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THE LOST KARST OF CANBERRA

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Historical background

The first printed account of what is now the ACT appeared in the *Australian Magazine* of June 1821. Written by Dr Charles Throsby it described the country as 'perfectly sound, well watered with extensive meadows of rich land on either side of the rivers; contains very fine limestone, in quantities perfectly inexhaustible, slate sand-stone and granite fit for building, with sufficient timber for every useful purpose...' (cited by Fitzhardinge 1954) . By 1822 the area east of the Murrumbidgee River bore the name of Limestone Plains (Lea-Scarlett 1968) and with such glowing reports of the resources of the area it was not long before settlers arrived. By the end of 1823 J.J. Moore had flocks and herds in the area which he later named 'Canberry', a name applied by Robert Campbell to the church he built at Duntroon. It then passed from the church to the village and in time superseded the older name of Limestone Plains (Fitzhardinge 1954).

In 1907 the Federal Government determined that the new capital would be in the Yass-Canberra district, which included the proposed sites of Yass, Lake George and Canberra. Surveyor Scrivener was instructed to recommend a site bearing in mind that 'the Federal Capita1 should be a beautiful city, occupying a commanding position with extensive views and embracing distinctive features which will lend themselves to the evolution of a design worthy of the object, not only for the present but for all time'. Early in 1909 Scrivener selected Canberra as the site and the necessary legislation received Royal assent the same year (Wigmore 1963). In 1911 the Commonwealth took possession of its new territory and began acquiring land in the Acton area to form the nucleus of the local administration (Knight 1973). At this time the capital site was wind-swept grazing land from which most of the trees had been removed providing aspiring city planners with a clean canvas for their designs.

Designs for the new city were sought from all over the world, with models of the site displayed in many of the world's capital cities. Competitors were supplied with base survey maps, cycloramic paintings of views from Camp Hill and what is now City Hill, as well as climatic studies and a geological report. In 1912, after considerable controversy, the design by Walter Burley Griffin was chosen as the winning entry (Wigmore 1963). His plan has long been praised as an inspired blend of a city with its landscape setting:

> Griffin recognised particularly the importance of the surrounding and distant hills and Molonglo River landscapes as features capable of providing a basis for the design of the city and a starting point for modifications to the landscape that urban development would bring (Commonwealth of Australia 1985).

The Canberra limestones

The geological descriptions and map provided to design competitors (Pittman 1911) show that the plain now occupied by the city was dotted with outcrops of limestone. Early photographs show how these outcrops were along the Molonglo River, particularly at important crossing points such as Scotts Crossing and Lennox Crossing. Some photographs show water-filled dolines used for stock watering (Öpik 1958). Even minor outcrops were conspicuous in the nearly treeless landscape.

The limestones of Canberra are a significant part of an important geological sequence deposited on the flanks of the ancient Yass-Canberra Rise at the margin of the Australian continental plate. The rise was a volcanic arch which had its maximum development during the Silurian and early Devonian and which provided shallow marine conditions suitable for the formation of limestones. Reflecting this depositional environment the limestones occur generally as small deposits within sediments and volcanics (Lishmund et al. 1986).

The sedimentary sequences and the limestones in particular became renowned for their fossil fauna. Important specimens were collected by L.G. DeKoninck and the Rev W.B. Clarke in the 1870’s, yielding a rich fauna of corals, brachiopods, gastropods, cephalopods, stromatoporoids, bryozoans, crinoids and trilobites. These were the first record of Silurian fossils in Australia (Rosengren 1985). Particularly significant sites for fossil fauna included Mount Majura, Woolshed Creek, Red Hill, Jerrabomberra Creek and Coppins Crossing (Mahony and Taylor 1913).

That exploitation of limestone outcrops had begun within a decade of settlement is evidenced by recording of a limestone quarry near Acton in 1833 (Knight 1973) and remains of a limeburner's cottage dating from about 1832 near Majura (Winston-Gregson 1985). Economic appraisals early in this century suggested that the Canberra limestones could beneficially be used to manufacture cement and mortar, which would be of great value to the construction of the new capital city (Pittman 1911). The Acton deposit was tested and found suitable for cement manufacture when mixed with the highly fossiliferous shales from the Yarralumla brick pit (Mahony and Taylor 1913).

Despite their apparent value only few minor quarries were recorded at Acton and near the present site of the ABC and these seem to have been closed prior to the late 1950's (Öpik 1958). The Acton limestone was considered to have potential as polished marble for interior use (Mahony and Taylor 1913) but no exploitation for this purpose is recorded. It appears that the decision not to exploit these deposits was based as much on concern for the visual impact of extractive activities in the new capital city as on paucity of reserves (Mahony and Taylor 1913).

Only one of the numerous outcrops contained caves that were open to the surface (Nicoll and Brush 1975). In the Acton limestone is the Limestone Plains (or Lennox House) Cave which is about eight metres long (Matthews 1985). A.P. Spate recorded this cave with the note 'contains lake'; this is something of an understatement as the cave is submerged beneath Lake Burley Griffin. The concern for landscape amenity shown by early geologists in assessing the economic potential of these deposits was in vain.

The toll of progress

This sacrifice to the city's grand design was unfortunate as the Acton limestone was one of the Canberra plain's more significant outcrops, occurring next to Lennox Crossing over the Molonglo, next to the original 'Canberry' property, and later in the heart of the administrative centre of the new city. It was used to supply lime for mortar in the first decade of settlement in the area (Knight 1973) and was long ago tested and found suitable for cement manufacture and polished marble (Mahony and Taylor 1913). Its modest cave also saw service as a rubbish tip in the finest tradition of pioneer use of karsts (A.P. Spate pers. comm.).

Most cities bear signs of their progressive historical growth into and around their landscape settings. By contrast, Canberra was placed in its site relatively recently, with modern engineering technology which obviated the need to incorporate or compensate for terrain features that were not fundamental to the prize-winning design. If the Griffin plan and its successors are to be credited with sympathy for the landscape setting of the city then care needs to be taken in defining the scale involved. A great many landscape features other than the most prominent hills and ridges have been heavily shrouded in urban development, buildings, roads and bridges, re-contoured into ordered parklands, submerged beneath ornamental lakes or removed altogether.

Such was the fate of the limestone outcrops on the plain now occupied by the city area. This is a marked contrast to such areas as Mount Gambier in South Australia where huge dolines are landscaped as sunken gardens and serve as a constant reminder of the presence of the karst landscape on which urban development has taken place. While the Canberra outcrops were by no means of the same order as the Mount Gambier limestone, it is unfortunate that we now have very scanty traces of them to remind us of the geological history, early settlement and naming of the area. Few people would now be aware of their presence let alone comprehend their significance.

Problems with solution

It was not long after construction of the new city began that limestones with no surface expression were encountered in excavations and a number of these contained caves and other solution features totally hidden from view. Probably the first major problem for the engineers occurred with construction of the city's main outfall sewer from 1915 to 1917 and 1922 to 1924. So much cavernous limestone was encountered in driving the tunnel from the Canberra Hotel to Weston Creek that the foreman declared his belief that the proposed ornamental lake would never be able to hold water (Dalgarno and Minty 1983).

These were prophetic words indeed, though apparently not documented at the time. Investigation of sites for the weir to impound the proposed lake included assessment of a site at Lennox Crossing, Acton. This site was said to be favoured by many as it would avoid inundation of the Royal Canberra Golf Links and the racecourse. The geological assessment however had to report that 'the locality could prove troublesome through excessive water loss both in cavernous limestone and in permeable beds of sand and gravel within the alluvium and the old lake sediments' (Gardner 1958). One drill hole entered a cavity that was about ten metres deep underlain by massive limestone. The cavernous area was thought to form a folded deposit over 650 metres long beneath the permeable alluvium, passing twice across the axis of the weir and passing beneath it. The potentia1 leakage was very large and the report recommended rejection of the weir site unless the position and nature of the limestone was thoroughly investigated (Gardner 1958). The golf course and racecourse were to suffer the same fate as the Limestone Plains Cave.

A decade later, on what became Acton Peninsula, the same limestone again caused problems for engineers. Inadequate test drilling had been carried out before foundations for the hospital were designed and geologists were called in to investigate only after problems were encountered on the site. They discovered that the limestone had been weathered beneath the ground surface by solution along intersecting joints to form hard residual blocks and boulders suspended in a thick dense clay (Gardner 1969). This really should not have been a surprise as the presence of solution features and floaters had been recorded in this outcrop over half a century earlier (Mahony and Taylor 1913). To test whether piers were being founded on floaters it was necessary to carry out very costly drilling to a depth of 45 metres below the foundation level. The same study cautioned designers about groundwater fluctuations in cavernous limestones such as those at Acton, pointing to damage that could be occasioned to foundations, particularly after impoundment of the lake (Gardner 1969).

One of the more interesting and best-documented encounters with hidden karsts occurred at the site of the Secretariat Building (later termed the Treasury Building). Surface deposits were shale from nine to twenty-four metres deep and preliminary testing had identified the underlying dark blue rock as a basalt. It was therefore difficult to explain why a sample core had dropped nearly half a metre and this was apparently ignored. The foundation construction for the seven-storey building with extensive basement began on the assumption that the substrate was basalt (Best and Henderson 1968).

It was not long before geologists were summoned to explain problems with subsidence of foundation piers and intensive drill sampling was carried out over the whole site. Drilling revealed that the site was underlain by cavernous limestone which was a main aquifer. Dewatering of the site was deemed impracticable as pumping at the rate of 180,000 litres per hour had made little impression on water levels. The base of the richly fossiliferous limestone was over 50 metres below the surface in places (Best and Henderson 1968) and solution cavities were located up to 36.5 metres below the surface (Henderson 1986). Single cavities were up to three metres in height with most less than 1.5 metres. Some of the caves showed evidence of collapse, others were clay-filled and one contained three metres of unconsolidated black carbonaceous silt (Best and Henderson 1968).

Extensive alteration to foundation design was required, and much of the building was supported by groups of piles founded in the shale at least three metres above the top of the limestone. Due to the widespread occurrence of caves the rest of the building had to be founded within the limestone itself. In one part piles were founded from eighteen to twenty-eight metres below the excavated rock surface (Best and Henderson 1968).

This study not only provided a fascinating cross-section of a buried karst but led to speculation of the presence of cavernous limestone under much of central Canberra including the Parliamentary Triangle area. This was confirmed to some extent with the detection of caves in limestone beneath the site for the Trade building in Barton. The limestone was within six metres of the surface and extended to a depth of over fifty metres. Caves were encountered at depths from twenty metres (Hill 1971). This added a new chapter to the records of buried limestone from foundation testing for such widely distributed buildings as the Canberra Hospital, Gowrie Hostel, Lend Lease project (opposite the ABC), National Library, Commonwealth Avenue Bridge, Kings Avenue Bridge and the Administration Building.

We may lament the ease and disregard with which design and construction of the city dismissed and removed virtually all traces of the once prevalent limestone outcrops from the Canberra landscape. It is however tempting to derive wry satisfaction from the ability of cavernous limestones hidden from view to 'strike back' and confound or complicate that construction. We probably have not heard the last of the lost karst of Canberra.

Postscript

The ACT Parks and Conservation Service, part of the Central office of the ACT Administration, is concerned to protect what remains of the drowned Acton limestone and some solution-sculpted outcrop will be interpreted on a planned Bicentennial Heritage Trail as a meagre link to the earliest description, naming and settlement of the area. The Service is also seeking to provide adequate protection for the remaining fossil sites not only for their intrinsic scientific value but also for their historical association with the birth of geology and palaeontology in Australia.

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