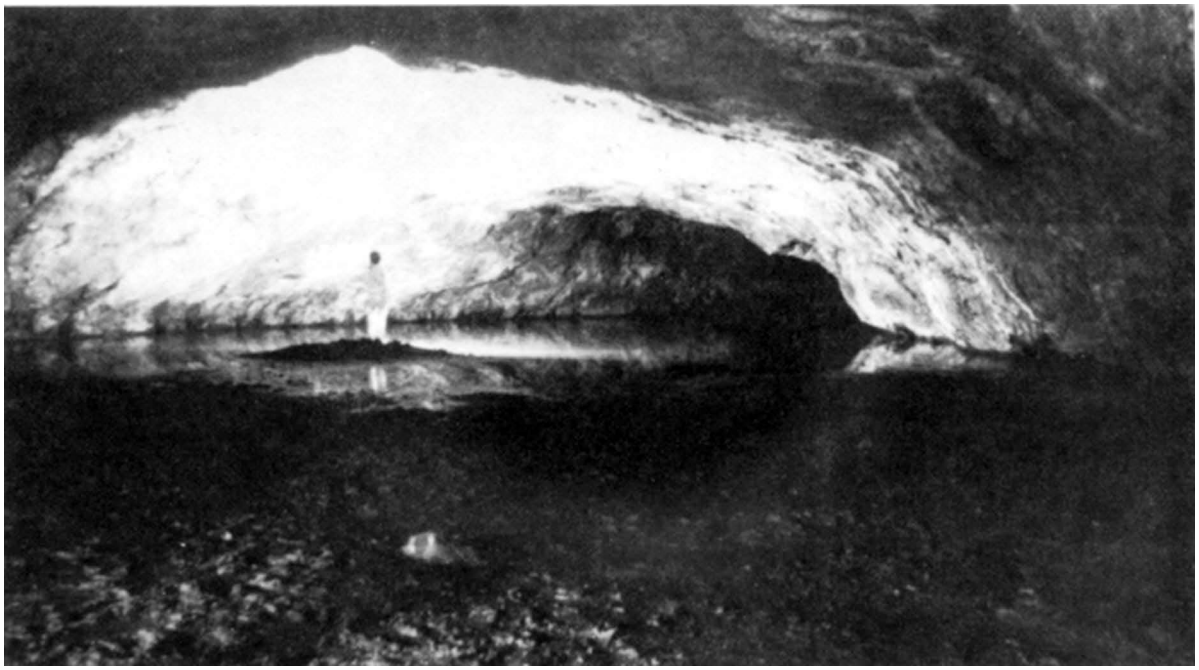

Figure 14-11: Terminal lake, Barker's Cave.

average height is 6 m, and the width is 7 m, expending to 21 m near the entrance. The entrance arch appears unstable. Near the entrance and also well within the cave, "runs" from the roof are visible, and also flow structures on the walls. Small lava stalactites and stalagmites were seen in a cavity on the north wall (Fig. 14-9). An interesting "pancake" structure was present in the stalagmites.

Barker's Cave. Barker's Cave is the only cave of this province described previously (Shannon, 1969; Watt, 1972). It is between Barker's Knob (a small granite hill) and the main granite inlier. Measured to the margin of an underground lake at the far end of the cave, its length is 518 m. This is less than previously measured; probably this was due to a record wet season in 1972 causing a greater amount of water in the lake. The lake extends at least a further 60 m. 60 m from the entrance, the width is 6.7 m (the minimum); 396 m from the entrance, it is 20 m (the maximum). The maximum height is 11.6 m. The floor slopes from east to west at approximately 3 degrees (Fig. 14-10). The entrance is in a small depression. It is unspectacular but the entrance arch is interesting in that it shows the curve of the tunnel roof. The lava at the center of the arch is only 48 cm thick. However the arch gives an impression of stability because of the height to width ratio, which is greater than that of other cave entrances. This ratio decreases with distance from the entrance (Fig. 14-11). Near the entrance is an area of recent rock fall.

A small cavity in the south wall close to the entrance shows fragments in the lava with twisted flow structure. The higher parts of the walls show "runs" (Fig. 14-12) with numerous small lava drips, forming a pattern of small triangles. Much of the lava is vesicular. At the base of the wall are very well developed flow structures which extend a long distance into the cave. Ropy lava forms a central raised section on the floor approximately 4.7 m wide, with trenches about 1.2 m wide at the entrance and increasingly wide down-flow. At the base of the walls, at approximately the level of the central raised section is a very distinct horizontal ledge or flow mark. Additional less distinct flow marks are seen at irregular intervals up to a height of 2.5 m (Fig. 14 13).

SPELEOGENESIS

The lava which flows in or around the tunnel probably followed a main river bed of a pre-basalt surface and became constricted between the granite of Barker's Knob and the main inlier. Many vesicular layers are present. Today, water flows in this part of the tunnel and forms a terminal lake already mentioned (Fig. 14-14). The slight curves in the tube may be in accord with the curves in the pre-basalt river valley.

It appears that the lava in the tube initially flowed at full capacity, filling the tube. The flow then diminished abruptly to half its volume or less, producing a fairly even cover of lava drips in the upper half of the cave. Later, when cooling had advanced sufficiently for a crust to form on the lava "river", this was forced to arch upward when it came to a constriction 60 m from the entrance, (Fig. 14-15), producing a raised "rope" formation.

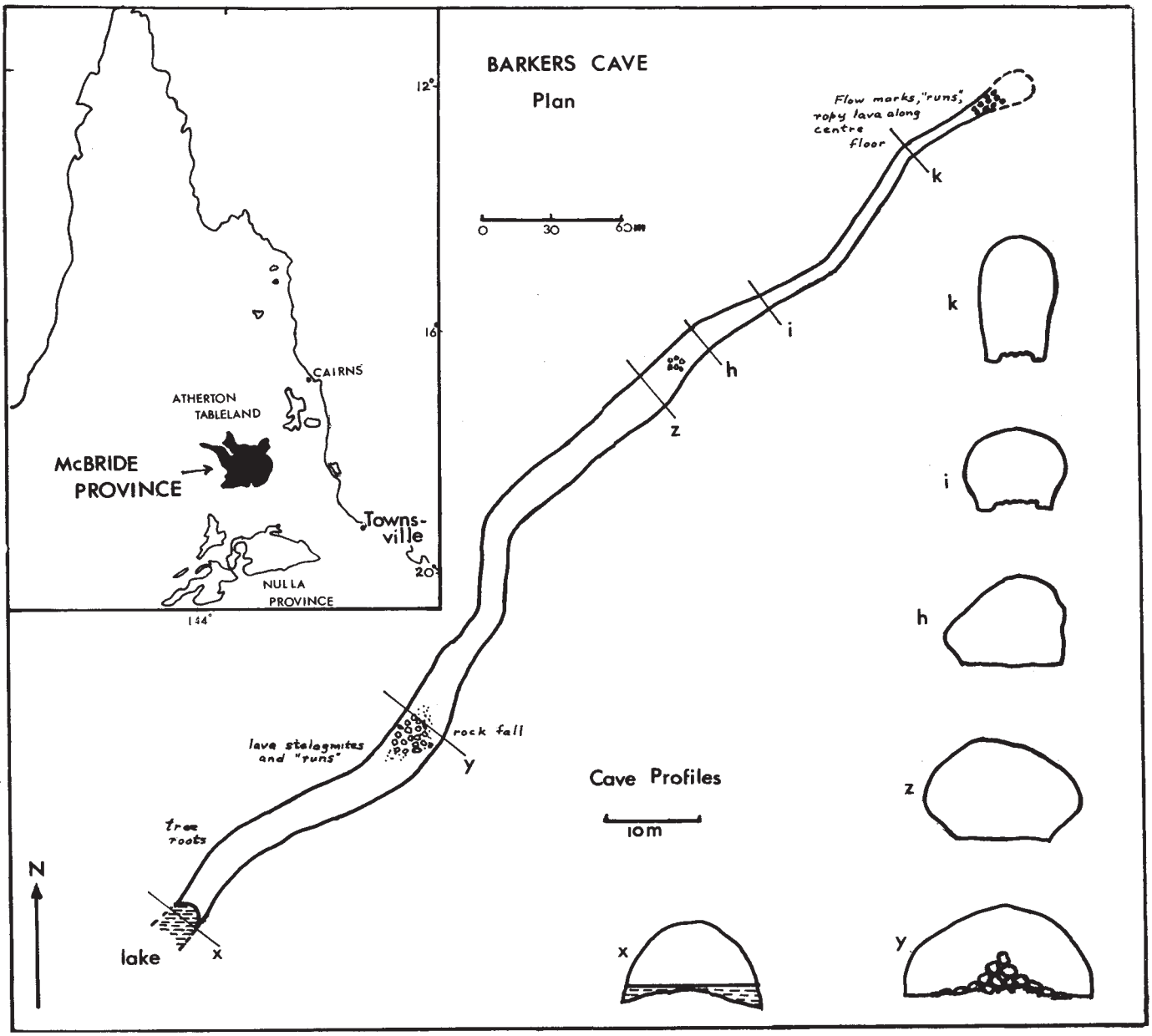

Figure 14-8: Map of Barker's Cave.

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