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SECTION 1
GEOLOGY AND GEOMORPHOLOGY - LIMESTONE KARST

PRELIMINARY REPORT ON THE GEOLOGY AND GEOMORPHOLOGY OF THE MARBLE ARCH CAVE AREA, NEW SOUTH WALES

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INTRODUCTION

The Marble Arch Cave Area is located 35 kilometers south of Braidwood in southeastern New South Wales. The cave area is one of a number of small limestone bodies situated along or near the divide between the Shoalhaven and Deua Rivers. Marble Arch is located just east of the divide and drainage is into the Deua River. This is a preliminary report of detailed studies of the cave area now being undertaken by the Canberra Speleological Society, a final report will be published at a later date. This has, in part, been necessitated by the discovery of a new, and geomorphically important, cave in mid-December of 1974.

GEOLOGY

Despite its small size, about 120 metres wide and 1 km long, the area is geologically complex (fig. 1). The caves are developed in a carbonate unit that trends roughly North-South along the valley of Reedy Creek. Exposure of the carbonate is generally good but contacts with adjacent rock units are usually obscured by scree or soil cover. The carbonate unit in which the caves are developed is named the Marble Arch Limestone (Best et al., 1964). This unit is believed to be of Silurian age, based on data obtained from the Wyanbene Limestone to the south and the Cheitmore Limestone to the north which are believed to be lateral equivalents along the regional strike. There is no paleontologic evidence from Marble Arch on which to establish an age.

The Marble Arch Limestone consists of coarsely recrystallised and brecciated carbonate along with irregular dolomitic lenses. The term marble more appropriately describes the lithology, than does the term limestone, and will hereafter be used. The marble consists of angular fragments of grey to white, coarsely crystalline carbonate set in a ferruginous, silty to calcareous matrix. There is no preservation of original bedding or sedimentary structures but there are well developed cleavage planes that appear to have had some control on cave development. Dolomite occurs as irregular patches near the northern and southern extremities of the main carbonate body but appears to be absent in the central portion. South of Moodong Creek the marble near the top of the ridge is very dolomitic. The dolomite is secondary in origin.

Where exposed, both the eastern and western margins of the marble appear to be in contact with a waterlain tuff. Thickness of this unit appears to be variable, from approximately one to 20 metres. To both the east and west of the tuff is a

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thin dark, fine grained quartzite. This unit, about one to three metres thick, is resistant to erosion and is thus a good marker bed. It forms the ridge crest immediately east of the marble and talus from this unit obscures much of the eastern slopes of Reedy Creek. The quartzite is generally not exposed west of the marble but a good exposure was observed near the southern end of the main carbonate body on the ridge that separates Moodong and Reedy Creeks.

Granite surrounds the sedimentary rocks on the north, east and southwest sides. The granite varies in colour from white to pink and may be either fresh or deeply weathered. Relationships to the south are unclear but the sedimentary rocks appear to be cut off from the granite by a fault. The western margin is not well exposed but metasediments, of both cherty carbonate and silty clastics are found as float along the western valley margin of Reedy Creek and the adjacent hill slope. These rock types have not been observed in place.

Structurally, there is very little control in the area. As a result of poorly preserved bedding the only dip reading taken in the area was on the quartzite and gave a value of strike N10°E, dip 85°E. Two faults effect the area. One fault, with right lateral movement, separates the southern extension of the carbonate from the main portion of the unit. This fault is topographically expressed by the course of Moodong Creek. The southern extension appears to be terminated by a second fault that brings the marble up against granite. Faulting probably took place at a late stage following emplacement of the granite.

GEOMORPHOLOGY

The Marble Arch Cave Area includes at least five major caves, Thermocline, Nargun, Marble Arch, Moodong and Bettowynd Caves (fig. 2). There are also an additional thirteen known minor caves and a total of 21 entrances have been tagged as of December, 1974. Surface exploration of the area has been reasonably thorough and it is not expected that further major discoveries will be made.

An elevation datum point for this study was taken as the junction of Reedy and Moodong Creek. On the Kain 1:25,000 topographic map this junction is at 1990 feet elevation and this was converted to an assumed value of 580 metres. The highest elevation of the marble is approximately 710 metres, near the south-eastern portion of the main marble body. The elevation of Reedy Creek where it leaves the lower end of the marble is 595 metres. This gives a figure of 115 metres (or approx. 380 feet) for the relief on the marble.

Within the marble three major levels of cave development have been recognized (fig. 3). These are level A, characterized by Bettowynd Cave and possibly by Nargun Cave; level B, by the upper passages of Marble Arch and Moodong Caves; and level C, by the active stream levels in the latter two caves. Because Bettowynd Cave was only recently discovered and has not been mapped, our discussion of level development will deal only with levels B and C.

This detailed study of the B and C erosion levels in Marble Arch and Moodong Caves can only be regarded as preliminary. We have not, as yet, attempted to relate, with confidence, these caves with Thermocline or Nargun Caves located further up Reedy Creek.

The elevation of the uppermost passage, the Ba level of the Marble Arch-Moodong Cave System is 642 metres at the upstream end. The Ba level passage has a flattened ovate cross-section and represents a period of base level stability during which enlargement of the cave cross-section is horizontal rather than vertical. The Ba level passage is partly filled with fine sediments and gravels but the time at which this sediment was deposited is unknown. The Ba level, at 642 metres, is 3.5 metres above the lowest elevation in the saddle above the Arch which indicates that surface stream erosion probably continued until some time during erosion of the Bb level.

After the Bb level all surface drainage in Reedy Creek was channelled through a cave passage.

A probable lowering of base level then lead to a period of rapid downcutting forming Dunn's Crack (level Bb). This passage is up to 7 metres high and is usually less than a metre wide. The Bb level connects the Ba and Bc levels, usually as an open, vertical passage intersecting the flat roof of the Bc level.

The Bc level is the lowest recognized part of the B level. The level represents a return to base level stability with development of large, anastomosing stream channels. Two extensive flat roof levels can be differentiated in part of the Bc level. The Bc level is up to 4 metres high, 12 metres wide and must represent a relatively long period of slow downcutting.

Bc level downcutting is apparently terminated by a period of deposition in the level of both coarse and fine clastic sediments. The change from degrading to agrading conditions could have been the result of a blockage of the valley at some point further downstream by slumping of large blocks into the stream. The Bc level was entirely filled with sediment and the active stream meandering on top of the deposited sediments began to cut upward into the ceiling. The phreatic conditions and hydraulic pressures developed an upward cutting channel with an irregular roof level. The meandering passage is cut into the ceiling from 10 cm to as much as 1.5m, using the flat ceiling of the Bc level as a datum. This mode of development would produce features analogous to those produced in subglacial ice caves. The lack of anastomosing ceiling channels probably indicates that this period of ceiling solution was of short duration. The stream then cut down through the accumulated sediments and into the underlying bedrock floor preserving with remarkable fidelity the meander form found in the ceiling.

There is no known stream passage connection between the lowermost B level and the uppermost C level. It may be that the transition from B to C levels took place by phreatic sapping upstream from the present extent of the cave. The separation of the lowermost B level from the highest C level is about 3 metres.

The uppermost C level (Ca) represents another period of base level stability. The Ca level passage is up to 12 metres wide but less than a metre high. This passage has subsequently become fully or partially sediment filled but the timing of this event is not known. The base level stability of the Ca level was replaced by a period of downcutting forming a passage, the Cb level, two to three metres wide and 11 metres high before another period of base level stability, level Cc, developed in which the cave passage again developed laterally.

At present level Cd, the active stream level, development downward appears to be taking place in three ways. First there appears to be continual downcutting by the stream at high flow periods in the major cave floor. Second there is sapping with resurgence of the stream in a minor cave (MA18) on the right wall of the gorge about 18 metres below the downstream entrance of the Arch. Thirdly a portion of the stream is diverted at two points through the Lake Chamber passage and exits through the lower entrance of Moodong Cave (MA4). Some water enters this flow path from within the Arch and the rest is believed to enter the system from the bed of Reedy Creek just upstream from the present cave entrance. The northern-most part of the Lake Chamber passage is about 7 metres horizontally from the surface stream and the top of the waterfall is 2.5 metres below the stream.

STREAM GRADIENTS

Using flat ceiling levels or meander niches it is apparent that during periods of base level stability that stream gradients in the abandoned B and C levels of the Marble Arch-Moodong Cave System were very close to measured stream gradients of the present day Reedy Creek when it flows on limestone. There is a marked

change in the stream gradient of Reedy Creek at the lower end of Marble Arch Cave where a major tributary enters from the left. As far as we are now able to determine this change in gradient is not reflected in the abandoned cave levels.

References

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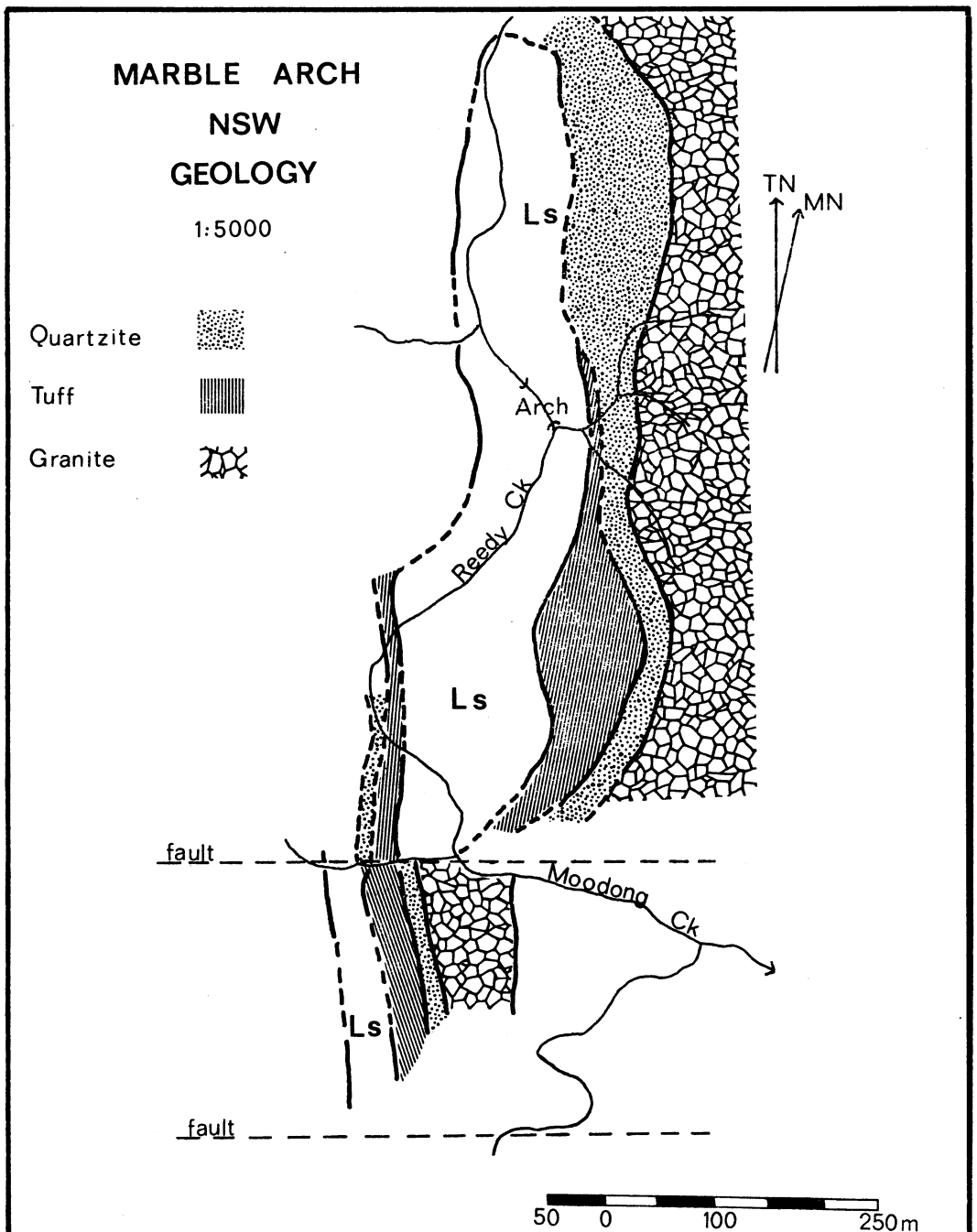

Figure 1. The geology of the Marble Arch cave area, N.S.W.