PRELIMINARY REPORT ON DRAINAGE MODIFICATION IN THE DEEP CREEK–EAGLES NEST BASINS, YARRANGOBILLY, NSW

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Abstract

To account for the present distribution of cave systems in the Deep Creek-Eagles Nest area of the Yarrangobilly Cave Area significant modification of drainage patterns must have taken place. The size of drainage basins has changed significantly in the past 22 m.y. The drainage basins now feeding the North and East Deep Creek cave systems have decreased in size, but the West Deep Creek drainage basin has greatly increased in size. Three upper level cave systems, Janus, Restoration and East Eagles Nest, are identified and are correlated with the One Tree Hill Erosion Level developed in the Yarrangobilly River valley. Lower levels of North Deep Creek, East Deep Creek and Eagles Nest Caves appear to be related to the present level of the Yarrangobilly River.

Introduction

The caves of the Eagles Nest-Deep Creek drainage basins form the largest integrated cave system in the Yarrangobilly Karst Area. The system is composed of four inflow caves – Eagles Nest (Y1–2), East Deep Creek (Y5), West Deep Creek (Y6), North Deep Creek (Y7); two dry high-level caves – Restoration (Y50), Janus (Y58); and the common stream resurgence – Hollin Cave (Y46). There are additional caves in the area which may be related to the system but these have yet to be accurately mapped and plotted.

This paper attempts to examine the origin of these caves in terms of successive development of cave levels and looks at stream piracy in the drainage basins to explain some of the observed variation in passage size and the size of the active cave streams. It must be noted that this is a preliminary study and that subsequent work, based on more data, may indicate that there are alternative explanations as to the origin of some of the features that are here related to stream piracy.

Geomorphology

A summary of our present knowledge of the recent geomorphic history of the Yarrangobilly Karst Area is presented in Table 1. The only fixed dates that have been obtained are for two basalt samples. One was collected from the basalt outcrop along the Bullock Track near its junction with the northern access road and gives an age of 21.9 + 0.5 m.y. The second sample was collected from Gravel Hill near Yarrangobilly Village and gives a date of 22.4 $\pm$ 0.5 m.y. The dates are in agreement with dates, obtained by Wellman & McDougall (1974), for the Snowy Province which range from 22 to 18 m.y.

These dates represent the age of the partial filling of a broad proto-Yarrangobilly Valley, formed in this area mostly on limestone, by basalt flows that probably originated on the surrounding highlands. As can be seen in the Bullock Track exposure, there was considerable relief on the limestone and the thickness of the basalt is variable but is estimated to have been in excess of 10m in some places.

Following the basalt flows in the early Miocene, the Snowy Mountains area was subjected to slight uplift and a period of rapid downcutting took place that initiated the development of the limestone gorge at Yarrangobilly. It should be noted that the present course of the river is strongly controlled by structural lineations in the steeply dipping Silurian sediments and is not a random meander pattern developed from a meandering stream superimposed from a flat basalt plain. It is possible that the basalt flows covered only part of the old valley floor.

The initial period of downcutting in the middle or late Miocene led to the development of cave systems that are presently preserved at high level on the limestone plateau, including caves such as Restoration, Janus and Jillabenan (Y22). These caves were graded to a river level that is thought to have been at an elevation of about 990 m in the Deep Creek area. At that elevation a short halt in the downcutting led to period of lateral erosion in the river valley. Only three or four remnants of this period are still preserved as bedrock notches, as at Funnel Pot spur and at One Tree Hill, within the entrenched Yarrangobilly Valley. This erosion level is here called the One Tree Hill erosion level.

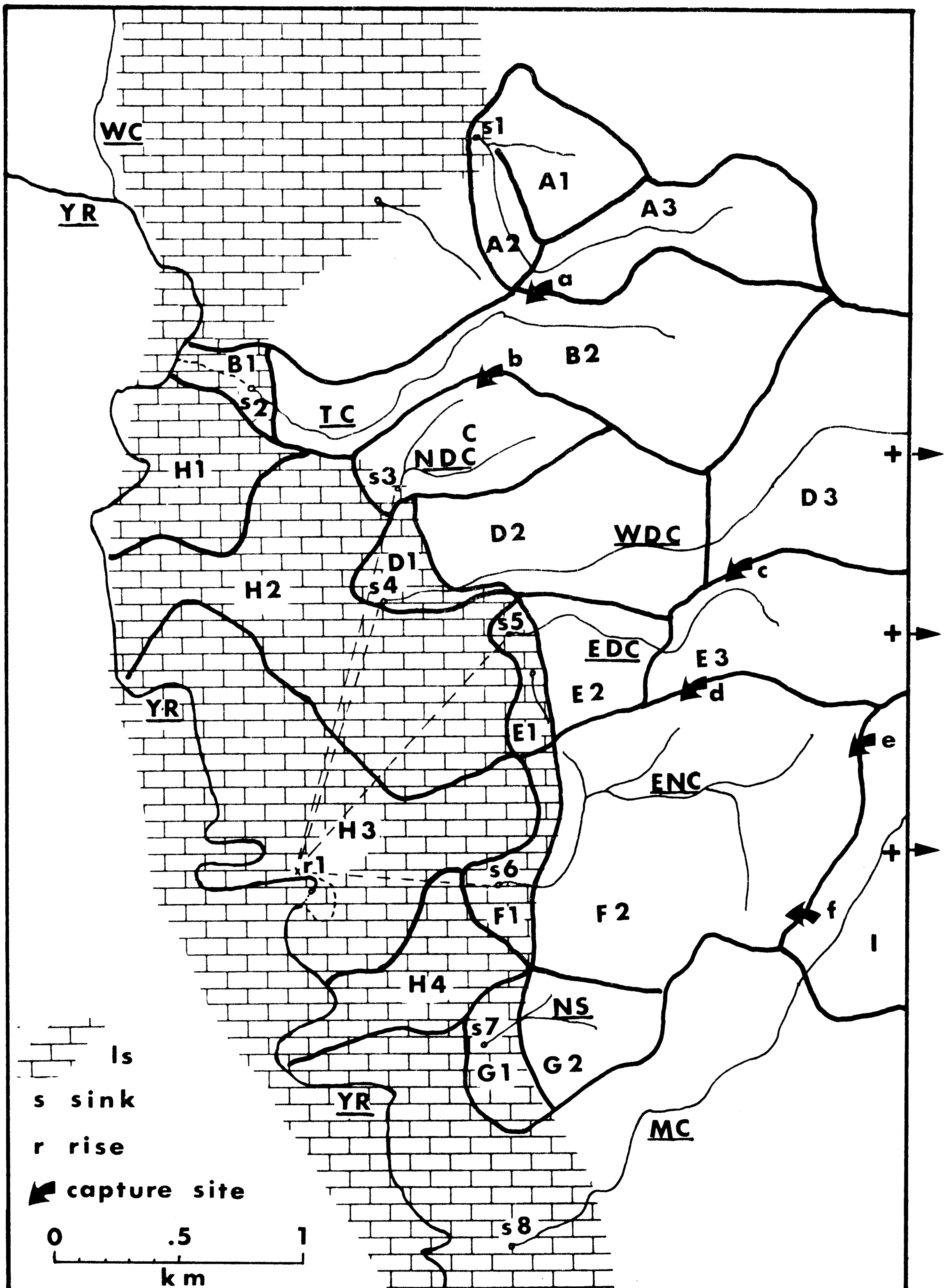

Fig. 1.
Drainage basins in the Eagles Nest-Deep Creek portion of the Yarrangobilly Karst Area, see Table 2 for identification of sinks and areas. WC – Wombat Creek, TC – Traverse Creek, NDC – North Deep Creek, WDC – West Deep Creek, EDC – East Deep Creek, ENC – Eagles Nest Creek, NS – Negative Series, MC – Mill Creek, YR – Yarrangobilly River.

Table 1. **Summary of middle Tertiary to Recent erosion history of the Yarrangobilly Region**

	Age	Development
1.	pre Miocene	downcutting and lateral enlargement of the Yarangobilly Valley, development of plateau at elevation of 1130 – 1150 m.
2.	Miocene	partial filling of the valley floor by basalt flow, dated at 22 million years.
3.	?late Miocene	uplift and renewal of downcutting, initial development of gorge and high-level cave systems.
4.		period of lateral erosion, development of the One Tree Hill erosion level at about 990 m.
5.		renewal of downcutting to present level.

Renewal of downcutting was accompanied by the abandonment of the high level cave passages for lower (middle) levels that are graded to the present river level with resurgences such as Hollin and Coppermine Caves. Recent examination of Hollin Cave by divers indicates that the stream passage is as much as 15 m below the level of the adjacent river only a few metres from the entrance. This, combined with the abandonment of middle level stream passages in caves such as Eagles Nest, may mean that active development of phreatic cave passages at a low level is now in progress.

Cave Systems

The active cave streams in Eagles Nest, EDC, and NDC caves are considered by the author to be underfit cave streams when compared with the fossil segment of the cave system. An underfit cave stream is one which is smaller than that judged to have been necessary to have formed the size of the passage now present in active or abandoned levels.

There are three major reasons for the real or apparent underfit streams in cave passages. These are changes in the size of drainage basins, changes in climate and local variability in the chemistry or physical character of the limestone. At Yarrangobilly the latter explanation is not considered because the caves generally developed across the strike of the bedding and the size variations do not seem to be related to bedding.

Variation in amount of rainfall is also not regarded as an explanation for the observed sizes of cave passages. There has been a progressive trend toward a more arid climate in Australia since the early Miocene (E.M. Kemp pers comm). However, the present size of some of the drainage basins is such that the variation in rainfall is thought not to have been enough to account for the observed change in passage dimension.

It thus seems probable that there has been a series of modifications of the size of local drainage basins, together with a general decrease in rainfall that must be examined in order to explain the relationship of size of fossil and active cave passages in the Eagles Nest-Deep Creek area.

A number of drainage basins (Fig 1, Table 2) have been delineated for the Eagles Nest-Deep Creek area at Yarrangobilly. These were generated using the preliminary edition of the Yarrangobilly 1:25 000 topographic map and the Tantangarra 1:50 000 topographic map. The size of the individual basins was calculated with the assistance of A.P. Spate. Following this air-photo interpretation and surface traverses outlined a number of potential stream capture sites on the Eagles Nest, North Deep Traverse and Bathhouse Creeks.

Table 2. **Drainage basins of the Eagles Nest-Deep Creek area** (see Fig. 1)

	Drainage basin	**Sub-Division**	**Area**	**Drainage point**	**Area drained**
A	Bathhouse	A1	25.9 ha	S1-Bathhouse Cave	76.0 ha
		A2	10.3		
		A3	39.8		
B	Traverse Creek	B1	9.7	S2–Traverse Creek sink (variable)	88.5
		B2	88.5		
C	North Deep Creek			S3–North Deep Creek Cave	31.6
D	West Deep Creek	D1	10.6	S4–West Deep Creek Cave	305.3
		D2	57.3		
		D3	237.4		
E	East Deep Creek	E1	8.3	S5–East Deep Creek Cave	79.8
		E2	21.6		
		E3	49.9		
F	Eagles Nest	F1	14.8	S6–Eagles Nest Cave	137.5
		F2	122.7		
G	Negative Series	G1	14.2	S7–Negative Series Sink	35.4
		G2	21.2		
H	Plateau	H1	33.8	infiltration	258.0
		H2	101.4		
		H3	95.2		
		H4	27.6		
I	upper Mill Creek			Mill Creek	395.0

Eagles Nest Caves

The sequence of drainage modification for the Eagles Nest-Deep Creek areas is outlined in Table 3. As I have only a very limited knowledge of Eagles Nest Cave discussion of that cave is limited. Pavey (1974) has commented in a general way on the geomorphology of the Eagles Nest System but has not suggested a sequence of events relating to the development of the cave. He does, however, note that the present stream is underfit compared with the passage size of the Eastern Eagles Nest section. The Rims End-Golden Streamway passage levels seem to be at grade with the Hollin Cave resurgence but these have now been abandoned in favour of a low level, probably phreatic, route through the Deepest Dig. The Eyrie and Western Eagles Nest passages may represent a passage graded to the One Tree Hill erosion level. The lower part of the Western Eagles Nest passage was later modified to grade with the Hollin Cave resurgence.

Table 3 **Summary of drainage modification and cave development in the Eagles Nest-Deep Creek area**

Stage	Drainage	Cave Development	Area
1A	All flow to Yarrangobilly River via Deep Creek dry valley	initial development Restoration Cave	835 ha (E,D3,F2,I+lower parts of WDC)
1B	capture by Restoration Cave of upper part of Deep Creek-Eagles Nest drainage	enlargement of Restoration, initial development of Eagles Nest Cave	EDC 834.9 ha (E,D3,F2,I)
2	capture by Eagles Nest Cave of all except E1, E2 drainage	Restoration Cave abandoned Eagles Nest Cave develops, initial development East Deep Creek Cave	EDC 29.9 (E1,E2) EN 819.8 ha (F,E3,D3,I)
3	capture by East Deep Creek of E3 and D3 drainage, reduction of flow to Eagles Nest Cave	East Deep Cave develops, Eagles Nest system continues to expand	EDC 317.2 ha (E,D3) EN 532.5 ha (F,I)
4	capture by West Deep Creek of D3 drainage, capture by Mill Creek of I drainage	reduced development of Eagles Nest Cave, reduced development of EDC Cave, West Deep Creek Cave develops.	EDC 79.8 ha (E) EN 137.5 ha (F) WDC 305.3 ha (D)

East Deep Creek – Restoration Cave System

Warild (1975, 1976) has mapped EDC Cave and suggested a three stage sequence of development. However, he has not taken into consideration the relationship of Restoration Cave to EDC Cave which, because of their proximity, must be physically related to each other. By adding Restoration to EDC the developmental stages presented by Warild must be modified to account for the higher level passage.

In terms of cave development the sequence below is generalized, but takes into account the present state of knowledge. The initial development of EDC-Restoration is seen in the small high level passage at the entrance level of approximately 1085 m. This is about 5–8 m below the tags of both Restoration (Y50) and the (Y4) entrance to EDC. Both entrances are late stage collapse features. The main high level passage – the lower level of Restoration Cave and Shattered Passage of EDC – are at an elevation of about 1050 m and are thought to be at grade with the One Tree Hill erosion level. Then the sequence of stream piracy envisioned by Warild (1976) may have taken place with the stream in the lower levels at grade with the Hollin Cave resurgence.

West Deep Creek Cave

West Deep Creek Cave is a relatively recent example of karst stream piracy. Deep Creek flowing in the old dry valley, enters West Deep Creek Cave along an old structural trend and drops rapidly to a depth of 51 m (Pavey 1976). The stream probably drops another 20 to 30 m and joins with either (or both) the North or East Deep Creek cave streams.

North Deep Creek Cave

The North Deep Creek drainage basin (Table 4) is the smallest basin associated with an active cave

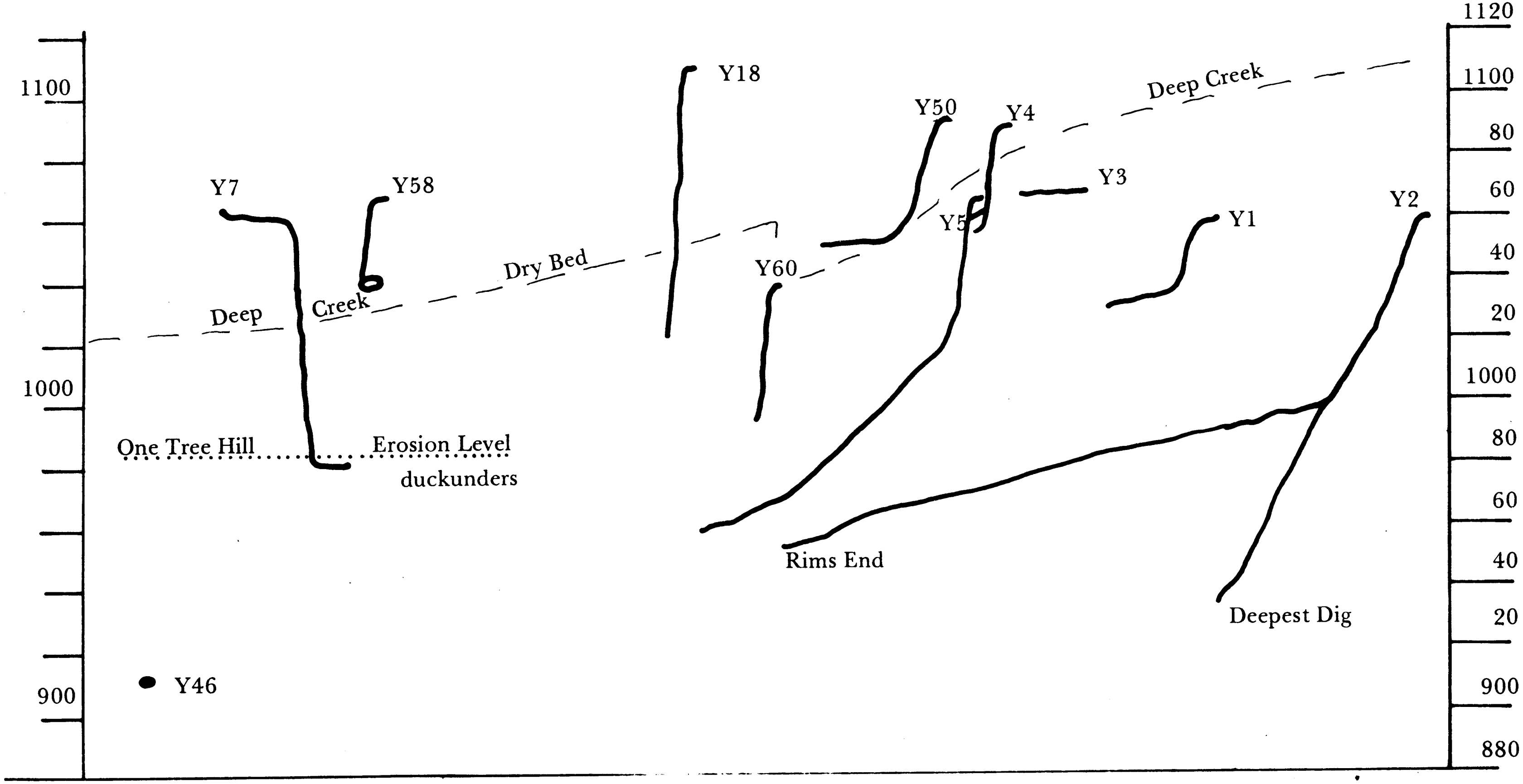

Fig. 2. East-west projected profile of cave systems in the Deep Creek – Eagles Nest area showing relationship of passage levels.

stream in the Deep Creek-Eagle Nest area. The cross-section of the active stream passage varies from a narrow canyon to a low roofed oval. This cross-section is much smaller than the collapse dominated section of the abandoned upper level of Janus Cave (Y58). This would seem to indicate that stream size has decreased from the time Janus Cave was being developed to the present.

Two basins, B2 and A3, now draining to other sinks, are thought to have originally drained into the NDC system. The stream in the A3 basin appears to be following the same structural trend as is the main part of Traverse Creek. The headward working Bathhouse drainage captured the A3 drainage. The B2 basin, which constitute the non-limestone part of Traverse Creek, is also thought to have drained into the NDC system. In this case the diversion is thought to have been caused by resistance in the volcanic rock and the diversion of the stream along a structural trend which now defines its path.

Table 4 **Summary of drainage modification and cave development in the North Deep Creek area**

Stage	Drainage	Cave Development	Area
1A	all flow to Yarrangobilly River via North Deep Creek dry valley	initial development of Janus Cave	159.9 ha + (A3, B2, C) + NDC dry valley
1B	capture by Janus Cave	expansion of Janus Cave	159.9 ha (A3,B2,C)
2	capture by Traverse Creek of headwaters	Janus Cave abandoned, initial development North Deep Creek Cave	NDC 31.6 ha (C) TC 128.3 ha (B2,A3)
3	capture of A3 drainage by Bathhouse Cave	continued development North Deep Creek Cave	NDC 31.6 ha (C) TC 88.5 ha (B2)

Negative Series

The Negative Series does not appear to have been ever related to a large drainage basin. As a result all cave development in this area is probably dependant on infiltration and the size of caves in this area would be expected to be small. An example is Hanging Spring – 1909 Cave that is a solution tube up to 1 m wide and 3 m high. Abandoned higher levels of 1909 Cave have similar dimensions.

Interpretation

This study points up several interesting exploration possibilities in the Eagles Nest-Deep Creek area at Yarrangobilly. First the high level cave systems of Restoration and Janus should be expected to continue, roughly at the level of the explored caves, toward the gorge with exit elevations of about 1000 m. Thus a two-prong study, one of an active examination for prospective entrances in the gorge, and the second of an active re-examination for leads within the caves, should be carried out.

The Eagles Nest system has not been adequately examined for the continuation of the high level passages of either the Eyrie-West Eagles Nest or the upper canyon of East Eagles Nest. The high level passage, if present, should lead to an exit at about 1000 m.

The mid-level passages in Eagles Nest, East Deep Creek and North Deep Creek Caves should be at grade with the present river level. However, cave sediments in the lower reaches of these caves may effectively block all passages when stream gradient becomes sufficiently low so that the wash load is deposited by the cave streams (Pavey 1974). This point also appears to have been reached at the deepest part of EDC Cave. Digging efforts in these passages may not be a rewarding task.

The active streams in all caves in the area are thought to drop rapidly to very low levels and new passage development may be restricted to the phreatic zone.

This interpreation also points up the need for a closer examination of the nature of all segments of the cave passage in regard to its origin at the time of exploration and mapping. In this regard most of the existing cave maps of Yarrangobilly do not contain enough information. Areas of solution passage are not differentiated from passage formed mostly by collapse. In addition most cave maps show only what is happening on the cave floor. Not enough cross-sections, long-sections and projected profiles are produced on which serious geomorphic studies could be based.

Conclusion

This paper has called upon several acts of stream piracy to explain the size and distribution of cave passages in the Eagles Nest-Deep Creek area. Stream piracy is not usually regarded as such a common occurrence and there may be other possible explanations of the features discussed above. Additional data on all caves in the Deep Creek area is needed before more interpretative work can be done.

References

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