KARST AND CAVE AREAS OF TASMANIA

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Tasmania has some of Australias deepest, longest and most spectacularly decorated karst caves, and it has been common over the years to refer to Tasmania as having a karst estate that is abundant in comparison to much of Australia. Founded on the testimony from Junee-Florentine, Mt Anne, Ida Bay, Mole Creek and elsewhere, this reputation arose before the true extent of potentially karstic rocks elsewhere in Tasmania was fully realised, or in the rest of Australia for that matter (Jennings 1975, Smith 1988). It also pre-empted any assessment of the actual density of caves and other karst phenomena in some of these rock units, for in reality, while most limestones exhibit some sort of karst phenomena to at least some degree, far from all the limestone in Tasmania is significantly cavernous, including extensive areas of the limestone within some of our better known karsts such as Junee-Florentine. The limited number of researchers and cavers and the relatively reconaissance standard of geological mapping available for much of the island mean that it is still not fully possible to evaluate Tasmania's karst estate. However, the data base has improved immeasureably over the last couple of decades and this conference provides a useful opportunity to take stock.

If we take as our starting point Albert Goede's catalogue of Tasmania's caves spanning 28 areas in the ASF's *Speleo Handbook*(Goede 1968) and his review of Tasmanian karst prepared for the 1970 ASF Conference in Hobart (Goede 1971, the extent and nature of the changes revealed by two decades of exploration become pretty evident. First, far more caves are now known in the karsts recognised in 1968 than were known then. Differences in accessibility have played an important part in conditioning how rich in caves various karst areas appear to be. The list of known caves at Mole Creek, long a relatively accessible karst, has roughly doubled from 102 to over 200. In two less easily accessible karsts into which new logging roads or other routes have increasingly provided access the increase in the number of known caves has been more rapid - at Ida Bay the number has risen from 9 to around 250, at Junee-Florentine from 17 to well over 200. The data base remains more embyronic at Precipitous Bluff, which remains fairly remote. There the efforts reported in 1968 were totally eclipsed by a second visit in 1973, then those efforts in turn were totally overshadowed by discoveries during a third and subsequent visits since the mid 1980s. On the other hand, perception and how fashionable an area is has also played a role. The presence of caves in and around the gentle farmlands of Gunns Plains, less than half an hours drive from Ulverstone, has been known for over a century, yet by 1988 I was able to compile a list of only 13 caves - since the Savage River Caving Club has taken an interest reports in *Speleopod* indicate that number has more than doubled, with new discoveries approaching 1 km long and approaching 40 m depth.

Since 1968 we also seem to have become aware of more new limestone areas than we have cavers to look at them, a plus from a management perspective although no doubt only a temporary one. Whilke their advent is exciting, not all these additional limestone areas are necessarily ever going to be attractive as recreational caving venues, despite whatever other scientific, recreational or aesthetic qualities they may have. The most important of Tasmania's karsts were already recorded when *Speleo Handbook* was published. This is despite the number of areas found since - Kiernan (1988a) recorded well over 100 outcrops of the most promising carbonate rock types, with karst phenomena confirmed from at least 60 of these. The fact of the matter is that Tasmania has heaps of limestone that seems to contain nary a cave, a pity for cavers no doubt but also a point that makes current and proposed limestone quarrying operations in important cave areas all the more nonsensensical. But there are undoubtedly many important new caves awaiting exploration in some of these new areas nevertheless, once cavers start looking at them. It is important also to recognise that a particular limestone area is not necessarily an appropriate place for a limestone quarry if the only reason it appears devoid of caves is simply that cavers have never got around to investigating it, as the current Risby Basin quarry proposal has exemplified.

As my intention is to provide only a brief overview of Tasmanian caves and karst and I do not propose to exhaustively reference this paper. Instead I will simply refer readers who desire more details to the *Bibliography of Tasmanian Karst* produced by the ASF Bibliography Commission some years ago (Kiernan 1989a) and add a few more recent references of importance, especially those that contain useful bibliographies that facilitate access to the relevant preceding literature.

TASMANIAN CAVE AREAS

Present indications are that the most widespread of Tasmania's potentially karstic rocks crop out over about 4.4% of the island (~277 000 ha). Just over half this area comprises dolomite and limestone of Precambrian-Cambrian age, just under half comprises Ordovician (Gordon Group) limestone. In addition to this 277 000 ha, some karst phenomena are also known in limestones of Siluro-Devonian age, a rock very restricted in distribution; some very localised karst occurs in limestones of Permian age which are widespread particularly in eastern Tasmania, including the Hobart area where no caves are known; in Tertiary marine limestones; and in Pleistocene aeolianite, the latter two rock types being confined to areas within a few kilometres of the coast in northern Tasmania and on some islands in Bass Strait. Little known but of particular significance is karst developed in magnesite in that part of northwestern Tasmania popularly known as the Tarkine wilderness. No other magnesite karst appears to have been recorded in Australia and I am unaware of any other examples in the world literature.

In additon to the karst caves that are the focus of most attention from cavers, a variety of parakarst and pseudokarst phenomena is known, including caves. I will return to karst caves in more detail later, but will take the opportunity first to briefly record the nature of Tasmania's parakarst and pseudokarst caves. In part, I give them this prominence because I believe we tend to overlook them too often. Some of these caves are intrinsically interesting and are important for biological, geomorphological, archaeological, social or other reasons. The principal caves of this type have formed in sedimentary and igneous rocks in a variety of environmental contexts.

Parakarst and pseudokarst caves

Jurassic dolerite is widespread in the eastern half of Tasmania, and commonly exhibits a columnar structure. A large, well decorated solution chamber formed in dolerite was discovered during tunnelling near Wayatinah in the early 1960s but has since been sealed off (Hale and Spry 1964). A curious large enclosed depression with centripetal drainage occurs in the same rock type on the Du Cane Range (Kiernan 1988a). However, for the most part the caves in dolerite comprise either boulder mazes in blockstreams, in fossil rock glaciers or in talus heaps. A couple of hundred metres of passage have been surveyed at Mt Arthur near Hobart, while the most protracted cave rescue Tasmania has yet seen took place in another dolerite cave, Devils Den, on nearby Mt Faulkner. There are also some deep rifts formed down joints close to escarpments where sheets of columnar dolerite began to peel away from the hillside during the late Pleistocene but have largely halted movement during the present interglacial conditions. Some very large masses have detached and begun to move downslope, one that hangs above Mole Creek on the slopes of Nells Bluff measuring over 1 km long and several hundred metres broad. Large closed depresions have formed in some parts of the island where rubble has accumulated in the margins of the trough that forms upslope of the detached masses, and some of these have erroneously been labelled as sinkholes on topographic maps. Some dolerite caves have proven of interest in various scientific fields, such as the mineralogy of the cave at Wayatinah (Hale and Spry 1964) and the fauna of the caves at Mt Arthur.

There are extensive areas of Tertiary basalt in eastern, central and northwestern Tasmania but no lava caves to speak of. Such tubes as have been recorded have a diameter of only milllimetres, although a few low bubble-type chambers a few metres long were intersected by cuttings of the Mole Creek - Gowrie Park road and proved notable for their minerals, although sadly these have succumbed to collectors.

Caves formed in sandstones and mudstones of Carboniferous-Triassic age include inumerable small rock shelters, some of which are important as archaeological sites (McConnell 1990), and some caves formed at minor spring sites or behind waterfalls. Minor spelothems occur in some of these, occasionally comprising uncommon minerals. The invertebrate fauna of sandstone boulder caves at Francistown has also proven significant (Richards 1974).

Sea caves are common around various parts of the coastline, some of the largest having developed in sedimentary rocks of Carboniferous-Triassic age. These include some of the impressive sea caves of Tasman Peninsula where there may be up to 200 m of passage associated with Tasmans Arch. There are others formed in a variety of other rock types including dolerite. Some minor limestone lenses or carbonate-rich mudstones have given rise to some speleothem development in sea caves at Variety Bay on Bruny Island and reportedly elsewhere. The most richly decorated sea caves have formed in quartzite on King Island, where overlying calcareous dune sands have given rise to extensive, speleothem develoment including columns up to 2 m high, although considerable vandalism has occurred. Various sea caves have proven important for scientific studies, such as those on King Island where dating of the cave sediments has shed light on the antiquity of coastal evolution, and those at Rocky Cape and Prion Beach where important archeological studies have been undertaken (Jones 1968, Dunnett 1992).

A few small caves, generally only of crawling dimensions, have been examined in areas of severe tunnel erosion of soils. The only ones large enough to have warranted mapping, near Hamilton in south-central Tasmania, have since been infilled as part of a land rehabilitation project.

The other quite delightful form of cave deserving mention comprises those that form seasonally in snow banks on some higher mountains. Some are no more than bergshcrunds, others comprise mazes of snow-roofed large dolerite blocks, but in other cases stream caves regularly form over allogenic creeks or springs. These snow caves are invariably small but over time the stream caves increase in diameter to a couple of metres and can be memorable for aerogenically sculpted walls and ceilings, including large scale scallops, and sometimes for their natural lighting through the snow. They are also of some micrometeorological interest. These caves are relatively robust to all but deliberate vandalism, and at any rate regenerate themselves every year. They are but relics of a far more glorious past - we no longer have glaciers capable of hosting the numerous kilometres of cave passage recorded from some overseas sites, but in the Pleistocene an ice cap of over 7000 km^2 existed in the Central Highlands and other smaller glacier systems existed elsewhere (Kiernan 1990a). At these times many of Tasmania's largest rivers, including the Mersey, Derwent, Forth, Gordon and Franklin, originated from glacier caves that doubtless were far larger than any of our present karst caves. In a few cases fossil subglacial meltwater channels remain like life-size cave maps that were etched into land beneath the ice. Their former presence is of scientific import since such channels can provide insight into past glaciological conditions, ice thicknesses and glacier extents (Kiernan 1981). Where the land beneath of adjacent to the glaciers was limestone, there were important implications for the development of karst caves.

Karst caves

The cold glacial periods of the Tertiary and Pleistocene have contributed significantly to the character of some of Tasmania' karst. At least six glaciations are known to have occurred over this period, the earliest apparently contemporaneous with the onset of glaciation in Antarctica about 30 million years ago (Kiernan 1990a, Macphail, Colhoun, Kiernan and Hannan, in prep). Pre-existing karst depressions may have been favourable sites for glacial eroson, as has been sugested in the case of some of the lakes at Frenchmans Cap (Peterson 1966), at Lake Timk (Kiernan 1990b) and elsewhere. Some karst features may have been eroded away, in other cases they were simply buried by glacial deposits as at Nelson River. Seasonal meltwaters were delivered onto adjacent karst areas, and driven into limestone beneath glaciers, as was probably involved in the development of some caves in the Dante Rivulet karst. This offered the potential for considerable cave development in some cases but in others the possibility of caves becoming clogged by sediment, depending upon specific circumstances. Beyond the margins of the glaciers the cold conditions meant considerable snow-pack development, a much more restricted forest biomass than now, and a variety of periglacial processes such as frost wedging and solifluction. As a result, considerable volumes of sediment were delivered into streams, again offering the potential either for considerable elargement of developing caves by mechanical erosion, or their total blockage by sediment and a reversion to surface drainage. During times when water was locked up in glaciers sea level was more than 100 m lower than at present, while during the Last Interglacial when conditions were perhaps slightly warmer than now the sea was a few metres higher. Hence, the base level to which streams drained, and the zone of mixing corrosion at the interface between the marine and terrestrial environments has shifted dramatically, often over many kilometres where the coast is flanked by plains rather than mountains.

In order to gain some sort of overview of Tasmanian karst it is useful to consider its evolution and nature at several levels of analysis. The first comprises the **karst systems level**, or the context within which each karst has evolved. The systems can be characterised on the basis of different rock types and sub types; different structural contexts; different climatic regimes (both present and past); different solvent systems (including whether the solvent is juvenile water or rain water, and whether the solvent falls directly onto the karst as rain and sinks diffusely, or flows onto it as concentrated streams from neighbouring rock types that impart chemical differences); differences in topographic setting that have major implications for hydraulic gradients and other matters; and the relationship between the carbonate rocks and the direction in which overlying rocks have been or are being stripped away. All these attributes condition the way karst phenomena have evolved The second level of analysis is that of the **landforms and landform asemblages** present in each karst. Caves obviously comprise only one of the many landform families that may be present in any karst, alongside other families such as the closed depressions, surface solution sculpture and such like. Differences in systemic contexts mean there are genetic and morphological differences sufficient to recognise many different species of caves just as there are different species of plants and animals. Some are common and some uncommon, some very fragile, others more robust, some recreationally attractive, others not (Kiernan 1990c, 1992). The third level, **landform contents**, comprises the various sediment accumulations, including speleothems, clastic deposits, bone deposits, and archaeological materials, and the biological values contained in karsts both above and below ground. The fourth level is that of **human use and aesthetics**, comprising the whole range of scientific, educational, recreational, economic, social and other uses of karsts above and below ground, in the past, in the present or in the future. As caves are the karst landforms of most interest to cavers I will, for present purposes, focus largely on these rather than the the other values of our karsts. I will also focus on their recreational implications rather than the subtleties of different cave types, genetic attributes and speleogens.

For the purpose of the present exercise I will consider the Tasmanian karsts from the perspective of their topographic setting, focussing on four broad types: karsts of the coastline; low relief karsts on riverine plains and elsewhere; karsts on steep hill flanks; and mountain karsts. Obviously some karsts span more than one setting, but this sort of framework probably offers more useful insight than does differentiation on the basis of rock type, a framework commonly used in the past (eg. Kiernan 1988a). There is probably no such thing in Tasmania, if anywhere, as a "pure" karst - in each locality other, non-solutional, processes are at play besides simple solution. Mechanical erosion by stream-borne sediment in essentially fluvial environments, wave action and salt spray on the coast, the impact of snow and ice in the mountains; differences in the biological environment that condition water chemistry, all these and a host more interact with solution processes and, depending on specific circumstances, may overwhelm solution processes or be overwhelmed by them. As a result karst may not initially seem conspicuous. Moreover, an observor from the tropics, for instance, might be tempted to dismiss Tasmania as lacking much karren, although closer inspection would reveal that the karren species present here are simply less ostentatious than what he or she is used to - it is a question of differences in karren type rather than in karren abundance.

Coastal karsts

The coastal karsts comprise those outcrops of carbonate rock that occur at the interface between the marine and terrestrial environments. The impact of "non karstic" processes on the coast can be profound and those elements cavers think of as karstic may be obvious, muted or absent: such places nevertheless remain karsts. A number of coastal karsts are known to exist at present, including one in Pecambrian rocks, three in Ordovician limestones, one in Devonian limestone, at least one in Permian limestone, and four in Cainozoic limestone. These diferent rock types have imparted some distinctive characteristics to the karsts that have formed in them, the Tertiary marine limestones, for instance, having given rise to some interesting shore platforms, the Pleistocene aeolianites to very ruged karren and deep notching. Small caves occur in each of these rock types.

When the sea level was slightly higher than present during the Last Interglacial other karsts such as Lower Gordon and Precipitous Bluff were essentially coastal karsts. Additional complexity has been imparted by the fact that the land itself has been raised by tectonic uplift around parts of the coastline, in some cases by 20-30 m just since the Last Interglacial (Murray-Wallace, Goede and Picker 1990), hence relict coastal karst may now lie well above present sea level, and, in areas of generally low relief, my now lie well inland. In addition, when the sea level was lower during the glacial periods some karsts that are presently on the coastline themselves lay well inland and developed as terrestrial karsts that drained to a lower base level than now, deeper conduits probably becoming flooded as the sea rose again. Extensive areas of Tertiary marine limestone that presently lie drowned on the floor of Bass Strait and at various places off the northern coastline would have been exposed to terrestrial karstification at times of low glacial sea level when the Strait was dry and Tasmania was a peninsula rather than an island. In the case of one apparent sea cave at present sea level on Flinders Island it has been revealed by radiocarbon dating of a stalagmite that the cave was in existence during the Last Glaciation and was invaded when the sea level rose again and converted it to a sea cave (Kiernan 1992b).

From a recreational perspective none of the coastal karsts presently offer any serious caving, with probably only Tearflesh Chasm on Maria Island, one cave on Ile de Golfe, or the cave at Rocky Boat Harbour requiring a torch. Nevetherless, some of these karsts do offer some very fascinating sightseeing for the curious or the photographer, notable features being the fossils in and around the caves on Maria Island, the karren at Surprise Bay and on Flinders Island, the shore platforms at Point Hibbs, and the aboriginal rock engravings in the aeolian calcarenite near Mt Cameron West. At a scientific level these karsts are of geomorphological interest in terms of process studies, the landforms that have developed on the different rock types, and sea level histories. The Mt Cameron West engravings are of major archaeological importance, and at least one known cave on Ile de Golfe is likely to offer potential in this regard. The archaeological potential of caves that probably exist below present sea level in several of these coastal karsts remains untested, as does their significance from the perspectives of geomorphology, palaeoenvironmental studies, marine biology and various other disciplines.

Plains karsts

The low relief plains karsts are widespread, particularly in the valleys of western Tasmania and on coastal plains in northwestern Tasmania, there being at least 44 examples in Ordovician limestones, 25 in Precambrian carbonates, and a handful in Devonian, Permian and Tertiary limestones. These karsts are characterised by low hydraulic gradients, a high "water-table", and the carbonate rock has frequently been mantled by fluvial, glacial, marine or other sediments. The karstic nature of these terrains may be evident only from infrequent sinkholes as is the case in the Vale of Rasselass, or the plains may be dimpled by many cover-collapse sinkholes - occasionally fresh ones assert themselves by engulfing a road or a cow. Where rock outcrops protrude through the alluvial covers the outcrops may be attacked laterally by seasonal swampwaters, giving rise to destinctive landforms such as deeply undercut notches as have formed in Tertiary limestone near Redpa, and seasonally flooded caves, some of which are moderately extensive such as Main Cave, formed in Precambrian limestone south of Montagu. Other very distinctive elements are the riverine cliffs along such rivers as the Franklin, where in addition to the fluting of the limestone there are riverside springs, small tufa accumulations and a variety of caves (Middleton 1977).

In the Smithton area marine sediments of Last Interglacial age occur up to 20 m above present sea level on broad plains formed on Precambrian limestone and dolomite. During the periods of low glacial sea level these plains stood well over 100 m above sea level and offered far more potential for cave development than present appearances suggest. Collapse sinkholes that have formed through considerable thicknesses of non-carbonate rocks in the Christmas Hills indicate considerable cavity development in underlying carbonate rocks, perhaps most markedly at these times when underground water circulation had the potential to be most vigorous. Dismal Swamp is a large, semi-closed depression 2 km broad and 3 km long that appears to be a polje that has been partly filled by sediment facilitating seasonal overflow - indeed it may be the nearest thing to a classical polje to be found in Australia (Kiernan 1990d). Mound springs are another unusual feature of the karst in the far NW, some being warm springs. The largest are up to 10 m high, but virtually none have escaped damage during pasture improvement programs. In one case a milking shed has been built atop a mound spring and the warm waters are used to wash out the churns.

Some reasonably substantial caves occur in these low relief plains karsts, but generally speaking the caving potential of these karsts is fairly low. Nevertheless, swimming the cold winter waters of Main Cave at Montagu will provide a reasonable test of any caver's resilience, while any who have explored their way through the Franklin cliffs at Galleon Bluff to emerge in a decorated grotto set high above the rainforest and the river will not question the recreational value of such a place. In scientific terms these karsts are among our most valuable. The archaeological importance of caves such as Kutikina and Deena Reena in the Franklin Valley is well known (Kiernan, Jones and Ranson 1983), but there are other important prehistoric archaeological sites in the caves of the Maxwell Valley, the Andrew Valley, the Acheron Valley, the Weld Valley, and at Brougham Creek in the Pieman River catchment (Jones et al. 1988, Allen et al 1989, Cosgrove et al. 1990). Nunamira Cave, which lies in a small residual hillock on the floor of the Florentine Valley, provides the oldest archaeological evidence yet revealed for human occupation of Tasmania, ~31 000 years (Cosgrove 1989). A small cave at Jukes-Darwin contains evidence of early karst engineering by Europeans (Kiernan et al. 1989). Caves at Montagu and others on the floor of the Florentine Valley have revealed important subfossil bone deposits including extinct marsupial megafauna. Some of these karsts are also of geomorphological interest, while others have proven important for their invertebrate fauna (Eberhard, Richardson and Swain 1991).

Hill-flank karsts

The karsts are perhaps those best known to cavers, since they host many of our deepest and longest cave systems. There are at least 15 areas of karst of this type formed in Precambrian carbonates, 18 in Ordovician limestones, a handful in Permian limestones, and a knuckle or two in Cainozoic carbonates. These karsts include Tasmania's principal caving areas such as much of Mole Creek Kiernan and Junee-Florentine. They are characterised by good topographic relief of the carbonate rock, relatively steep hydrulic gradients, and, for the most part, allogenic streams that deliver chemically aggressive water to the margins of the limestone outcrops where steep cave systems have developed. Almost all these karsts have been subject to periglacial environmental conditions during the course of their evolution, and a few to glaciation (Kiernan 1992c).

The caves and other karst phenomena in these hill flank karsts are so varied as to preclude adequate description in a brief review such as this. The longest cave system yet recorded in Tasmania, Exit Cave Ida Bay, is developed in Ordovician limestone beneath Marble Hill, which is capped by non-carbonate sediments. Major discoveries made over the last couple of years in Little Grunt represent part of the Exit Cave system and when the two are connected underground by direct exploration the length of the system will probably approach ~ 25 km. However, the issue of the quarrying of the Exit Cave system is not yet fully resolved. In due course caves of similar length may well be explored in the Junee-Florentine karst, already the location of some of the deepest caves in Australia. The Mole Creek karst is particularly famed for the quality and profusion of the speleothems found in its caves. New exploration in areas like Mt Cripps and Gunns Plains, and in more remote areas such as Precipitous Bluff and the Cracroft Valley, will doubtless reveal many further exciting caves in years to come.

These hill-flank karsts are a major focus of recreational caving. The evolution of Exit Cave has been greatly influenced by environmental change and this karst complex is of great importance to several scientific disciplines (Houshold and Spate 1990, Eberhard 1990, Kiernan 1991). The caves of Junee-Florentine are already known to be of major importance in the fields of archaeology, hydrology, geomorphology and biology (Cosgrove 1989, Hume 1991). Similarly, the caves at Mole Creek are of major significance in many disciplines although curiously perhaps, archaeology has not yet proven to be one of them (Kiernan 1989b, 1990e, Eberhard et al. 1991). Also of geomorphological interest are the caves of Mt Cripps (Shannon et al., 1991). The biological significance of Pecipitous Bluff warrants particular mention (Eberhard et al. 1991). The hill flank karsts will doubtless occupy the attention of both cavers and scientists alike for many decades to come.

Mountain karsts

The division between hill-flank karsts and mountain karsts is again somewhat arbitrary, but in general I use the term mountin karsts with respect to karsts that are higher and often steeper than the hill-flank karsts, have been significantly over-run by glaciers during the course of their evolution, have also been strongly influenced by periglacial conditions, and which in many cases remain today generally susceptible to alpine climatic conditions to a significant degree. On this basis some plains karsts are also in a real sense mountain karsts, such as the high altitude Vale of Belvoir. About 6 areas of Precambrian carbonates warrant description as mountain karsts but only a couple of outcrops of Ordovician limestone (although about 19 have previously been glaciated to at least some degree) and a single area of Devonian limestone.

The mountain karst *par excellence* is Mt Anne (Bunton and Eberhard 1984). The deep vertical caves of this area are well known, as is the spectacular glacial scenery of the mountains. Other karsts in Precambrian rocks that probably warrant description as mountain karsts occur at Mt Weld, in the Gell-Alma area, and even at Frenchmans Cap were some karst phenomena have been recorded. Karst in the headwaters of Cook Creek in the Picton Range may be developed in Ordovician limestone. Also of interest is the karst in Devonian limestone further south near

Lake Sydney, which is a lake of glaciokarstic origin. The outlet cave system appears to have been clogged by sediment during the Last Glaciation, but tributary streamsinks downvalley offer at least some prospect of entry. Recent explorations recently undertaken in the Vanishing Falls karst, which borders on description as a mountain karst, have revealed a cave so far explored for 2.3 km (Eberhard, Eberhard and Wong, in prep).

The recreational significance of the mountain karsts varies considerably, with probably only Mt Anne being of major significance to cavers at the present time but many of the others being used by bushwalkers to enjy the surface scenery. In scientific terms, the karst at Mt Anne is of great geomorphological and hydrogeologcal interest (Kiernan 1990f) while the Lake Sydney area has also proven of interest (Kiernan 1989c). The karst at Vanishing Falls is now known to be of biological importance (Eberhard, Eberhard and Wong, in prep.). Further research will doubtless reveal still more of value in the mountain karsts.

The largest cave systems

The worth of any cave cannot be measured in terms of its size. Many highly important caves are relatively miniscule. However, cave size certainly impinges upon the perceptions of both cavers and political decision-makers, and it also offers some feel for the extent and intensity of karstification in different areas.

Given the incomplete state of exploration, the uncertainties of cave surveying and the perils of spelo-politics, only a fool would attempt to list the deepest and longest caves presently known, so I shall endeavour to do so. However, none of the three longest caves have been exhaustively surveyed and a little uncertainty also surrounds just which is Tasmania's deepest cave since only a few metres appear to separate a few systems, within the likely range of survey error. At present the longest caves known in Tasmania are Exit Cave at Ida Bay (perhaps 20 km of passages), Growling Swallet in the Florentine Valley (>12 km) and Herberts Pot at Mole Creek (>5.3 km). All three have formed in Ordovician limestones. The deepest known caves in this rock type are Niggly Cave (~371 m), the Ice Tube/Growling Swallet system (~354 m) and Khazad-Dum/Dwarrowdelf (~323 m) in the Junee area, all of which represent different sections of the same hydrological complex. The deepest cave in the Precambrian dolomites is Anne-a-Kananda (373 m), which at >3 km is also the longest dolomite cave, ahead of Newdegate Cave at Hastings. Deep vertical shafts are also worthy of note. Niggly Cave at Junee-Florentine contains a single continuous vertical pitch of 190 m, while Heartbeat in Anne-a-Kananda is 118 m and the entrance pitch in Kellar Cellar at Mt Anne is 115 m. More than 50 pitches have been explored in Anne-a-Kananda (Bunton and Eberhard 1984).

Where are the areas that offer greatest potential for the discovery of further large cave systems? We can be guided in our search by the fact that cave systems serve as subsurface drainage conduits, hence the relative position of streamsinks and springs therefore remains the best guide as to where we should look for large caves.

The longest underground hydrological system focusses on Junee Cave. Proven tributaries include Growling Swallet, a linear distance of 9.4 km from Junee Cave (Gleeson 1976). Direct exploration from Growling Swallet has penetrated scarcely 1 km of this linear distance. Other streamsinks up to 14 km from Junee Cave may also be part of the system (Hume 1991). The potential is immense although secrets are seldom revealed easily. The six longest underground drainage systems in the Mole Creek area span linear distances of 2.2-3.6 km. The most complex system at Mole Creek is that beneath the Mole Creek-Lobster Rivulet surface drainage divide, which includes Herberts Pot. Wargata Mina (Judds Cavern) in the Cracroft Valley lies 2.5 km from its most distant tributaries. The enigmatic Lake Timk at Mt Anne is 1 km long and 25 m deep. Water drains from the margins and bed into a cave system which can be followed in underneath the lake bed when the lake level is low, but this cave has seen no concerted attempt at exploration. This water is believed to be the source of a large spring 2.4 km away (Kiernan 1989c). It is vaguely conceivable that the drainage from Anne-a-Kananda forms part of the same system, which would increase the linear extent to ~4.8 km. While too much should not be made of the fact, it is thought provoking to contemplate that most of these drainage systems are longer that the 2.3 km between the Exit Cave outflow and its most distant streamsinks.

The greatest topographic relief of carbonate rock, and hence the greatest theoretical cave depth potential, is ~ 600 m in the Mt Anne/Weld Valley area, followed by ~ 450 m at Mt Ronald Cross, both Precambrian carbonate areas. The topographic relief of Ordovician limestone approaches 400 m at Junee-Florentine, and is also very considerable at Precipitous Bluff, in the Cracroft Valley and at Mole Creek. In the latter area the altitudinal diference between some streamsinks and their proven or probable springs approaches 300 m (Kiernan 1984).

LAND TENURE AND MANAGEMENT

Current estimates suggest that roughly 31% of Tasmania's carbonate rocks lie beneath State forest, 17% beneath parks and reserves, 33% beneath private land and 19% beneath other Crown lands. While ~24% of the Ordovician limestones lies in parks, only ~16% of the areas with sufficient topographic relief to offer much potential for significant caving are reserved. Most of the Siluro-Devonian limestone karst is reserved, but none of the magnestite karst, all of which occurs on Crown lands. If the exent of cave and karst resources in Tasmania represents a fairly happy story, the management of Tasmania's karst generally does not. Notwithstanding the fact that a number of areas have been formally reserved, the standard of karst management is generally very low, the legacy of past neglect considerable, the inertia huge. Political processes and issues that appear to have resolved some land-use and land allocation issues, for the present at least, have contained the seeds of some major management difficulties (Kiernan 1989d). The karst management problems involve surface land-use, groundwater quality, and in-cave management issues (Kiernan 1988b, 1989f)

The management of privately owned karsts varies from careful and considered to deliberately vandalistic, based in part on the political attitudes of particular property owners. No karst management expertise exists in the Tasmanian Department of Primary Industry to guide activity in agricultural areas, although logging of private forests on karst is subject to some influence by the Forestry Commission. About 5% of Tasmania's State forests are underlain by carbonate rocks. Karst management concerns in these areas include soil erosion; cave sedimentation; landslips in cave catchments; drainage and groundwater quality changes; and recreational pressures that stem from the construction of logging roads to within close prioximity of sensitive caves. District offices are responsible for land management on the ground. Forest Practices legislation prescribes some standards for logging operations in karst areas. To facilitate the implementation of these standards and other work, the Commission's Forest Practices Unit contains two karst specialists, Kevin Kiernan and Rolan Eberhard, both employed on temporary contract. The attitude of forestry companies varies. Two small forest reserves were established by the Commission in the 1970s to protect karst phenomena considered to be scenically attractive, but no progress has been made towards establishing the reserves recommended by the major karst management study of the Mole Creek area in 1983-84 undertaken within the Commission in 1984 (Kiernan 1989b). Some work has been undertaken towards management planning for the Croesus Cave area at Mole Creek (Spate and Holland 1990) and Welcome Stranger Cave in the Florentine Valley.

Carbonate bedrock underlies ~5% of Tasmania's parks and reserves, but until very recently the only karst management by the Department off Parks, Wildlife and Heritage (PW&H) has been focussed on the tourist caves at Hastings, Mole Creek and Gunns Plains. Nevertheless, at Mole Creek rangers Chester Shaw and Vic Fahey and their colleagues have undertaken excellent cave cleaning and restoration work in Marakoopa Cave with very little support or recognition. Steps have also recently been taken by Phil Bradley and his colleagues at Hastings to start to address the deplorable condition of the tourist cave there, initially through the construction of a new access walkway that will limit the carriage of material underground on the feet of visitors. Until very recently there has been virtually total neglect of the other karsts administered by PW&H, despite the fact that many lie within the World Heritage Area for which specific management funds are made available by the Australian Government (Kiernan and Eberhard in press). In some cases political influences have underlain the poor management standards, as in the quarrying and pollution of Exit Cave. Equally deplorable has been the situation in the Lower Gordon karst. After the Franklin dam was blocked by the Commonwealth government in line with its responsibilities as a signatory to the World Heritage Convention, and after the conservation movement had moved away to taller pastures, annoyed pro-dam state politicians were only too happy to foster the tourist operators at the expense of the environment. The Commonwealth Government that would tolerate no ground disturbance when the glare of publicity shone on the area now sat back and let 40 km of rainforested riverbanks be quarried into the river by the wakes of tourist vessels. But at least after years of lobbying, management plans for Kubla Khan and Exit Cave are now in preparation (Spate 1991), and Ian Houshold has been appointed on temporary contract as PW&H karst officer. Among his many dificult tasks is to repair the legacy of tensions that arose when concerned people within PW&H felt compelled to establish a holding operation by restricting access to some caves that were suffering damage until such time as their struggles to obtain adequate resources to plan and implement management responses could bear fruit. There was little communication between the parties or much attempt to understand the problems faced by the other.

Apart from such well publicised matters as the Exit Cave Quarry, karst resources are at present under considerable pressure from quarrying and other proposals and pressures. Investigations for possible new limestone quarries are underway in several areas, the past year has seen the partial inundation of the Nelson River karst beneath a new hydro-electric impoundment, controversy surounds a large tourist development at Lake Lea in the lovely Vale of Belvoir karst. There are incresing concerns about the implications of comercial adventure tours in caves. Meanwhile nature's processes continue, and the Gowrie Park road has in recent weeks collapsed into the same sinkhole as engulfed it with some publicity in 1974 - eighteen years on will we see it fixed properly this time? That the progressive impact of cavers feet continues to outpace the progressive impact of cave drps is only one of Tasmania's karst management issues.

TASMANIAN CAVE RESEARCH

It is worth recording here the research currently being conducted in Tasmanian karsts. The first group involved comprises the Tamanian Caverneering Club, Southern Caving Society, Northern Cavemeers,Savage River Caving Club and the Tasmanian Cave & Karst Research Group. The exploratory, surveying, collecting and documentation efforts of these groups have provided a vast amount of information over the years, much of it disseminated through their publications. Without their efforts many of the more detailed studies undertaken by universities and government agencies would have been much more difficult and sometimes impossible. From a management perspective the efforts of the Savage River Caving Club in the Mt Cripps karst warrant particular recognition (Shannon et al. 1992). It is instructive to compare the level of understanding that has developed between this group and the forestry company that manages the area and which fosters cave exploration as an aid to wise planning, and the very poor relations between cavers and the managers of the Junee-Florentine karst where cavers seem to have been regarded simply as a nuisance and a threat.

The government agency with the most longstanding involvement in karst research is the Forestry Commission, within which the geomorphology section of the Forest Practices Unit is involved in research focussed on the implications of karst for forest management, both in terms of nature conservation and karst hazards (Kiernan 1989e, 1990g,h). The Tasmanian Karst Atlas Project involves the progressive documention of karst, is funded by the forest industry through the Tasmanian Forest Research Council, and in some cases is involving work done on contract by caving clubs, individual cavers and geomorphologists. . Another project which focusses on the effects of logging on karst caves, has been funded initially by a grant from the Australian National Parks & Wildlife Service and has involved the establishment of a small underground laboratory in Little Trimmer Cave (Eberhard and Kiernan 1991). A major documentation and management study of the Junee River catchment is planned for 1993, funded by the Forestry Commission itself. The archaeology section of the FPU is also occasionally involved in karst work, primarily involving the Senior Geomorphologist, Anne McConnell. Within the Department of Parks, Wildlife & Heritage the archaeology section has also been involved in research in karst areas, generally involving external research grants and often undertaken in collaboration with mainland university researchers. Other karst area research has been undertaken by the earth science section, involving Mike Pemberton, Grant Dixon and others, mostly focussed on the Lower Gordon and on the Exit Cave Quarry (eg Houshold and Spate 1990, Eberhard 1990, Kiernan 1991, Clarke 1991) the latter studies generally undertaken by outside parties contracted to PW&H or in some cases to the Department of Mines. Andy Spate and Stefan Eberhard have been among those involved in management-related reserch in Kubla Khan, and since his appointment Ian Houshold has initiated further work.

University-based research has involved the ongoing sterling efforts of Albert Goede from the Department of Geography & Environmental Studies at the University of Tasmania, whose karst research is now focussed on speleothem dating and paleaeotemperature work (Goede 1988, 1990, Goede et al. 1990), but recently involved supervison of Nick Hume's honours thesis study of the hydrology of the Junee catchment (Hume 1991). A major study of Tasmanian cave fauna, funded by the Australian Heritage Commission, was recently completed by Stefan Eberhard from the Zoology Department, in conjunction with Alastair Richardson and Roy Swain (Eberhard et al. 1991). A current research project is focussed on cave ecology, and includes work in Little Trimmer Cave.

The outstanding contributor to archaeological study of Tasmania's caves over many years has been Rhys Jones of the Australian National University, who has layed the foundation for ongoing work in Tasmania's karst caves that will last for decades, and who has defined many issues that demand resolution (Jones 1984)). Such challenges have been taken up by others from the same institution, and more recently by workers from La Trobe University including Jim Allen and Richard Cosgrove. Archaeologists from the University of Western Australia have also undertaken work in the Nelson River karst for the Hydro Electric Commission.

CONCLUSIONS

The karst estate of Tasmania is extensive, varied and valuable. Just as caves are not the sole attribute of karst, neither are cavers the only group that competes to exploit our karst resources.- a fact that underscores many karst and cave management issues. Some of the karsts contain important cave systems of recreational significance, many of the karsts are of scientific importance, some are of economic significance. Ongoing research continues to provide insight into the karst resources and their management implications. Tasmania will remain the home of Australia's deepest caves and has the potential to remain the home of this country's longest caves. However, for the most part the response by land management agencies to the management implications of this karst estate remains very inadequate. Some caves have been heavily impacted by recreational use but many remain in relatively good condition in comparison to some caves elsewhere in Australia where the cave-using population is more numerous. Tasmanian cavers and land managers have the choice of responding to this situation either by seeing it as grounds for complacency or as an opportunity to ensure that Tasmanian caves remain in a better condition than is now possible over much of Australia. If the latter opportunity is to be seized it will necessitate the acquisition of good informtion, the adoption of high standards of protection of the cave environment, and a high degree of self discipline and genuine commitment by all involved.

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