QUATERNARY KARST AT BAT RIDGES, VICTORIA

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Abstract

Bat Ridges is an area of Quaternary calcareous dunes near Portland, Victoria. The dunes have karst development which appears to be syngenetic, as the karst processes have occurred concurrently with the consolidation of calcareous sand into aeolian calcarenite. Features related to syngenetic karst development such as solution pipes, cap rock, horizontal development, low solutional ceilings, roof collapses and secondary features are described. The Victorian Speleological Association is currently engaged in detailed exploration ana documentation of the area.

Introduction

Bat Ridges is an area of calcareous dune ridges approximately 10 km N.E. of Cape Bridgewater near Portland. About 300 ha (800 acres) of this is a Fisheries and Wildlife Division Reserve surrounded by Crown land and private property. There are about 40 caves known, many of which occur in a fairly small area and are probably interrelated.

The land use of the area is primarily a wildlife reserve and the Land Conservation Council in its Final Recommendations for the South West Study Area District 1 (April 1973) recommended that the reserve be extended to include all the adjacent Crown Land. Surrounding the reserve is cleared farmland used mainly for cattle raising. Although this is similar geologically to the area on the reserve, not many caves have been found except in the uncleared area (Mr Davies' property).

These limestone dunes support a complex mosaic of coastal heathland communities as well as Brown stringybark *(Eucalyptus baxterii)* and Manna gum *(E. viminalis),* open woodland and acacia scrub. The heathland communities are dominated by epacrids such as *Astroloma* sp, Xanthorrhoea and Banksia. Acacias, Leucopogon and Leptospermum form the majority of understorey vegetation in the open woodland. Evidence of burning can be seen e.g. Xanthorrhoea and Banksia.

The Reserve has been subjected to grazing – evidence can be seen in the vegetation – and the presence of the old lime kiln indicates the limestone has been quarried for lime, probably only for local use.

The existence of the caves in the dune ridges has been known to the locals for many years. Coulson(1940) reports visiting a number of caves and makes reference to their particular character. Whilst the area has occasionally been visited by cavers, systematic exploration and documentation by the Victorian Speleological Association (VSA) was not commenced until late 1973.

Geology

The entire area lies in the Otway Basin, a trough filled with a maximum of 7,500 m of Mesozic and Tertiary sediments extending across the southern portion of southeast South Australia and western Victoria, and separated from the similar Murray Basin to the north by the Dundas High of Palaeozoic rocks. The oldest sediments of the Otway Basin overlie the eroded surface of folded Palaeozoic strata of the Tasman Geosyncline. The Tertiary stratigraphy starts with Cretaceous non-marine sediments which are overlaid by series of marine sediments. At the end of the Miocene the sea receded in stages due to the upwarping of the continent, and at the end of the Pilocene renewed activity along the Kanawinka Fault to the northwest resulted in further marine recession. Over these predominantly marine Tertiary sediments the Pleistocene series of calcareous dunes were deposited. The Pleistocene sea level adjustments related to the formation and melting of large ice caps which meant that shelly Tertiary beds were exposed to vigorous wave action, breaking them down into bioclastic sand similar to that on the present coast. As the coastline receded, dunes of calcareous sand up to 30 m high marked the position of further strand lines. These dunes were then subjected to terrestial weathering conditions which, in the case of Bat Ridges, has meant the calcareous

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Proceedings of the 11th Conference of the ASF 1976

material was dissolved, seeped downwards and redeposited as a secondary limestone layer, leaving a residual surface layer of unconsolidated silica sand. This has, during arid periods, been transported by prevailing winds to the lee of the dunes. The limestone dunes are called the Bridgewater Formation, of which the Bat Ridges dunes are an example, and the unconsolidated sands are the Malanganee Sands.

Syngenetic Karst

Karst terrain can be defined as one which is underlain by a dominantly calcareous rock to the virtual exclusion of other kinds, and whose surface and subsurface features are determined by the characteristic responses of soluble rocks to weathering and erosion. These features include caves as well as surface features.

Cave genesis, that is the development of caves, is the subject of many papers and research. We do not propose to discuss it here except by defining the concept of syngenetic karst.

Syngenetic karst was defined by Jennings (1968a) as karst landforms which are developed concurrently with the consolidation and compaction of limestone itself. The phenomenon occurs in calcareous dunes which lithify to aeolian calcarenite.

The calcarenite is cemented by the formation of a cap rock in dunes which have been fixed by vegetation. The caprock forms by the solution and subsequent redeposition lower in the profile, cementing the loose bioclastic sand grains in a calcite matrix. This hardened layer forms the necessary structural conditions for the removal by water of the underlying softer limestone and the formation of shallow linear caves.

Characteristics of Bat Ridges Caves

At Bat Ridges the caves are characteristically shallow and linear (Bastion 1964), often with extensive areas of low unsupported solutional ceilings. These ceilings are an expression of the hardened caprock which provides sufficient structural strength to permit the removal by water of the softer material underneath. The floors beneath these areas are typically covered with insoluble residues of the solution process together with sediments probably carried in from outside.

Collapse breakdown has been a significant part of the development of most caves. A majority of the caves have collapse type entrances downslope from the crest of the dune. Domed roof structure due to collapse (Jennings 1968a) is in evidence to varying degrees, however, in some places cross-bedding of the limestone appears to have influenced an inclined ceiling structure.

Another common feature of syngenetic karst is the development of solution pipes. A number of theories have been advanced for their formation (Blackburn and others 1965; Jennings 1968a & b) of which the case hardening of caprock material around tree roots appears to be favoured. A well formed example gives rise to the local name of Chimney Cave for BR1. It is one metre in diameter and drops some 7 metres into the cave below (see Fig). A number of other caves in the region have similar features including and interesting 'window' into cave BR8 due to collapse between two adjacent solution pipes.

Also of note are a number of blind shafts or foibes similar in appearance to the solution pipes but not opening to the surface. Big Cave (BR6) has such a feature with a diameter of about one metre and rising up several metres from the passage ceiling to a hemispherical closure. (Lowry 1967; Jennings 1968b).

Although Speleothems are not the most prominent feature of the caves, they do commonly occur. These fall into two major groups which imply two periods of active calcite redeposition in the caves. The older more massive form is in general no longer active but the younger still active series of helictites, straws and rimstone pools are maintained by minor surface water. Chimney Cave (BR1) has an attractive example of the latter where a small surface soak above appears to maintain its activity. Other secondary calcite features include large areas of moonmilk and cave coral.

Surface Features

A notable feature of the surface karst in the exposure of the large areas of caprock near the crest of the dunes. This exposure related to the removal of the Malanganee Sands after formation of the caprock with redeposition in the lee of the dunes.

Other clear surface exposures of the caprock appear at most of the collapse entrances to the caves as mentioned previously.

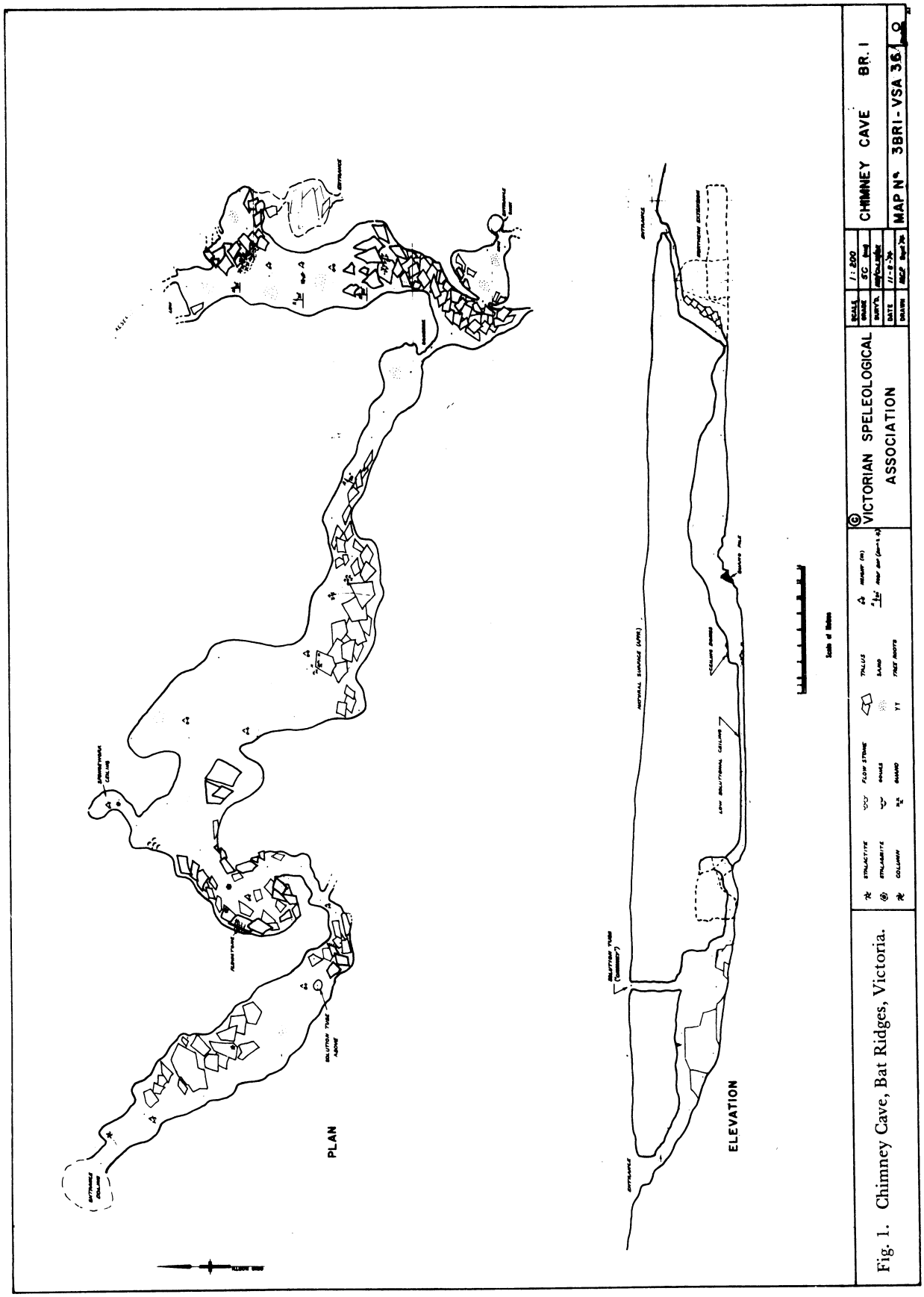

Fig. 1. Chimney Cave, Bat Ridges, Victoria.

The exposed caprock exhibits varying degrees of secondary surface solutional features such as rillenkarren and mottling. These are not in evidence on the more unconsolidated limestone elsewhere.

Drainage

The area to the north is low lying, and in places swampy, draining seawards via the dunes. This water has undoubtably been important in the hydrology of the caves. However, in recent years the artificial Bat Ridges drain on the northern boundary of the reserve has significantly altered the natural drainage pattern making it difficult to assess the details of the past hydrology.

Some water now enters the north of the reserve from the drain during winter and fills the shallow impounded lake area. At this time River Cave (BR4) becomes an active inflow cave and its waters ultimately appear to resurge into the southern reaches of the lake. Other nearby caves, particularly BR5 also become inundated when the lake level is high. Southward drainage of water from the lake itself appears to take place very slowly. Existing caves to the south of the lake are shallow and no evidence of flow through them has been observed in recent times.

Conclusion

Further mapping and detailed documentation which the VSA is undertaking as a continuing program should permit a more comprehensive understanding of the karst processes of the area. Many of the caves are interconnected, for example River Cave (BR4) has a current surveyed length of about 1.4 km and five entrances. With further exploration this cave will probably be linked to other nearby caves in the same dune ridge.

The whole area illustrates the ability of calcareous dunes under suitable conditions to develop caves during lithification by syngenetic karst processes. Whilst cave formation has been extensive the dunes are far from completely and/or uniformly lithified.

Bibliography

BASTION, L. (1964) Morphology and development of caves in the Southwest of Western Australia, *Helictite 2*(4): 105-119.

BLACKBURN, G., BONO, R.D. and CLARK, A.R.P. (1965) Soil development associated with stranded beach ridges in southwest South Australia, *CSIRO Soil Publication 22*.

BOUTAKOFF, N. (1963) The Geology and Geomorphology of the Portland area, *Mem. Geol. Surv. Vic. 22*.

CENTRAL PLANNING AUTHORITY, VIC. (1964) *Glenelg Resources Survey.*

COULSON, A. (1940) Caves in the Portland District, *Vict. Nat. 57:*36.

JENNINGS, J.N. (1968a) Syngenetic karst in Australia in Williams, P.W. and Jennings, J.N. *Contributions to the study of karst,* A.N.U. Dept. Geog. Pub. G/5.

(1968b) Recent Australian Contributions on Pipes, Foibe and Climatic History from Speleological Evidence, *Helictite 6*(3):50-56.

(1971) *Karst,* A.N.U. Press, Canberra, 252 pp.

KENLEY, P.R. (1971) in Wopfer, H. and Douglas, J.G. (eds) The Otway Basin of South East Australia, *Geol. Surveys of SA and Vic. Sp. Bull.*

(1976) Quaternary Geology – South Western Victoria, in Douglas, J.G. and Ferguson, J.A. (eds) *Geology of Victoria, Geol. Soc. Aust. Sp. Pub. No. 5*.

LAND CONSERVATION COUNCIL OF VICTORIA (1972) Report on South West Study Area 1.

(1973) Final Recommendations, South West Study Area 1.

LOWRY, D.C. (1967) The origin of blowholes and development of domes by exsudation in caves of the Nullarbor Plain, *Geol. Surv. W. Aust. Rec. 1967/12*.

SPRIGG, R.C. (1952) The geology of the South East Province of South Australia with special reference to Quaternary coastline migrations and modern beach development, *Geol. Surv. S.A. Bull. 29*.

WHITE, S. (1975) Karst landforms and land use at Bat Ridges, Portland, unpublished project in physical geography, Dept. of Geography, University of Melbourne.