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PSEUDOKARST CAVES OF THE GAZELLE PENINSULA, NEW BRITAIN, PAPUA NEW GUINEA

R. Michael Bourke*

ABSTRACT

Volcanic pumice ash deposits blanket much of the north east lowlands of the Gazelle Peninsula of New Britain. Ten pseudokarst caves are known in this area, nine occurring in the volcanic ash and one within an active volcano. Clay or rock layers have been noted at about floor level in some of the caves. It is postulated that cave formation occurs because ground water moves more easily through the coarse sand ash layers then it can through the denser lower beds. Lateral movement of water occurs and tunnels commence forming where the water effluxes. A carbon sample from one cave was dated by radiocarbon age determination as 1475± 80 years B.P., thus indicating maximum cave age. Other areas in Papua New Guinea where similar cave development is possible are noted.

INTRODUCTION

New Britain is barely known in the speleological literature. Some of the features of the island are extensive karst landforms occurring on upland plateaux, several very large dolines, a number of explored limestone caves, and cave depth potential of 750 m and possibly up to 1000 m. The caves discussed here are developed in recent volcanic deposits, and whilst small, they are nevertheless interesting. They were first reported by the author in an earlier paper (Bourke 1972). The pseudokarst caves should not be confused with the numerous and sometimes extensive man-made tunnels dug for the Japanese occupation forces in World War II.

The only other reported pseudokarst caves in Papua New Guinea are in the Cape Hoskins area of New Britain and on Lihir Island. Johnson and Blake (1972) include a photograph of a cave containing boiling mud pools on the flank of Witori volcano. In the same general area, they report volcano-karst erosion features in moderately welded pyroclastic flow deposits south of Waisisi. Fluted gullies and small sink holes connecting with underground channels are developed where the moderately welded deposits are exposed in valley floors. Karst-like erosion features also occur in some older tephra deposits. On Lihir Island off New Ireland there is at least one pseudokarst cave developed in basalt (H. Gallasch, pers. comm.).

Rainfall varies in the different areas where caves occur on the Gazelle Peninsula, but is of the order of 2500 mm per year.

GEOLOGICAL BACKGROUND

The Gazelle Peninsula consists of a low isthmus in the south-west that separates it from the rest of New Britain, the rugged Baining Mountains, and the north-east lowlands. The Keravat and Warangoi River valleys separate the north-east lowlands from the mountains (see Figure 1).

* (Papua New Guinea Cave Exploration Group), D.A.S.F. Keravat, East New Britain, PAPUA NEW GUINEA.

PSEUDOKARST - R.M. Bourke

There are four eruptive centres on the Gazelle. The Rabaul eruptive centre is now a partly submerged caldera, breached on one side, and forming Rabaul harbour. It was formed during a climactic eruption 1000 to 1500 years ago. Two other centres, Mt. Varzin and another peak, are about 20 km south of Rabaul and the fourth is Watom Island 15 km north-west of the town (Macnab 1970).

Quaternary pyroclastic deposits from the Rabaul eruptive centre blanket much of the north-east lowlands (Macnab 1970), and a layer of pumice ash underlies the present day soil cover. Buried clay horizons a few metres below the present landsurface can be seen in road cuttings, these being old soils derived from earlier volcanic deposits.

THE CAVES

Ten caves are known to the author. These will not be described fully here, but descriptions and maps will be published in *Niugini Caver* in the future. Caving activity has not been concentrated on these caves because of their small size. Many others probably exist. In general the caves consist of a single stream passage with few or no branch passages.

The five Malabunga Caves are near the High School. Malabunga No. 1 is 52 m long. The cave is several metres tall and wide for most of its length. A small stream flows through the cave, and small springs emerge in places from the walls. The cave has five entrances, three occur in two dolines, the fourth is an efflux entrance, and the fifth is a daylight hole. There are two side passages. The floor of the cave is at or just below the contact between an overlying coarse sand layer containing pumice and a layer of heavy clay. At the contact there is a hard layer some 1 cm thich. The contact can be seen for most of the length of the cave.

Malabunga No. 2 is about 27 m long. Again, it is several metres wide and tall for most of its length. The cave is formed along the contact between the sand and clay. The contact is steeply dipping in places, and passage shape reflects this. Caves 3, 4 and 5 are about 24 m, 10 m and 30 m long respectively. They are smaller in section than the former two, and exploration involves crawling. The contact has not been observed in these caves.

All caves contain streams except No. 3. The entrance of this cave was located in a natural archway but was blocked by the collapse of the arch during a major earthquake in July, 1971. All caves have efflux entrances which are located at the base of cliffs. Tubes generally of 10 cm diameter and up to 30 cm in diameter occur in the walls of the caves, as do pieces of carbon. The latter are presumably the remains of trees buried with the ash falls.

Ngoat cave in the Gaulim area is 73 m long and also is a stream cave. There is an influx and efflux entrance. Similarly a small stream cave 10 m long at Keravat has both influx and efflux entrances. The influxes are not located in dolines. The streams are in fact underground sections of surface streams. Komunga cave near Taulil village is about 18 m long. The cave is dry and is on the side of a steep ridge some 15 m above the nearest creek. These three caves consist of single passages.

Matanakamalan cave near Rabagi village is 51 m long and contains a small stream. This cave is formed along the contact of the volcanic sand and the underlying volcanic rock. There are two passages. In a section where bats are very numerous it appears possible that they have enlarged the cave upwards as coconut roots are exposed in the roof.

The final cave is not in pumiceous ash as are the others, but is located within one of the craters of the active Tavurvur (Matupit) volcano. Cave origin is not known but the cave appears to be formed by collapse. It is well decorated

with a variety of coloured sulphur containing minerals. The minerals appear to be precipitates from the sulphur containing volcanic gases.

DISCUSSION

It is postulated that the caves were formed as follows. The presence of a buried soil profile of heavy texture, or a rock layer that underlies the coarse volcanic sand deposit is a prerequisite for cave development, as is a place where the contact between the two layers reaches the surface. Water infiltration and percolation through the coarse permeable layers is rapid, but it is impeded by the denser lower layers. Lateral movement of water occurs and tunnelling commences where the water effluxes. The tunnelling process moves back from the efflux at the same time enlarging the cave. Collapse may open dolines. Collapses at the efflux are likely, thus forming the cliffs observed at the efflux entrances of the caves. Stream erosion may occur within the cave thus lowering the floor below the contact level. Alternatively subsequent collapse of material within the cave may raise the floor level above the contact. This is likely where streams are no longer active. Graham and Baseden (1956) have proposed that similar processes give rise to tunnel erosion in these soils.

Freshly erupted volcanic minerals, especially pyroclastics such as certain tuffs and agglomerates that contain unstable minerals, are highly susceptible to corrosion by rainwater and a variety of karst-type microrelief forms develop, just as in a limestone karst. This is termed volcano-karst (Fairbridge, 1968). Weathering of volcanic sands to fine clay particles which can be readily washed out of the coarse sand framework is likely. However the significance of solution processes, as distince from erosional ones, in cave development here is unknown. It is suggested that the erosional processes are dominant.

A sample of carbon was collected from the wall of Malabunga No. 1 cave for radiocarbon age determination which was performed by the Sydney University Radiocarbon Laboratory, The age of the sample (SUA-245) was 1475 ± 80 years B.P. (475 A.D.). This date sets the upper age of the cave, and indicates that cave development has been rapid when compared with limestone caves. The age lies within the eruption period of the Rabaul caldera proposed by Macnab (1000 to 1500 years ago). However, all the caves described here, except the one within Tavurvur volcano, are located closer to Mt. Varzin than the Rabaul caldera, so the origin of the parent material is uncertain.

Ash deposits also occur along the north coast and at the western end of New Britain, on much of Bougainville, on the islands off the north coast of the New Guinea mainland, such as Umboi, Karkar and Manam Islands, around Mount Lamington in the Northern District, in volcanic areas in the Gulf, Western, Southern Highlands, and Western Highlands Districts, and on some of the small islands off New Ireland. Similar caves are likely to occur in these areas, where ash deposits overlie buried soil profiles.

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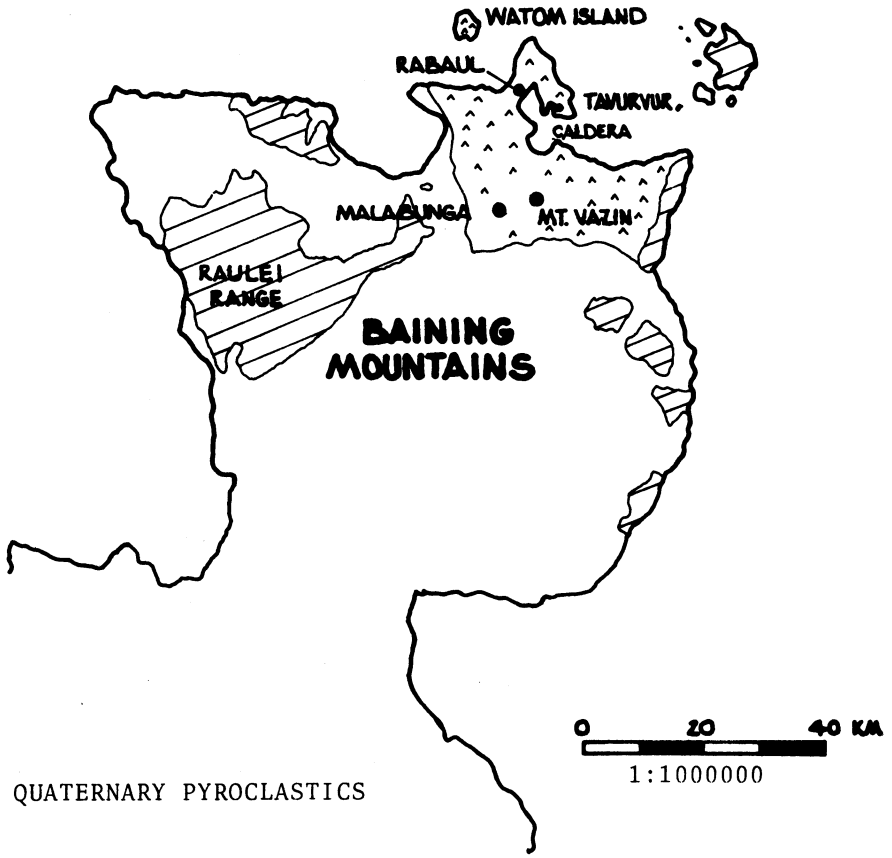

Figure 1. 1:1,000,000 Geological sketch map of the Gazelle Peninsula, New Britain.