Lefroy, T., & Lake, P., 1972
A laterite cave in the Upper Chittering Region, Western Australia.

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NOTE...
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* The photos mentioned in the text were not included in *The Western Caver* version (they would have been in the original school assignment).

ABSTRACT

A laterite cave in the Upper Chittering region was investigated with reference to the geology, flora, fauna and climate of the area. The significance of these phenomena is discussed under separate headings and combined to present our theory of the cave's formation.

PART 1.a - Situation of Cave System

The cave is situated approximately fifty miles north-east of Perth (position as per Military Survey Map Australia, Sheet No. 387 Chittering 1 miles series - second edition. Grid reference: 098081) and is on the south-west rim of a laterite capped hill which is on the course of the Brockman River. The cave is, in essence, an extensive system of tunnels resembling a labyrinth some three to seven feet below the surface. As yet we have discovered five thousand, seven hundred square feet of tunnels. We have noted many indications that a larger area of the hill is similarly affected. The surrounding district is a dissected plateau near the faultline of tho Darling escarpment and the cave is of an altitude of just over 800 feet.

PART 1.b - Method of Investigation

The cave was known to exist by a nearby resident but only as a small laterite shelter. During the Easter Vacation 1968 we found a tunnel leading from the entrance. We followed this passage and after numerous subsequent visits have mapped, excavated, searched and sampled the area.

The mapping of the cave proved to be extremely difficult due to a lack of light, limited clearances and the extensive nature of the tunnels. Conventional methods could not be used and triangulation was used using a tape measure and a large protractor.

Maps of the vegetation areas were paced.

An excavation was dug at the left wall in the entrance area to sample the floor fill systematically. Four pegs were hammered into position at the corners of a four by three foot rectangle and string connected each peg. The soil was sifted at two and a half inch levels down to three feet. Geological specimens were taken from throughout the cave and five soil samples, including two from different levels of the excavation, were tested for their pH. These samples were taken to determine whether the soil was acidic or not so as to assess its effect upon the laterite. The Department of Agriculture tested the soils.

All geological specimens were identified by the Geology Master at Christ Church Grammar School. The animal remains were identified either from keys or Dr. Merrilees of the Western Australian Museum.

As the cave is the only one recorded that exists in laterite, all the investigation was in the field and required long periods of searching.

PART 2.a - Assessment of Geological Evidence

The hill in which the cave is placed is just on eight hundred feet and as with hills of a similar height in the neighbourhood, it is capped with a duricrust. This flat upper surface was once a peneplain and it is noticed that the cave hill is abnormally like a razor-back and the southern end of the duricrust slopes at a twenty degree angle. (Normally the duricrust is parallel to sea level.)

The tunnel system is capped by an "A" horizon of Pisolitic Hardcap (Diag.3) some three to four feet in depth. Except for the rim this is rarely broken (a few sink holes occur between five and fifteen feet from the rim). Along the pisolite rim, the rock has broken off in long rectangular slabs or in blocky chunks and older rocks have rollen down the fairly steep hillside forming a scree.

Within the hardcap it is apparent that many irregular and regular shaped pipe-like structures (photos 4,5) occur. Though not easily traced upon the surface, many of these structures penetrate into the underground area and protrude from the roof. Those are usually clogged with vegetable matter and other debris and roots dangle down from them. (photo 8)

Outside along the chunky broken rim of the laterite there are many examples of these pipes (photo 4). They are in cross-section generally circular or rectangular having a width of between one and six inches and no way has been found to determine their length but one-is known to be at least nine feet long, (photo 6)

Beneath the hardcap exist a pisolitic and nodular bauxite which is extensively hollowed out for four feet. (photo 1). In this zone the roof is supported by numerous pillars within which sometimes occur the pipe structures. Other pipes end abruptly on the roof of the tunnels. (photo 1)

The roof and walls of the tunnels is studded with the nodules and is very irregular whilst the floor is generally a flat even slope, (photo 11) tilting from north to south-east or south-west. (map 1). The floor is a mixture of clay-like soil and laterite nodules. (the clay soil doesn't become sloppy when wet but spongy.) Both the constituents appear to accumulate from the breakdown of the roof and walls.

Animal faeces, vegetable matter and other debris also form part of the cave fill. The depth of the cave floor soil is unknown but we know it to be at least three feet deep.

Kaolinized schists occur within the cave as small chunks imbedded in the bauxitic material becoming more numerous the further one goes in to the cave.

Haematite also occurs within and in close proximity to the cave as a large band of ore. (photo 14). There is too some areas of honeycombed rock which indicates active weathering; (photos 13, 17) it crumbles easily leaving a more resistant worm-like rock. The surfaces of the majority of the rocks are indented with laterite-nodules (photo 12) which can be easily dislodged by brushing ones hand against the rock surface.

Against the pillars and walls of the tunnel system, there is a concentration of nodules as also in a few shallow depressions which occur in the system. (photo 11).

PART 2.b - Assessment of Flora

The Chittering area is in the dry sclerophytic forest in which *Eucalyptus redunca* (wandoo) and *E. calyphylla* (red gum or marri) predominate.

Both these trees occur on the cave hill. In the underbrush *Banksia grandis* and thickets of *Dryandra sessilis* grow while the low undergrowth is characterized by introduced weeds and pastures with a few endemic plants.

Within the cave grows algae, mosses, ferns, slime molds, lichens, and fungi; these all growing in sufficient incident or indirect lights, the furthest being slime molds and algae which have been found twenty feet back. One fungi, however, grows on fresh echidna faeces and grows anywhere in the cave.

It is surprising to find the area above the cave almost completely void of any significant vegetation cover - only clover, lichen, cape weed and winter grass (except for one marri and one wansoo, both small in size).

The plants that we are concerned with are the eucalyptus species whose roots have been noted protruding from the pipes in the roof and also under the cave floor.

PART 2.c - Presence of fauna

Throughout the tunnel system there are obvious indications of animal habitation. This is apparent in three main forms:

1. Bones
2. Scats
3. Miscellaneous.

1. Bones

Abundant bone material is present throughout the entire system on the floor surface and to a depth of three inches in the soil. More or less ninety percent of the bone material is rabbit, the remaining ten percent consisting of sheep or lamb, with single representatives of the Grey Kangaroo, *Macropus fuliginosus*, Possum; sp...(a portion of skull), Birds; sp... (one tibia and sternum the size of a swan), a fox, *Vulpes vulpes* (skull) and a domestic fowl carcass.

The presence of the fowl carcass and large numbers of rabbit we attributed to the fox and this was further strengthened by our discovery of a complete fox skeleton adjacent to the cave.

It was suggested that the soil fill may be acidic because of the puzzling total absence of native bone material within the soil. A soil test was conducted on five samples by the Department of Agriculture. The result showed that the soils were alkali with a pH of 9.5. So as yet no solution is present for the explanation of the phenomena.

The tunnels would provide an ideal site for Tasmanian Devil habitation *Sarcophilus sp*. which formerly lived in Western Australia, (fossil records: Hasting's Cave, Jurien Bay, Wanneroo and Strong's Cave, Cape Naturaliste, Cape Leeuwin Region) but this is unsupported by any findings of crushed marsupial bones. However, alkaline chemical action may be responsible for this absence. Other native animals which are suited to conditions present at the cave are wombats (also extinct) and *Bettongia Leseueri*.

2. Scats

The most obvious indication of animal habitation is fresh echidna scats which have been found in two successive weeks. Also fresh rat and older fox scats have been found.

The echidna scats are very abundant, characterized by the plentiful insect exo-skeletons. These scats deteriorate and become the site of a fairly rich insect population consisting of cockroaches, millipedes and smaller insects, all pale and anaemic in colour.

3. Miscellaneous.

As with the scats, echidna quills confirm tho animal's presence. The quills have been found throughout the cave and in association with numerous shallow depressions.

Broken shells, of the land snail *Botlerienibryon indutus* (Menke) occur on the surface and to a level of two foot and in the soil in the excavation in the entrance area. These shell bits were bleached. However, live specimens have been found crawling on wet rocks on a drizzly day. They apparently only emerge from their rocks and crevices during drizzle to feed. The shell is a handsome yellow brown banded turban.

PART 3.a - Theory of the Cave's Formation

The formation of the cave system seems to us to be complex combination of climatic, floral, faunal and geological factors.

The occurrence of the pipe-like structures inside and nearby the cave come to our attention; these formations [are] usually regular in shape and sometimes with a thin root extending into the tunnel.

The pisolitic hardcap was very pervious and also through the root holes water rapidly dripped and in one case flowed down the pipe. (photo 9) During June 1968 the whole roof became completely covered in drops of water and the floor became pitted with splash holes.

The water, we thought, would partly, by capillary action through the laterite, and visibly via the root holes, enter the bauxitic and nodular zone. With this water dissolved organic salts would be carried by the water and there is evidence of deposition of the salt (photo 17), or if in suspension, accumulation of a chemical on the rock surface.

By careful investigation we followed the floor levels and it appears that there is a definite watershed within the cave (map 1). Soil appears to move from the north-west to the south-east and south-and overall the floor level is parallel to the upper surface of the duricrust. It is obvious a large volume of water travels through the soil. (Soil creeps and slumps are all over the hill and this is an obvious indication of a saturated soil.) There must also be a good drainage system on the hill because the cave floor drains well and the clay never becomes sloppy.

If the climate were slightly wetter, large bodies of water could remove the cave fill in sizable quantities, however, the laterite-pisolite must have been affected originally in some way so as to form the initial holes.

Sheer root pressure may have been responsible because of the extremely tough pisolitic hardcap, straightness of the holes and mainly because both the trees concerned are surface feeders with large lateral roots and fine, deeper roots. (This is shown by uprooted specimens of those trees whose roots follow the mentioned pattern.) Another answer to the formation of the cave is the rising and lowering of the watertable which would therefore cause an annual expansion and shrinking of the clay and thus the cause of hollows under the pisolite during summer.

However, at Jarrahdale there is an average rise and fall of seventy feet at the bauxite open cut without any significant expansion of the Kaolin. [Information from a geologist currently employed at Jarrahdale].

Thus tree roots seem to be the only logical explanation but not the sheer root pressure. On the other hand, the single fine vertical roots who penetrate the pisolite cap could bring detritus and chemical action would then begin on the laterite.

The roots of the trees also penetrate the exposed pisolitic and nodular zone along the duricruct rim. (photo 10, Diag. 1) In this cave the larger lateral roots play a major role. In one tunnel a root of two inches width, follows the tunnel's path and divides and extends on the soil up the subsidiary tunnel. As the finer roots (photo 8, Diag. 2) reach the area affected by the lateral roots, more and more water increases to concentrate around the roots until cave fill is washed away. Gradually this process escalates as more fill is removed.

The pipe structures we think form buy the drainage of surface runoff into the roots passage, and this water plucks nodules from the rock and carries the kaolin in solution and suspension. Gibbsite has been noted to be deposited down the pipe colunn as an orange substance. Other forms of erosion in the honeycombed area and haematite region, also help create space. As the cave faces south-west, it receives the full force of the majority of Western Australia's weather. Wind deflation would be responsible for the removal of most amounts of fine duet if it were dry. During May 1966, we lit a fire in the entrance area during a very strong gale. The smoke was whisked into the tunnels and issued forth through numerous holes in the duricrust.

One, perhaps, example of the importance of wind as an erosion agent, is the depressions at the foot of the pillars and walls and the predominance of nodules in these shallow pits. (photo 11).

Apart from water and deflation as agents for the fill removal, once the tunnels are large enough animal habitation could greatly develop and widen the tunnels; this is shown by the mere brushing of one's hand, we could dislodge large sections of nodular roof. Also Chemical action of the scats could increase the decomposition of the matrix which binds the nodules.

As we have realized, the cave system is not the result of one phenomena but the combination of many factors that formed the tunnel system. Yet another factor which explains the large open entrance area (photo 3) is the effect of insolation. The suns rays evaporate the moisture within the rock causing crystallization and breaking down of rock surfaces. Direct beating of rain would also loosen nodules and wash away finer kaolin.

To the right of the cave, the duricrust rim has obviously broken down and the cave outline takes a ninety degree turn for thirty feet before it returns to normal, facing south west. This area of scree appears to formerly be a cave which has collapsed. (There are numerous tunnels leading from this area into the duricrust.) On the opposite, northern side of the cave a younger stage of tunnel system is in progress with the tunnels only one to two feet in height.

One interesting suggestion concerning the cave was that of the feasibility of aborigines using the entrance area as a shelter. However, there is no conclusive evidence of this as yet.

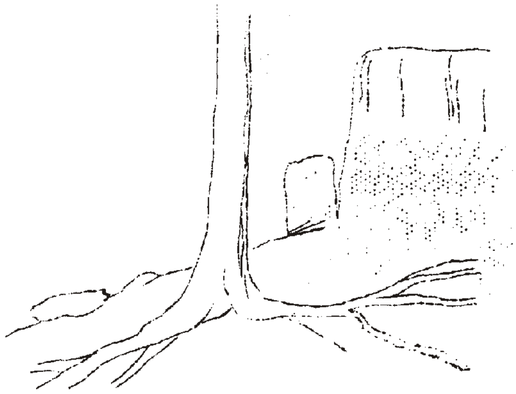
PART 3.b - Conclusion

From the foregoing information it is impossible to pinpoint the caves formation to one sole factor, however, primarily, the action of the roots in the duricrust triggers off several other factors which removed the decomposed fill and thus form an underground system of tunnels.

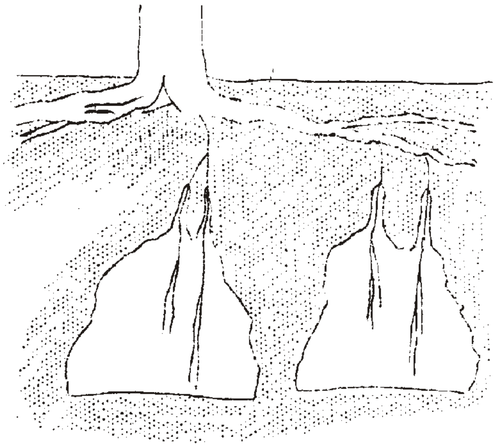
All in all, the geological, floral, faunal and climatic factors present at Chittering are at a point, so balanced, so as to produce this formation, previously unknown to exist on such an extensive scale in laterite.

TWO DIAGRAMS OF ROOT ACTION WITHIN THE DURICRUST.

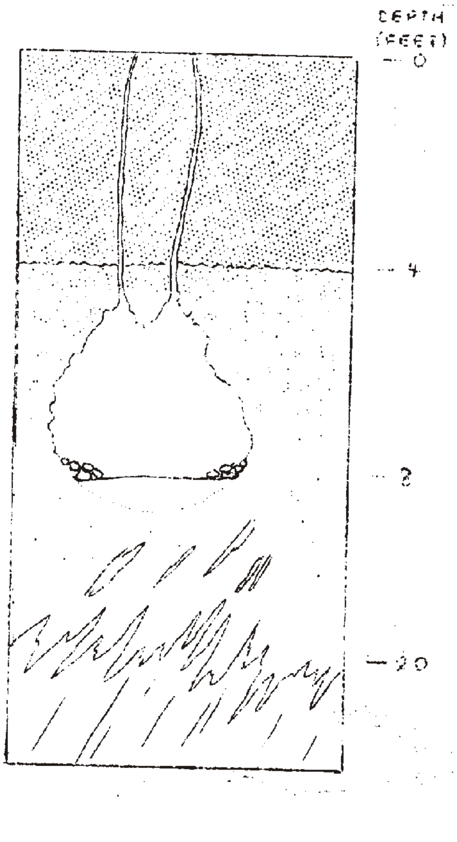
DIAG 1 LATERAL ROOT ACTION IN THE "B" HORIZON – PISOLITIC AND NODULAR BAUXITE ZONE.



DIAG 2. HORIZONTAL FINE ROOT ACTION THROUGH THE PISOLITIC HARDCAP – REACHING THE "B" HORIZON.



SOIL PROFILES



PISOLITHIC HARDCAP ZONE WITH PIPE STRUCTURES.

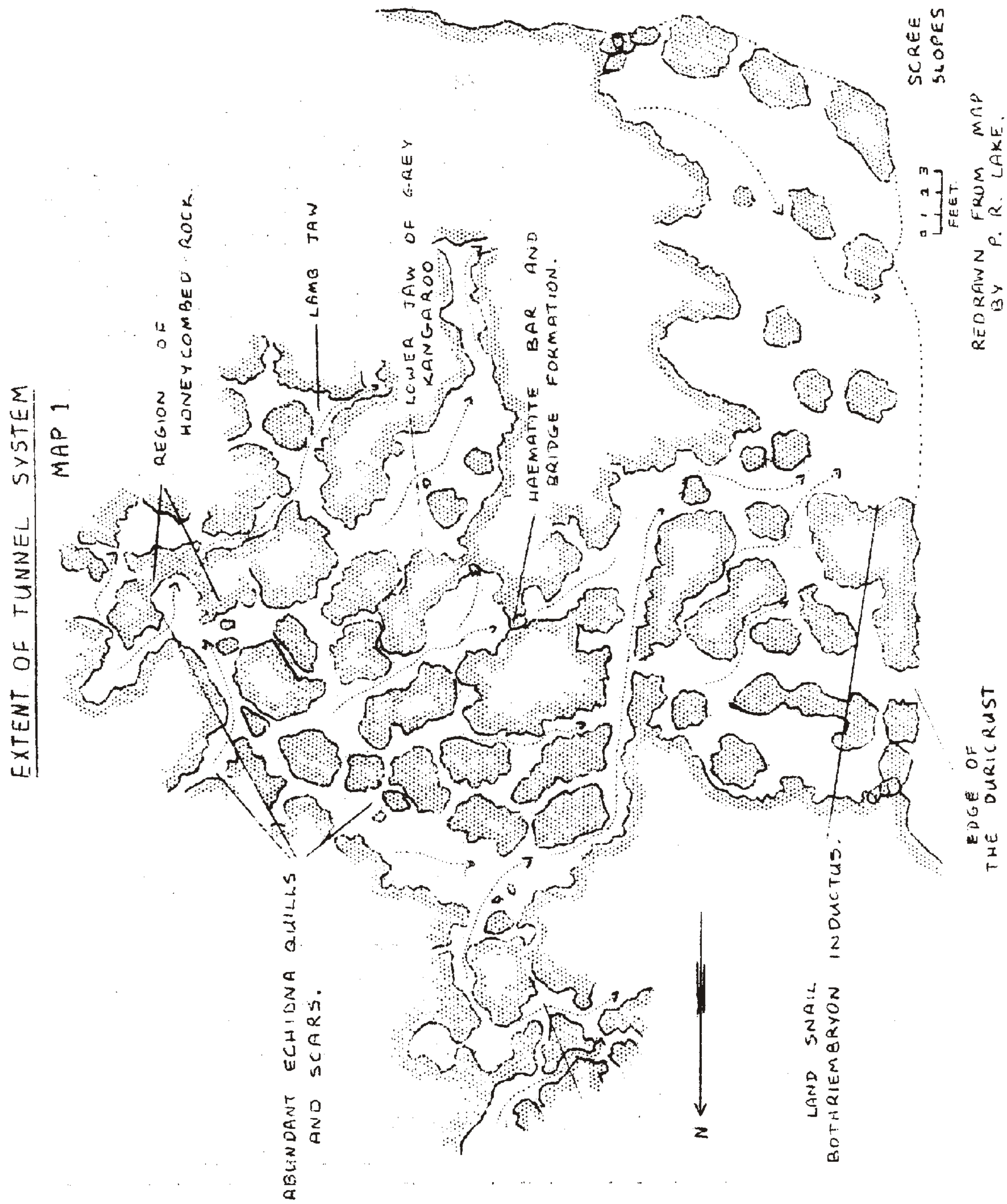
PISOLITHIC AND NODULAR BAUXITE CONCRETIONARY – EXTENSIVEY HOLLOWED OUT – TUNNEL SYSTEM. SOME HAEMATITE AND KAOLINIZED SCHISTS – PIPES OPEN ABRUPTLY.

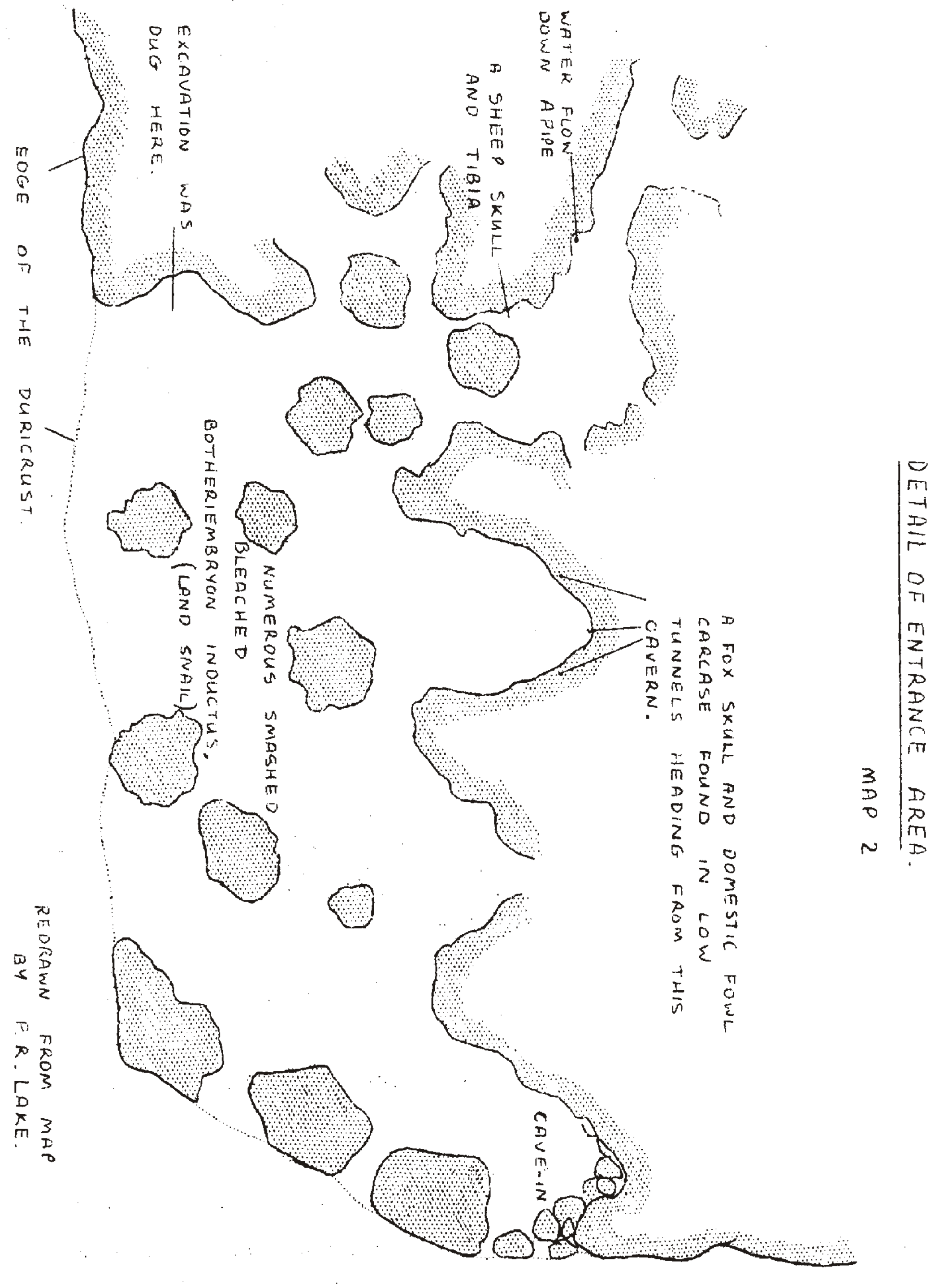
CAVE FLOOR – FILL HAS HIGH % OF CLAY OR SILICA

POSSIBLE BAUXITE AND KAOLIN ZONE

BEDROCK – SCHISTS KAOLINIZED ON UPPER SURFACE.

REDRAWN FROM DIAGRAMS BY P. R. LAKE.


EXTENT OF TUNNEL SYSTEM
MAP 1
REGION OF HONEYCOMBED ROCK.
LAMB JAW
LOWER JAW OF GREY KANGAROO
HAEMATITE BAR AND BRIDGE FORMATION.
SCREE SLOPES
0 1 2 3
FEET
REDRAWN FROM MAP BY P. R. LAKE.
EDGE OF THE DURICRUST
LAND SNAIL BOTHRIEMBRYON INDUCTUS.
ABUNDANT ECHIDNA QUILLS AND SCARS.
N


DETAIL OF ENTRANCE AREA.
MAP 2
A FOX SKULL AND DOMESTIC FOWL CARCASE FOUND IN LOW TUNNELS HEADING FROM THIS CAVERN.
WATER FLOW DOWN A PIPE
A SHEEP SKULL AND TIBIA
EXCAVATION WAS DUG HERE.
EDGE OF THE DURICRUST.
NUMEROUS SMASHED BLEACHED BOTHERIEMBRYON INDUCTUS, (LAND SNAIL)
CAVE-IN
REDRAWN FROM MAP BY P.R. LAKE.