KARST AND CAVES IN THE CANBERRA AREA - PAST AND FUTURE MANAGEMENT

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Abstract
A number of karst areas and limestone outcrops within a thirty kilometre radius of Canberra City are discussed with an emphasis on those managed by the ACT Parks and Conservation Service of the Department of Territories. The history, conservation status and significance of these areas is reviewed and proposed directions for management are derived from their values, with priority placed on education and scientific enquiry. The need for an organisational approach to karst management is emphasised.

Introduction

There are numerous limestone lenses amid the Silurian and Devonian formations in the Canberra area, including a number of karsts surrounded by impervious volcanic rocks. Most of the karsts are very small - only a few metres thick and less than a kilometre long - and few contain caves. Where caves are found they are usually small and short, but of reasonable complexity (Nicoll & Brush 1976b).

For these reasons, the significance of the karst and caves around Canberra has been long underestimated, but such areas are now receiving higher priority in the resource management programmes of the ACT Parks and Conservation Service, part of the Department of Territories. This Service, established early in 1984, is responsible for management of natural and cultural resources, wildlife and open space recreation throughout the Australian Capital Territory (ACT) and the Jervis Bay Territory, and in the Commonwealth Reserve associated with the Googong Reservoir in New South Wales (NSW).

Within the areas managed by the Service are found the Paddys River (or Cotter) Caves, the London Bridge and associated caves, and scattered lesser karsts on the plain now occupied by the city area and along the Murrumbidgee and lower Molonglo Rivers. These, and another karst on the Queanbeyan River in NSW known as White Rocks, are described and discussed in this paper.

Canberra City Area

Few residents of, or visitors to, the ACT would be aware of the widespread occurrence of limestone in what is now the city area, as the imposition of the grand layout, buildings and monuments of the national capital has markedly blurred landscape features other than the most prominent hills and ridges.

In the first printed account of what is now the Canberra area, Charles Throsby described 'very fine limestone, in quantities perfectly inexhaustible' (cited by Fitz-hardinge 1954). By 1822 this description was reflected in the name of Limestone Plains (Lea-Scarlett 1968). Early geological descriptions and maps (e.g. Pittman 1911) showed the Plains were dotted with outcrops of limestone, and these were evident along the Molonglo River and at important crossing points. Early photographs (e.g. Opik 1958) show that the plain which

now accommodates the 'garden city' was largely treeless and even small limestone outcrops and waterfilled sinkholes were conspicuous in the landscape.

Parts of limestone outcrops were being exploited, presumably for lime to manufacture mortar, by 1833 when Surveyor Hoddle recorded a limestone quarry in the Acton area (Knight 1973) and remains of a limeburner's cottage have been recorded in the Majura area, believed to date from about the same period (Winston-Gregson 1985). Early economic appraisals suggested that the Canberra limestones could beneficially be used for the manufacture of mortar and cement, expected to be of great value to the construction of the new capital city (Pittman 1911) and their suitability for road metal was also noted (Strusz 1971). Despite this apparent value, only a few minor quarries have been recorded (Mahony and Taylor 1913), and these were closed prior to the late 1950s (Opik 1958). Limestone from Acton was also tested and found to be suitable as polished marble for interior decoration (Mahony and Taylor 1913) but no quarrying for this purpose is recorded.

Many of the limestones were richly fossiliferous, and important specimens were collected by L.G. deKoninck and Rev. W.B. Clarke in the 1870s, yielding a rich fauna of corals, shells, bryozoans, crinoids and trilobites. These were the first record of Silurian fossils in Australia (Rosengren 1985). Of particular note are sites at Woolshed Creek, Mount Majura, Red Hill and Jerrabomberra Creek (Mahony and Taylor 1913).

The cavernous nature of some of the karsts is well-documented. A.P. Spate (cited by Matthews 1985) recorded the Limestone Plains (or Lennox House) Cave with the note 'contains lake'; this is something of an understatement, as it lies submerged under Lake Burley Griffin. This cave has a length of about eight metres (Matthews 1985) and was used for some time as a rubbish tip (A.P. Spate, pers. comm.). It is believed to have been the only cave on the Plains which was open to the surface (Nicoll and Brush 1975a), but others made their presence felt as the city was being developed. Foundation excavations and geological investigations for major buildings and structures from the 1950s to the 1970s confirmed the presence of cavernous limestones beneath central Canberra (Henderson 1986; Butz 1987).

The proposed weir at Acton - one of the possible sites for a dam to impound Canberra's proposed lake - was abandoned due to fears of excessive water leakage through the cavernous limestones encountered there (Gardner 1958). When construction began on the Treasury Building in the 1960s, extensive caves were uncovered below the site. These extend from eight to thirty-six metres below the surface through a richly fossiliferous limestone layer that is over fifty metres deep in places (Best and Henderson 1968). The discovery of caves under the whole site led to some extensive alterations to foundation design, and some piers had to be founded within the limestone at depths of twenty to thirty metres below excavated rock surface - in some cases well in excess of the building's height (Gardner 1969). The caves also posed a problem for de-watering the building site; even pumping at 180,000 litres per hour made little impression on water levels (Best and Henderson 1968).

Alerted to the potential for such construction problems, geologists located another large cavernous limestone deposit at the site of the Trade Building, extending in depth from six metres below the surface to over fifty metres, with the shallowest caves at about twenty metres depth (Hill 1971). The hidden caves would not have been a total surprise had an earlier encounter been better documented. So much cavernous limestone was encountered when the city's main outfall sewer was being constructed in the 1920s from the Hotel Canberra to Weston Creek that the foreman in charge of driving the tunnel declared his belief that the proposed lake would never be able to hold water (Dalgarno and Minty 1983).

The ACT Parks and Conservation Service can do nothing to conserve the lost karsts which now lie under the lake, gardens, roads or buildings. However, some solution-sculpted limestone on the foreshore at Acton Peninsula above the drowned Limestone Plains Cave will be protected from any further damage, and interpreted in a proposed Bicentennial Heritage Trail (J. Feint, pers. comm.) as a meagre link to the earliest description, naming and settlement of the area. The educational and scientific values of the more significant fossil sites are recognised and an effort will be made to protect these from development and uncontrolled collecting.

Paddys River Caves

The Paddys River (or Cotter) Caves escaped the fate of the Limestone Plains complex by their relative isolation. They lie about twenty kilometres west of Canberra in a steep outcrop up to fifty metres above the south bank of the Paddys River. The limestone here is about one hundred metres long and forty metres thick, tilted to near vertical, and metamorphosed to marble by an intrusion of adamellite (Owen and Wyborn 1979). The deposit has not been economically exploited despite favourable reporting of its suitability as a 'handsome ornamental stone' after successful polishing (Mahony and Taylor 1913). Because of the metamorphic effects, fossils in the outcrop tend to be limited to crinoid stems (Rosengren 1985).

Three caves have been described - the Cotter, Powder Store and Blasted Caves. The lengths of these are sixty-five, fourteen and twenty metres respectively. All were probably interconnected and formed by the one stream (Nicoll and Brush 1975a).

The values of the karst area and its environs are gaining wide recognition: The National Capital Development Commission (NCDC) have registered the caves as a geological monument (NCDC 1984) and a larger area as a Site of Significance (Rosengren 1985), and they are also listed on the Register of the National Estate (AHC data file) and on the Register of Classified Places (National Estate (AHC data file) and on the Register of Classified Places (National Trust 1982). To give force to such listings a great deal more attention needs to be paid to management for long-term conservation. Past management has been marred by lack of awareness of the area's values, inappropriate design and construction, fragmentation of responsibility and a lack of consultation with community interests. Despite some heavy-handed gating, access to the caves has rarely been controlled. From the combined effect of this unsupervised access and unsympathetic management nearly all accessible speleothems have been removed or destroyed, floor deposits have been altered, roosting bats caused to vacate and the caves littered and defaced. This legacy has led to a view of the lost caves as 'no longer sensitive' (Rosengren 1985) or as a lost cause, leaving them open to proposals for development as a recreation asset at the expense of other values.

Rather than accept this view of expendability, the Service would prefer to recognise that the caves are a non-renewable resource and have intrinsic value as the only accessible caves in the ACT to survive Canberra's construction.

Specimens of cave-dwelling spiders have been collected from the Cotter Cave, including *Stiphidon facetum* (AP Spate, pers. comm.) and *Epimecinus* sp.nov. (Gray 1973). While these species also utilise surface habitats, all cave invertebrates are significant elements of the biota (Poulson and White 1969) and their continued survival may require careful management (Reider 1977).

The Cotter Cave is still sometimes occupied by bent-winged bats (*Miniopterus schreibersi*) and this cave (together with a nearby water supply tunnel at Cotter Dam) may be an important staging point between maternity caves at Wee Jasper and coastal roosting sites (AP Spate, pers. comm.). In 1958, the first recovery in Australia of a banded bat occurred at the Cotter tunnel, fifteen days after the bat was banded at Wee Jasper, thirty kilometres to the north-west. This was the start of a new understanding of seasonal bat migrations, biology and life cycles (Purchase 1962). There has also been speculation that the caves may be an overwintering site for the bats (C.R. Tidemann, pers. comm.). This implies a need to control public access (Voute and Lina 1986) although the existing gating would require extensive modification to facilitate bat movement (Tuttle 1977).

Other bat species that inhabit caves have not been examined for stratified bone deposits or evidence of prehistoric occupation (JH Hope, pers. comm.) although the Cotter Cave has considerable potential to contain occupation evidence due to ample headroom, daylight entry, a view over the river, and close proximity to recorded Aboriginal campsites. Such deposits and traces in caves have great scientific importance (Jennings 1979) and a trial stratigraphic excavation should be made in these caves before any further developments or modifications are effected.

The caves have a physical and historical association with an adjacent mineral deposit at the contact of the limestone and adamellite. This is a magnetite skarn containing small quantities of lead, silver, zinc, gold (Smith 1963) and the Congwarra Copper Lode was first prospected in 1895 (Smith 1963) and prospecting continued until 1908, and again in 1946 (Owen and Wyborn 1979). At an early stage there was an adit up to thirty-six into the copper lode (Jaquet 1901) and at least three other adits and seven pits were shown on a surveyor's plan of 1917 (Barz and Winston-Gregson 1982). Mine remains still visible include a pit and a partly closed adit. The particular usefulness of Powder Store Cave to the miners is self-evident. This is the only significant mining area known in the ACT and is thus of considerable historic importance in the Territory (Barz and Winston-Gregson 1982).

The combination of karst landform, surface solution, contact metamorphism, mineralisation and mine remains make this a valuable geological teaching site (Rosengren 1985; Deverson et al. 1986) but the potential for damage or destruction of the mine remains is considerable and some restriction of public access may be essential for conservation of the remains (Barz and Winston-Gregson 1982).

Adding another dimension to the conservation values of the precinct is the only ACT occurrence of a rare perennial herb, *Drabastrum alpestre*, located in grassland adjacent to the caves and mine remains. The conservation of this feature too, may require some restriction of public access (Briggs and Leigh 1985).

The area has another interesting association in an early account of the Federal Territory which provided a commentary, rare for its time, on the relation of the vegetation to the geology:

> The limestone supports a growth of she-oaks; the sandstones, eucalypts; and the decomposed igneous rock with their associated and very distinct types of vegetation, forms a most interesting example of the interdependence of the trees and the underlying strata. (Mahony and Taylor 1913).

The themes of soluble terrain, cave-dwelling invertebrates and bats, possible bone deposits and/or prehistoric occupation, enhance the importance of the area for promotion

of the values of karst and caves in the community in general, and schools in particular. In Heritage Week 1987 the first public guided tour of the caves and mine remains was conducted by the ACT Parks and Conservation Service and the Geological Society of Australia. The area could be of great significance to the Service in its education programs, but careful planning and a conservative approach to development and use are required in view of the fragility and sensitivity of some of the features.

Proposals for the future management of the area will be subject to comment by the community during preparation of the Service's draft management plan for the Murrumbidgee River corridor.

Molongolo and Murrumbidgee Rivers

A number of small limestone deposits outcrop along the Molonglo and Murrumbidgee Rivers. None of these are significant as karsts, although they do exhibit some surface solution features. All, however, are fossiliferous and their Middle Silurian faunas have been useful for stratigraphic correlation (Rosengren 1985).

Part of the complex along the Molonglo, ten kilometres west of Canberra, has been greatly disturbed by blasting, excavation and road construction for a sewer outfall pipeline (Henderson 1980) but a number of outcrops remain largely intact. These, together with adjacent fossiliferous shales, constitute a site of considerable scientific and educational value as one of the best documented fossil fauna assemblages from the Middle Silurian of eastern Australia (Rosengren 1985).

Both these sites are listed as Sites of Significance by the NCDC (Rosengren 1985) and their scientific and educational values will be recognised in development and management decisions which could affect them. Some control may need to be exerted over fossil collecting, and this may require appropriate signposting or even a special-purpose conservation reserve. Maintenance of the existing limitations on public access should probably afford sufficient protection for the time being.

London Bridge

The London Bridge limestone is situated in NSW on Burra Creek, a tributary of the Queanbeyan River, about thirty kilometres south-east of Canberra City. The site was first described in the journal of Captain Mark Currie, RN, describing his 1823 journey of exploration, in which he discovered the Monaro Plains. On his return journey folklore has it that Currie was shown the Bridge by local Aborigines (P. Higginbotham, pers. comm.). He described it as 'a natural bridge of one perfect Saxon arch, under which the water passed' (Currie 1825), but he made no mention of any caves. The Bridge has been a well-known landmark since settlement began in the immediate area during the 1830s (Moore 1981) but access was very limited in recent decades due to the protectiveness of local landowners.

The area received some notoriety through the 'London Bridge mystery' with the discovery in 1875 of human (supposedly European) bones in a small cave near Burra, leading to an inconclusive coronial inquest and rumours of murders committed by bushrangers (Moore 1981). Another story, seemingly unrelated, reports the discovery in 1874 of `a veritable catacomb' containing `many hundreds of human bones and skulls, centuries old'. These were carried away by the bagful and pronounced by three surgeons, including the Coroner, to be `the skeletons of the Aborigines of former times' (Brennan 1907). It has

been widely believed that such Aboriginal cave burials are rare in the region (Flood 1980) but more recent analysis suggests that caves were used for burials (Spate, in prep.).

The London Bridge has been widely investigated and well documented in scientific literature. The geological characteristics were recorded about seventy years ago (Carne and Jones 1919) describing a fairly pure white to dark grey fossiliferous limestone interspersed with thin shale bands and intruded by small granitic dykes. The outcrop was not considered to have great economic potential due to relative isolation and, as was stated: 'it would, indeed, be vandalism to interfere with so remarkable a feature as London Bridge' (Mahony and Taylor 1913).

The limestone's rich fossil fauna of brachiopods, corals, crinoids and trilobites and its relationship to other outcrops to the north and south have been described (Veevers 1953). The closest related outcrop, near the old 'London Bridge' homestead, has no caves but does have many fossils, an interesting metamorphic occurrence (Richardson 1979) and, therefore, some educational value.

The geomorphic features of the site have been interpreted as a natural bridge and caves formed from complex repeated stream self-capture by karst action in a meander spur (Jennings et al. 1976); it is a classical example cited in international texts on karst geomorphology (e.g. Jennings 1985). The arch is thirty-four metres long, twelve to fifteen metres wide at water level, and about five metres high above normal summer water level. Six additional entrances are known, relating to two minor caves of four to five metres length and the more substantial Burra and Douglas Caves of about thirty-five and forty metres length respectively (Nicoll and Brush 1976a).

For some years speleologists and geomorphologists, led by the late Joe Jennings, made representations to Government to establish London Bridge as a geological monument in recognition of its outstanding scientific interest and natural beauty and to open it to the public as an educational and recreational area (Jennings et al 1976). The area's scientific and educational value was further reinforced by the recording of significant bone deposits in a number of the caves including remains of mammal species now locally extinct (Hope 1976). The sediment accumulation in the Douglas Cave has considerable potential to yield sub-fossil material. It is likely that this is the 'very spacious cave, which bore traces of having been used in early times by Aborigines' (Brennan 1907) and it still may contain evidence of Aboriginal occupation. No excavation has yet been attempted but careful stratigraphic investigation is well warranted (JH Hope, pers. comm.).

In 1975 the Commonwealth acquired land for the protection of the foreshores of the newest element of the Canberra-Queanbeyan water supply, Googong Reservoir, and in the process acquired the London Bridge. For some time it was feared that this karst too, would be drowned. That these fears proved groundless was due far more to the Bridge's elevation above sea level than to the sensibilities of planning engineers. The environmental impact statement (EIS) for the project recognised only the tourism value of the feature and assessed only the likely physical impact of flood waters on the rock itself. Other karst values were omitted completely, despite several submissions on the need to save the Bridge (NCDC and Dow 1973). Such shortcomings could perhaps be excused by the fact that this was the first EIS to be prepared under the Commonwealth Environmental Protection (Impact of Proposals) Act 1974 (Dalgarno and Minty 1983).

In 1982 the southern half of the Googong Foreshores Reserve was opened to the public, thus affording to many local residents and visitors their first view of the London Bridge.

Access was made available by a walking track, with the closest vehicular access at a distance of less than a kilometre. The formation has been nominated to the Register of the National Estate (AHC data file), and in that sense might be seen as a geological monument.

While the aspirations of speleologists have been partially met by the provision of better access and nearby recreational facilities, and by National Estate recognition, the educational effort is at best a fledgling one. A general information leaflet for the Reserve includes a summary of the history and mode of formation of the Bridge. A number of the dates and inferences are inaccurate (AP Spate, pers. comm.) but this is being remedied. The leaflet associates the Bridge with the nearby 'London Bridge' homestead - a feature of major historical and architectural interest (Philip Cox 1983) which is listed on both the Register of the National Estate (AHC data file) and the Register of Classified Places (National Trust 1982). The Service has been offering guided walks to the homestead and Bridge for some years and these have proved very popular (P. Higginbotham, pers. comm.).

White Rocks

The White Rocks karst area is located on the Queanbeyan River about sixteen kilometres south-east of Canberra and three kilometres south of Queanbeyan in NSW. It comprises lenses of Middle Silurian shale and limestone, folded, faulted and tilted to near vertical. The white to pink recrystallised limestone has given the area its name, forming cliffs up to fifty metres above the river in four main outcrops (Mahony and Taylor 1913). Within these only one cave has been tagged and described - White Rocks Cave, about ten metres long, with no decoration. Past quarrying in the limestone has revealed remains of other cave passages now filled with sediment, flowstone and bone conglomerate, but has also led to hazardous rockfalls and unstable faces. The outcrop on the eastern side of the river has not yet been examined for caves (Nicoll and Brush 1975b).

A number of geological features are of considerable interest, including some remarkable corrugation and crumpling of the limestone due to pressure folding (Mahony and Taylor 1913), but the scientific value of the area rests primarily on the presence of bone breccia exposed by quarrying (Nicoll and Brush 1975b). This breccia contains small and medium-sized bones of a number of mammal species (Hope 1976). Such exhumed fossiliferous cave fill can provide valuable stratified evidence for interpretation of prehistoric fauna and environmental change (Jennings 1979).

A number of quarries have been recorded (Smith 1950) and two old kilns remain to suggest one of the uses to which the limestone was put (Nicoll and Brush 1975b). While the outcrops still have economical potential, they are unlikely to be exploited due to the environmental sensitivity of the area (Lishmund et al. 1986). The karst is probably more at risk from uncontrolled access from nearby urban areas and small-acre subdivisions, and is often visited by trail-bike riders and rubbish-dumpers (AP Spate, pers. comm.). Permanent reservation of the area by the NSW National Parks and Wildlife Service is probably not as readily justified as measures to protect or salvage remaining bone deposits. Further excavation and study of these deposits is warranted, perhaps in conjunction with that already recommended for London Bridge, and the values of the whole area should be subject to comprehensive appraisal before further degradation occurs.

The Management Challenges

The significance of the karsts in the Canberra area can be described in the following terms (after Davey 1984):

* the remains of the Limestone Plains karsts are of some value as cultural features for historic enquiry, education and presentation;
* London Bridge is an outstanding example of its landform type, and is highly significant for aesthetic appreciation;
* both London Bridge and Paddys River Caves are of great value for education and presentation, and for scientific enquiry as examples of natural features, landscapes and natural processes;
* both London Bridge and Paddys River Caves are of great value as cultural features for prehistoric and historic enquiry, education and presentation;
* both London Bridge and Paddys River Caves provide valuable recreation opportunities;
* fossil sites in the city area and in the lower Molonglo and Murrumbidgee outcrops are of value for education and presentation, and for scientific enquiry as examples of natural features and also as cultural features with interesting associations; and
* the White Rocks karst is of value for scientific enquiry as an example of a natural feature or landscape.

There are conflicts readily apparent in managing the karst areas and their environs for such a range of values, and each poses different challenges to managers.

All that can be done for the last traces of the 'lost karsts' in the city area is to protect them from any further degradation and to interpret their role in the area's history. Remaining fossil sites in the city and in the lower Molonglo and Murrumbidgee outcrops need to receive similar protection from development and from uncontrolled fossil collecting.

The Paddys River Caves present a particular challenge: to redress the impact of many years of inconsistent management, to commence a thorough investigation of the scientific values of the area, and to overcome the misconception that the caves are no longer sensitive and can thus be sacrificed to recreational development or to careless educational use.

Free of the kinds of constraints inherited with the Paddys River Caves, the Service has been fortunate to be able to maintain the qualities of the magnificent London Bridge and associated cultural remains, but we need to sustain this capability in the face of increased visitor use. Of particular importance is the protection of deposits of sub-fossil bones and possible occupation evidence.

The ability of resource management authorities to face these kinds of very different challenges is usually constrained by factors of insecure tenure and/or inappropriate ownership or custodianship arrangements. It would be widely assumed that, in the ACT and in the Googong Reserve, ownership of the karst resources by the Commonwealth and the vesting of their management in the ACT Parks and Conservation Service would serve to virtually assure their long-term conservation. But these factors, while advantageous, do not in themselves guarantee such security.

Our ability to meet the above challenges is dependent far more upon our willingness to adopt a systematic approach to karst management (after Davey 1980) and in particular to address the need for:

* an improvement in the level of understanding of the special values, dynamics and resource management requirements of karst

systems among managers, visitors and the general community;
* improvement of management powers by incorporation of karsts in dedicated and secure conservation reserves and by protection from inappropriate development;
* collection of baseline resource data, on-going monitoring and incorporation of research findings into management strategies;
* preparation of conservation and interpretation plans for karst areas, with due consultation of community interests; and
* commitment to karst management objectives that emphasise education and scientific enquiry above development.

Conclusion

We have not had an enviable history of karst management in the ACT - most of our karsts were drowned or buried to provide the Nation with a showpiece capital city; our only remaining caves have been degraded to provided recreation; and a world-renowned natural bridge in nearby NSW was almost drowned to provide drinking water. From the high ground of hindsight past management of these karst areas might be criticised as ill-informed, reactive and inconsistent. With establishment of the ACT Parks and Conservation Service, it is an appropriate time to commence to redress (or at least not repeat) some of the previous mistakes. We need to adopt a management style that is more positive, systematic, resource-driven and consultative if we are to identify and implement the most appropriate balance of preservation and use.

Planning for our karsts and their environs will address their special and sensitive values by observance of sound principles and practices (as in Butz and Worboys 1980) and will incorporate classification of caves according to nationally-accepted categories and criteria (Davey et al. 1982). Wherever possible, these will be embodied in statutory plans of management which are subject to public and Parliamentary scrutiny. This systematic approach should complement karst management efforts by the NSW National Parks and Wildlife Service in areas adjacent to the ACT and elsewhere in the South Eastern Region. Through such energetic attention to the protection of the resource and the education of our visitors, the ACT Parks and Conservation Service will be able to make its own significant contribution to conservation of the nation's scarce karst resources.

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