KEYWORDS: ***Cave art – Preservation – Protection – Management plan – Australia***

PRESERVING AUSTRALIA'S CAVE ART

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Abstract. A key reason for the need for a national management plan for Australian cave art is that the fifty-four known sites occur on the traditional lands of several different language groups; and they are found on private land, public land and land dedicated to the production of pine trees, but under different management systems and in different states. This complex mosaic of management structures is not conducive to the uniform preservation of cave art. A few sites are already subject to existing management practices, but most are not. Since all face the same preservation issues, they need to be subjected to uniform effective protection and conservation regimes. The key variables for this to be achieved are listed and elucidated, and it is noted that not one of the sites is suitable for tourism. Human visitation of the caves is considered the greatest threat to the conservation of rock art found in them. However, it is recommended to consider the establishment of cave art facsimiles, which have proved extraordinarily successful in France and Spain. The management plan proposed here recommends the creation of an entity responsible for the perpetual preservation of all Australian cave art sites.

1. Introduction

The most outstanding cultural resource representing the first 99.5% of Australia's history is the continent's rock art, considered the most extensive such national corpus in the world. A small but extraordinary component of this unparalleled body is the country's cave art, much of which seems to date from the Pleistocene, like much of that of south-western Europe. However, whereas the picturesque cave art of France and Spain has attracted significant attention and massive preservation efforts, the enigmatic Australian cave art has not and remains largely unprotected. This report is based on the assumption that Australians value the earliest history of their country just as much as the French or Spanish people do and on the proposition that they consider it just as worthy of preservation.

Australia boasts one of the three largest known concentrations of cave art in the world, but whereas the largest, in France and northern Spain, has been the focus of massive protection programs, there has been no concerted effort of this kind in Australia. For instance, the French Ministry of Culture alone has spent many dozens of millions of euros on protecting cave art sites. By contrast, Australia's cave art is almost unprotected in practical terms: relevant legislation is significantly inadequate and ineffective in all states, and there has been minimal budgetary allowance for protective measures. Until now, the main form of protection of most of the known fifty-four Australian cave art sites has been the complete confidentiality of most of the site locations, maintained for several decades by the Parietal Markings Project (PMP). This measure is now considered to be inadequate to meet the challenges of the future.

The PMP has operated formally since 1980 and, in 1983, was integrated into the newly established Australian Rock Art Research Association Inc. (AURA) operations. Besides relevant Traditional Custodians, it includes scientists from various fields, such as rock art research, semiotics, forensic science, microbiology, karst studies, speleo-ethology, archaeology and anthropology, and it has been responsible for locating most of the cave art sites known in Australia. PMP researchers have produced most of the scientific literature dealing with Australian cave art. In addition to the cave art, the PMP also studies other cave markings, such as animal scratch marks (e.g. Bednarik 1991a), other natural wall markings in caves, inscriptions and marks related to utilitarian human activities. Its work also extends to many other countries.

Cave art occurs in all continents except Antarctica, almost exclusively in carbonate caves (mainly limestone), with notable examples in the U.S.A., Caribbean, India, Russia, South Africa, Indonesia, Philippines and China, but these are all relatively isolated cases. In SW Europe, Papua New Guinea and southern Australia, significant numbers of sites occur regionally. In two of these three regions, a large component of that cave art is of the Pleistocene. Australian cave art is found in isolated cases along the continent's southern coast and in Tasmania. However, its main corpus occurs in a well-defined karst area roughly between Millicent and Portland. This is referred to as the Mount Gambier Cave Art Precinct, which comprises forty known sites.

The locations of a few sites of the Mount Gambier cave art are on the public record in some form (Malangine, Koongine, Gran Gran, Paroong and Prung-kart Caves), and they have all been subjected to physical protection. One more, Ngrang Cave is the subject of planned management work in collaboration with the Traditional Custodians, while all others are only protected by strict confidentiality of their locations. The sites occur not only on both sides of the state border; they are on land managed by various agencies, i.e. they are subject to non-uniform policies of management. For instance, most land managers are unfamiliar with the *Burra Charter* or *Venice Charter*, the instruments governing the guardianship of cultural heritage sites. Moreover, there is no set of guidelines applicable specifically to cave art in Australia, and it needs to be emphasised that such sites are the most fragile of all forms of rock art. Considerations must, therefore, address the unique preservation conditions of cave art. These relate to the susceptibility of cave walls to fluctuations in atmospheric carbon dioxide levels, relative air humidity and temperature, all of which are significantly influenced by human visitation. Moreover, extensive experience with European cave art implicates humanly introduced microbiota in infestations that have already cost the French government over $30 million at just one site, Lascaux but remain fundamentally unresolved. To solve these issues, France has established a 'laboratory cave', and it is expected that vast resources will still be required to eradicate current problems. It is entirely unnecessary to repeat the disastrous French experience in Australia, provided appropriate measures are taken.

Australian cave art sites attract interest from many groups, such as speleologists and cave divers, who may be unconcerned about and even oblivious to the rock art's preservation needs. The Mount Gambier region's historical practice of filling caves with rocks, rubbish and animal cadavers is continuing in some cases. The recommendations of the most comprehensive management plan for the karst province (Grimes et al. 1995) are not being implemented. For instance, this authoritative blueprint recommended that concerning those caves that contain rock art, 'advice should be sought from AURA [the Australian Rock Art Research Association, Inc.] re priorities' (ibid.: 3), yet in the twenty-eight years since, this has never once taken place.

Similarly, the Traditional Custodians of all Australian rock art sites have scarcely been consulted before the final twentieth century, a practice that has been eroded by the work and campaigns of organisations such as AURA. Today, the system of Indigenous stewardship of cultural sites has been widely reinstated, and this also needs to be reflected in cave art management practices. The quite specific conservation requirements of cave art sites need to be manifested in a uniform national management plan for such places that provides for control by the traditional caretakers within the framework of scientifically based conservation practice. Another need for such a plan arises from the planned nomination of these sites for National Heritage listing and, eventually, UNESCO Biodiversity Reserve listing, for which such a measure is a prerequisite. To achieve this, a committee was established to formulate a management plan for the cave art sites of Australia, comprising representatives of relevant Traditional Custodians, land managers, private landholders and specialist researchers. The tourism industry has not been consulted because the sites concerned are generally unsuitable for tourism, and one of the principal objectives of this management plan is to discourage human visitation to the caves.

2. Aims of the management plan

The ultimate result from this exercise should be that all cave art sites are protected just as well as those in France and Spain; that the survival of the cave art can be guaranteed in perpetuity; that the relevant Traditional Custodians are the ultimate decision-makers in matters of Aboriginal heritage; and that the conditions required for heritage listing can be met, based on a well-considered, well-agreed and universally accepted policy. More specifically, the aims are to:

1. Identify the various present and likely future threats to the cave art sites of Australia, with particular attention to the Mount Gambier region, where most of these sites are located.
2. Examine and consider, in the light of overseas experience (especially in France), all possible remedial procedures and policies that might help ensure the perpetual survival of Australian cave art.
3. Formulate detailed recommendations to achieve this goal and secure stakeholders' consensus support for such measures.
4. Design a management plan specifically related to the Mount Gambier Cave Art Precinct but whose underlying principles are applicable nationwide.
5. Prepare recommendations for relevant legislation to be drafted in consultation with supporting agencies, universally applicable across state borders and all jurisdictions.
6. Prepare the Mount Gambier Cave Art Precinct for National Heritage listing by the Commonwealth Government and as a Biodiversity Reserve by UNESCO.

Beginning in 2014, we assembled a team of stakeholders interested or involved in Australian cave art to formulate a consensus-driven and realistic management plan to facilitate the perpetual preservation of this particularly fragile corpus of rock art. It includes representatives of relevant Traditional Custodians, state government land managers, *Pinus radiata* plantation operators, national parks, private landowners, rock art facsimile specialists and specialist researchers. This committee included the following:

Traditional Custodians:
Damein Bell, Gunditj-mara
Karen Glover, Pangula Mannamurna Inc.

Ken Saunders, Gunditj-mirring

State government land managers:
Peter Scott, Department of Sustainability and Environment (Vic.)
Oisin Sweeney, Department of Environment and Natural Resources (S.A.)
David New, Limestone Coast Landscape Board (S.A.)

Plantations:
Troy Horn, South Australian Forestry Corporation
Adrian Lynch, HVP Plantations
Ruth Ryan, HVP Plantations

National Park:
Dave Ryan, Parks Victoria

Private landowners:
John Hunt, grazier
Liam Brokensha, grazier

Site facsimiles:
Greg Muller, City of Mount Gambier
Kelvin Smibert, rock art facsimile specialist

Researchers:
Akin Adetutu, microbiology
Geoffrey D. Aslin, rock art research
Robert G. Bednarik, rock art research
Andy Spate, speleology
Keryn Walshe, archaeology

3. Methodology

There are two basic reasons why cave art preservation issues differ from those of open sites of rock art. First, the cave environment is far more delicate in several respects, and cave art on identical lithology would usually not survive in the conditions faced by open sites. Second, it tends to be easier to restrict access to caves than to open sites. Cave art shares many conservation issues with open sites rock art, but also it is susceptible to threats not relevant to open sites. Notably, damage from water (precipitation, runoff, capillary, interstitial, condensation) applies in both cases but is much less effective in caves for various reasons. However, caves are notoriously susceptible to changes in the hydrological system, often even where these seem minor. Another critical issue is the involvement of microorganisms, which is far more crucial in cave sites than in open sites. Perhaps more importantly, cave sites tend to have far more stable climatic conditions than rockshelters or open-air sites. The principal consideration in any preservation issues is that the rock art that has managed to survive to the present has done so because it has acquired a level of equilibrium with its environment. Consequently, any change to ambient conditions is likely to endanger the rock art, which applies to cave art more than it does to open sites rock art.

Therefore, the null hypothesis in rock art conservation is that the natural conditions of a site before the European past tend to be the most favourable and should be preferred or retained. Changes to the landscape of the Mount Gambier karst region over the last two centuries have been substantial, particularly in the vegetation and hydrological regimes. This includes the effects of deforestation and large-scale planting of pines; the common deposition of refuse, chemicals and animal carcasses in the region's caves; and frequent closures of caves by landowners. Since in karst, all water drainage occurs below ground level, and caves or dolines are principal drainage points in the landscape, the contamination of many caves has no doubt contributed to the poor condition of the region's aquifer water supply. Most of the direct interference with caves occurred in the 19th and early 20th centuries, but there are still isolated instances of caves being sealed off by landowners, which in one case involved a cave with extensive cave art, Nung-kol Cave.

It follows from this that a code regulating any modifications to caves by landowners and managers needs to be formulated as part of the management plan, the purpose of which is to ensure the sustainability of the cave art and the cave's integrity as a system. Other guidelines need to be formulated concerning uncontrolled human access and managing the caves' microclimates, hydrological regimes and physical stability by regulating the principal factors responsible for these crucial factors.

In compliance with UNESCO's practice, cave art is the primary Outstanding Universal Value (OUV) of the sites considered here. However, it is acknowledged that all these sites also embody several other heritage values, such as their speleological, speleobiological and hydrological significances. Overall, it is considered that similar policies best serve the preservation of these values.

4. Description and recent history of the sites

Australian cave art sites are limited to the continent's southern coastal or near-coastal regions and Tasmania. All occur in limestone caves. Petroglyphs (made by a reductive process) dominate numerically, while pictograms (paintings or stencils) occur only in eleven of the sites (Table 1). The two types of cave art are found together in only two places, and in one, the pictograms can only be detected under UV light.

Most Australian cave art sites have been located in the Mount Gambier karst region, where Tertiary limestone is exposed extensively between Portland and Millicent. Hundreds of caves exist in the region, of which only a tiny percentage, forty, are endowed with rock art. Morphologically these sites include marine caves, tunnels formed by underground rivers, and passages formed along fault lines. Many sites have been affected by the significant fluctuations of aquifer levels caused by sea-level changes. Present-day access to Australian cave sites varies greatly, ranging from horizontal walk-in passages to sites no longer permitting human access without artificial means, such as steel ladders or belayed descent. The cave art sites range from small caves of just a few metres in depth to major systems of

No.	Site name	Region	Contents								
			Finger fluting	Karake petroglyphs	Tool marks	Deep pits	Shallow engravings	Recent petroglyphs	Pictograms	Chert mining	Occupation
1	Koonalda Cave	Nullarbor	3		2					3	3
2	Abrakurrie Cave	Nullarbor							2		2
3	Murrawijinie Cave No. 1	Nullarbor							3		3
4	Murrawijinie Cave No. 3	Nullarbor							2		1
5	Knowles Cave	Nullarbor							2		2
6	Orchestra Shell Cave	Perth	3		1						2
7	New Guinea 2 Cave	Buchan	2		1				1		3
8	Cloggs Cave	Buchan							1		2
9	Malangine Cave	Mt Gambier	2	2			1	1		1	3
10	Koongine Cave	Mt Gambier	2	1	1	1	1			1	3
11	Gran-Gran Cave	Mt Gambier	2						1	3	
12	Koorine Cave	Mt Gambier	1							2	
13	Marmine Cave	Mt Gambier	2								
14	Karake Cave	Mt Gambier	2	2			1				1
15	Karlie-ngoinpool Cave	Mt Gambier	3	3		3	3			3	
16	Walnut Cave	Mt Gambier		1							
17	Prung-kart Cave	Mt Gambier	2							2	
18	Snake Hill Cave	Mt Gambier	2								
19	Wando Cave	Mt Gambier	1								
20	Drop Drop Cave	Mt Gambier	2								
21	Karra Cave	Mt Gambier	2								
22	Murna Cave	Mt Gambier	1								
23	Kra-we-al Cave	Mt Gambier		2							
24	Paroong Cave	Mt Gambier	1	3	1	2					1
25	Snowflake Cave	Mt Gambier	2		1						
26	Mooraa Cave	Mt Gambier	1	2				1			
27	Nganap Cave	Mt Gambier	2								
28	Nung-kol Cave	Mt Gambier	2	2	3						
29	Mandurah Cave	Perth	1		2						
30	Kooramo Cave	Mt Gambier	2								
31	Kooraa Cave	Mt Gambier	1	1							
32	Mar-e Cave	Mt Gambier	1	1							
33	Kurt Cave	Mt Gambier	1								
34	Boopeo Cave	Mt Gambier	1								
35	Mushroom Cave	Mt Gambier	1								

36	Wargata Mina (Judds C.)	Tasmania							2		
37	Ballawinne Cave	Tasmania							2		
38	Keyhole Cavern	Tasmania							1		
39	Riveaux	Tasmania							2		
40	Middle Cave	Perth	1								
41	Ngrang Cave	Dartmoor	1		3	3		1			2
42	Wirlap Shelter	Dartmoor		1					1		
43	Marmon Cave	Mt Gambier	1								
44	Ya-lo-ing Cave	Dartmoor	1								
45	Kra Cave	Dartmoor	2		2						
46	Kriton Cave	Dartmoor	2		2						
47	Kapen-karo Cave	Dartmoor			1						
48	Yaranda Cave	Dartmoor	3		1	1					
49	Bat Ridges BR6	Portland					2				
50	Bat Ridges BR2	Portland					2				
51	Mirnat Cave	Dartmoor		2							
52	Ulul Cave	Mt Gambier	2				1				
53	Yambuk Cave	Portland	1								
54	Mootha Cave	Mt Gambier	2	3							

Table 1. *The known cave art sites of Australia (adapted from Bednarik 1990). The defined contents are 1 = rare; 2 = intermediate; 3 = large quantities.*

many hundreds of metres. Five contain exposed bodies of water today, which may have been one reason for human entry in the distant past. Another indication of human attention is the presence of chert mining evidence in seven of the caves with rock art. Several of the sites served Aborigines as occupation sites, and in at least one case, European settlers too.

The Nullarbor sites occur on the world's largest karst, consisting mainly of Lower Miocene Nullarbor Limestone, a hard, crystalline, well-jointed biosparite 15–30 m thick. This is underlain by the Upper Eocene Wilson Bluff Limestone, a friable, highly permeable biomiorite of over 200 m thickness in the Nullarbor's central part. The nature of the friable and more soluble lower facies has given rise to substantial cave systems along the top of the aquifer.

The main corpus of Australian cave art sites occurs in the Gambier Limestone, which ranges in age from the final Eocene through the Oligocene and the first half of the Miocene. The Mount Gambier karst occupies much of the western Otway Basin, a geophysical feature extending from Robe in the west to Mornington Peninsula in the east. It is underlain by Cretaceous sediments and punctuated by four clusters of geologically recent volcanic vents (Sheard 1983). These erupted more than 20 000 years ago (Mt Burr Range), during the early Holocene (Mt Schank) and between 4000 and 4300 years ago (Mt Gambier). An archaeologically important feature of the uppermost (early Miocene) limestone is the occurrence of several horizontal strata of chert deposits, which are frequently exposed along the present coast (Bednarik 1980). The Nullarbor limestones also contain sedimentary silicas, e.g. at Koonalda Cave, but these are chalcedonic.

Australian cave art occurs in five regions, some of which have only produced a few sites (Fig. 1). Sites in the Chillagoe-Mungana area of north Queensland are omitted here as the rock art there is thought not to occur in zones of speleoclimate. Although eleven of the sites have yielded clear evidence of human occupation (other than wall markings), and five of these have been, to some extent, excavated, the archaeology in these regions remains relatively poorly connected to the rock art. Most of the archaeological data are not directly relevant to the cave art as the sites were frequented at various times, and the cave art cannot be convincingly related to any of the occupation phases. It may even relate to none of them. In some cases, the occupation evidence is probably much more recent than the cave art, e.g. in Orchestra Shell Cave, where the occupation stratum is in a deposit formed after floor subsidence. In contrast, the rock art antedates the time of that collapse (Bednarik 1978/88). At Malangine Cave, the excavation was abandoned because rabbit burrowing had rendered the stratigraphy unreliable (Frankel 1986). At Koongine Cave, the cave art predates the extensive

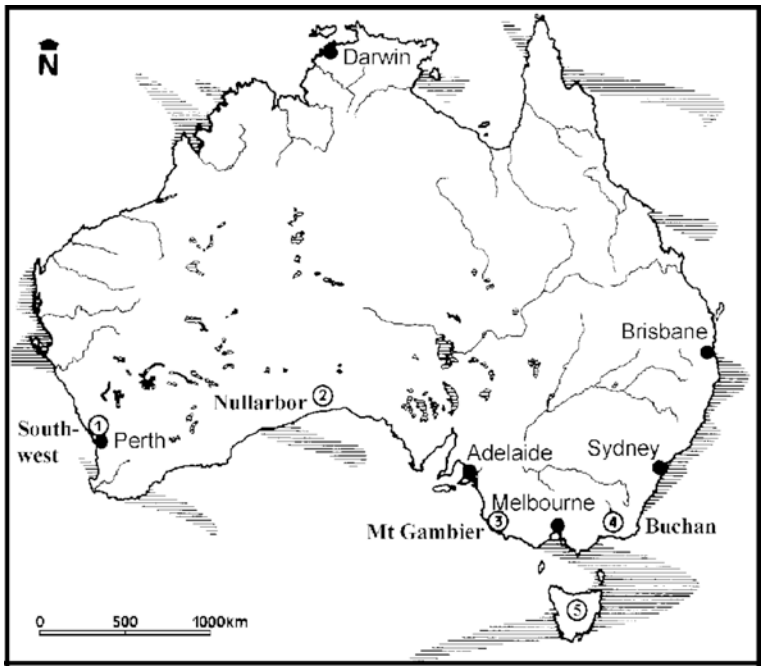

Figure 1. *The five areas of occurrence of Australian cave art.*

ceiling collapse, which prevented excavation beyond the lowest Holocene sediments (Bednarik 1989).

Scientific dating of the cave art remains limited to direct dating results obtained from Malangine Cave (Bednarik 1984) and Prung-kart Cave (Bednarik 1998, 2022: Fig. 1); and the indirect dating evidence from Orchestra Shell, Yaranda, Koonalda and Koongine Caves; while the data from Wargata Mina are not credible. However, there is ample potential to secure direct dating from several of the sites, including minimum dating of underground silica mining. Nevertheless, these opportunities have so far been neglected.

The first recorded report of cave art in Australia is the re-discovery of Koonalda cave art by Adrian Hunt in 1957 (Gallus 1968). However, there can be no doubt that in various cases, cave art occurrences were noticed earlier by a variety of non-Aboriginal people, including early settlers and land surveyors. The cave art in Koongine and Malangine Caves had long been known to T. D. Campbell, R. Black, G. D. Aslin, T. McCourt (1975: 30) and N. Tindale. However, it was through the PMP, begun in 1980, that the majority of the cave art sites known today in Australia were re-discovered in the course of a systematic search over many years. Of particular importance in this was the reconnaissance work conducted by Aslin (Fig. 2), one of the principal researchers of the PMP. He applied his thorough knowledge of the Mount Gambier region to search for cave art sites. Throughout the 1980s, dozens of sites were thus added to the register in the Mount Gambier region.

In 1980, the PMP introduced the practice of providing most newly re-discovered sites with names in the local Boandig people's language (Smith 1880) unless there was a well-established name already. The translations of these thirty-one names are as follows: Malangine = my wife, Koongine = my son, Koorine = my daughter, Marmine = my father, Karake = marks, ornamental carving, Karlie-ngoinpool = many, plenty, numerous, Prung-kart = the root of a tree, Wando = one, Karra = fern-leaved wattle, Murna = hand, Kra-we-al = we two will share together, Paroong = abundant, Mooraa = wombat, Nganap = husband, Nung-kol = these two, Kooramo = large possum, Kooraa = tea tree, Mar-e = a female kangaroo, Kurt = inland, Boopeo = on the hill, Ngrang = a hole in the rock, Wirlap = ochre, Marmon = white, Ya-lo-ing = dreaming, Kra = water well, Kriton = scratching, Kapen-karo = sunset, Yaranda = sweep, Mirnat = bulrush, Ulul = small housefly, Mootha = blackwood tree.

5. Ownership and management

Australian cave art sites occur on privately owned or leased grazing land, in national parks and other reserves of public land, and on land dedicated to the commercial production of *Pinus radiata*. The complexity of this mosaic of ownership and management is increased because different entities operate in different states. For instance, different operators of pine plantations exercise control in various regions, and sites on privately owned land are, in nearly all cases, owned by different individuals. Different entities administer the few sites subject to existing management measures. Moreover, the sites occur on the traditional land of several different Indigenous groups. It is almost universally recognised today that their Traditional Custodians should ultimately control the sites' management.

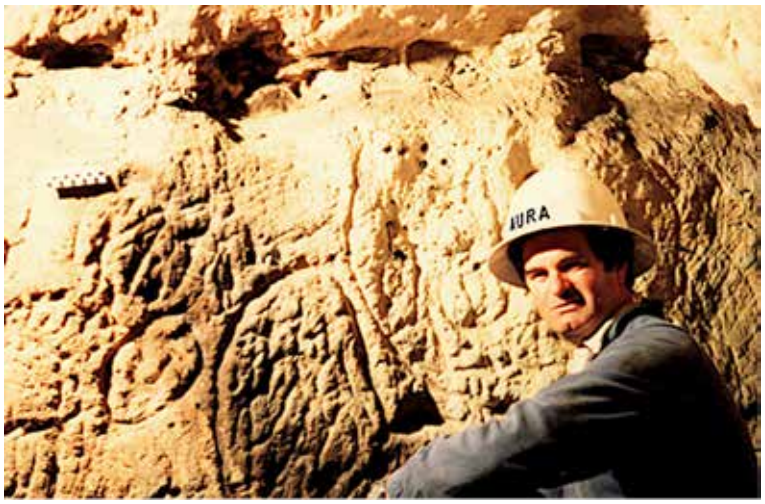

Figure 2. *Geoffrey D. Aslin in Karlie-ngoingpool Cave. Note the seam of fractured chert nodules in upper part of image.*

From a management and conservation perspective, all these sites are connected: they are all limestone caves, are subject to identical or similar preservation conditions and threats and need to be uniformly managed to ensure their safeguarding in perpetuity. Therefore, a management plan that forms a nexus between the interests of the landowners/managers and those advocating the cave art's preservation is required, meeting the requirement of providing ultimate management control to the Indigenous communities.

Figure 3. *Well-preserved finger flutings in Prung-kart Cave.*

The present state of conservation differs significantly among the sites, ranging from superbly preserved rock art to wall markings in such a poor state that only specialists in the field can detect them. There can be no doubt that the surviving corpus represents only a tiny remnant of the repertoire of Australian cave art that must have existed in the past. Efforts to preserve this cultural heritage range from exemplary existing protection to very minimal safeguards. At the upper end of this scale are the few sites with fully effective control of human access, combined with measures to create the best possible preservation conditions for the rock art in terms of hydrology, speleoclimate and other environmental conditions. The overall aim of the management plan is to facilitate conditions that would achieve circumstances conducive to securing maximal favourable effects for all cave art sites. These would need to address the regulation of human and animal access, vegetation regime, speleoclimate, rock and surface hydrology, aspects of land use, entrance morphology and microbiota.

6. Australian cave art

A simplified taxonomy of Australian cave petroglyphs as it is currently understood identifies six basic classes:

A. *Finger flutings* occur on formerly soft calcite deposits, which in all but two sites are of a secondary, i.e. reprecipitated carbonate (moonmilk, *Mondmilch* or *Montmilch*). This speleothem, consisting of a microscopic, fibre-like lattice of calcite crystals, can absorb a great deal of moisture and be as soft as snow. These white cave deposits were extensively marked (in France, Spain, Austria, Russia, Dominican Republic, New Guinea and Australia), and they survived in some cases through desiccation or carbonatisation of pore spaces (Bednarik 1980, 1999). Only 74 sites of this form of cave art are known worldwide, of which 37 occur in Australia, most of them within 80 km of Mount Gambier. The finger flutings are among the earliest forms of intentional marks on rock surfaces that have survived to the present (Fig. 3).

Figure 4. *Deeply carved Karake genre petroglyph, Paroong Cave.*

B. *Karake genre:* these petroglyphs are deeply abraded (up to 40 mm deep) and often probably pounded as well (Fig. 4). Circles and cell-like or reticulate arrangements dominate motif types. The circles are usually under 50 cm but may range up to about a metre in diameter, while the panels of mazes may extend over several metres. Motifs also include parallel lines, arcuate designs, 'convergent lines motifs' (including the 'trident' but also with two, four or five 'toes' which are not necessarily connected at the point of convergence), wave lines, circles with internal design (vertical barring or lozenge lattice), and radial and dot arrangements (cupules). This motif range has many parallels in other Australian rock arts, which are frequently considered to be of Pleistocene age. It is also similar to that of pre-iconic rock art globally. Several Australian sites have provided good evidence for such Pleistocene antiquity

Figure 5. *Tool marks in Koonalda Cave.*

Figure 6. *Deep pits or cupules in Ngrang Cave.*

C. *Tool marks:* there is no indication that these are utilitarian and, in contrast to the Karake motifs, which are found on walls only, they are as likely to occur on ceilings (Aslin and Bednarik 1985). They may form groups of sub-parallel lines or occur as apparently unstructured assemblages. However, they occasionally form patterns such as lattices (Fig. 5). The tool material used in their production has been identified at two sites by microscopy (Nungkol and Mandurah Caves). Tribological analysis has provided much information about production sequences (Bednarik 1987/88, 1992a).
D. *Deep pits:* traces of a widespread activity in which a soft rock, such as a cave wall, has been extensively marked by a non-utilitarian but quite specific percussion activity that resulted in panels of deep gashes, including the highly distinctive, pocket-shaped 'deep pits' (Fig. 6). This phenomenon has been extensively studied by replication work in Ngrang Cave (Bednarik and Montelle 2012), but it is not restricted to caves and has not been widely recognised at open sites, where it occurs in the form of cupules (Bednarik 2008).
E. *Shallow engravings:* usually incised with single strokes of a pointed tool, these are frequently responses to earlier designs of which they are sometimes copies. The 'shallow engravings' occur at very few cave sites and are separated from the preceding Karake style by a substantial layer of cutaneous calcite precipitate in Malangine Cave.
F. *Recent petroglyphs:* occur at only two of the cave sites and only at the entrances.

Cave paintings (pictograms) have only been reported from eleven Australian cave art sites, and most of these sites feature only relatively small corpora. Large-scale pictogram sites in limestone caves, such as those known in south-western Europe or south-eastern Asia, do not occur in Australia, where petroglyphs of several types greatly dominate cave art.

7. Significance

The significance of Australian cave art as embodied in its Outstanding Universal Values (OUV) is essentially fourfold. To the descendants of its creators, it represents a powerful and tangible link with their past and land; and a manifestation of their ontology and ancient laws. To the nation, it is a prime cultural heritage of world standard and a stark reminder of the First Australians' enduring culture. To humanity at large, it is an integral component of its origins myths and one of very few surviving cultural remains of the world's Pleistocene civilisations. To researchers, it is a source of crucial scientific evidence that can provide insights into the cognition of early human societies, as significant as the European Palaeolithic cave art contemporary with it. In short, Australian cave art is utterly unique, irreplaceable and of incalculable value. However, it is also fragile and endangered, a residue that survived many millennia to confront us with an unimaginably remote world.

Whereas we tend to see much of European Pleistocene rock art as comprehensible to us (a largely mistaken reaction, conversely; this derives from the often near-naturalistic iconographic component of these traditions), we experience Australian rock art of the same age as too remote to 'communicate' with it. Research has shown that it bears witness to intense human experiences, providing evidence for great time investments or complex ritualistic behaviour of depth that non-Aborigines cannot begin to comprehend. Of all the earliest art-like systems in the world of which traces have survived the ravages of time, Australian

cave art is perhaps the most inaccessible today. This is not because it is simple or primitive but because it is conceptually too complex to grasp. It probably relates to constructs of reality that differ significantly from that subscribed to today.

Although some of the Australian cave art has been demonstrated to postdate the Pleistocene (especially in Prung-kart Cave; Bednarik 1998), it has been established that a significant part of it is of the Pleistocene. In Europe, cave art is safely dated to up to 40 000 years before the present, although there are recent greater but controversial age claims. Some of the Australian cave art is of similar antiquity; for instance, one tentative but controversial analysis suggests that the intermediate of the three rock art phases of Malangine Cave is considerably older than 28 000 years (Bednarik 1995). This result might appear confirmed by the evidence from other sites where megafaunal claw marks were superimposed over cave art, and the megafauna is thought to have faded out between 50 000 and 20 000 years ago (Miller et al. 1999; Gillespie 2004; Rule et al. 2012). For instance, some human markings in Yaranda Cave, part of a very complex design, predate claw marks of *Thylacoleo*, a carnivore thought to have become extinct around 46 000 years ago (Roberts et al. 2001) (Fig. 7). This is currently the earliest securely known cave art in the world, exceeded in age only by open-air petroglyphs in India (Bednarik et al. 2005) and Africa (Bednarik 2013; Beaumont and Bednarik 2015).

Figure 7. *Complex design made of finger flutings in Yaranda Cave, probably over 46 000 years old.*

Although the cave art is the OUV and the uniting factor of the sites under review, other values are also associated with these caves. As indicated in Table 1, seven of them feature evidence of underground chert mining, which in five of them has been defined as extensive and is all provisionally attributed to the Pleistocene (Bednarik 1990, 1992b). This is another outstanding feature, considering that only nine sites of Pleistocene underground mining are known worldwide. Many Australian caves with rock art also contain horizontal seams of chert or other silica, which the First Australians eagerly sought before the nearby massive coastal deposits became available after the Pleistocene. Evidence secured in these sites provides most of the knowledge we have of very early underground mining technology, when miners often worked in darkness, no doubt using torches for lighting. Once again, this evidence is virtually unique in the world.

In addition, many of the cave art sites have been shown to contain occupation evidence in their floor sediments. Six have been subjected to archaeological excavations: Koonalda (Gallus 1971; Wright 1971), Orchestra Shell (Hallam 1977), New Guinea II (Ossa et al. 1995), Clogg's (Flood 1980), Malangine and Koongine Caves (Frankel 1986; Bednarik 1989). In Koonalda Cave, occupation evidence is bracketed between 15 000 and 31 000 years ago, while the rock art in Orchestra Shell Cave predates the early Holocene floor subsidence. The cave art in New Guinea II Cave remains undated, while that of Koongine Cave predates the massive ceiling fall towards the end of the Pleistocene. The two early cave art traditions of Malangine Cave are of the Pleistocene, and this also seems to apply to much of the rest of Australian cave art. The occupation and economic use of deep caves, especially evident in Koonalda, coincides chronologically with similar practices extensively documented in south-western Europe.

Finally, the cave art sites of southern Australia also feature speleological and speleobiological values, which in various cases are relatively pristine. These include several forms of speleothems, extensive galleries of animal markings (Bednarik 1991a), fossils embedded in cave walls and historical inscriptions (many of them with dates), as well as geological evidence and speleomorphological features.

8. Management assessment

The devastating effects of human visitation in European cave art sites, such as Lascaux and Altamira, have already involved large expenditures in remedial work. It is essential that the mistakes made there, mainly in the 1950s and 1960s, not be repeated in Australia. No Australian cave art site is suitable for tourism because of the particularly fragile nature of this phenomenon, and often also due to access difficulties and unstable conditions. Cave art is susceptible to the effects of human visitation (including raised levels of carbon dioxide, temperature and relative humidity, and the introduction of microorganisms, spores, fungi etc.). In Europe, the alternative of creating facsimiles has been economically the most successful. For instance, the cost of constructing Lascaux II, US$8 million, was

Figure 8. *Addressing fungal infestation in Lascaux Cave, France (photo credit: CNP/Ministére de la Culture et de la Communication).*

unexpectedly recouped within three years. However, well over 40 years after the original site was closed, biologists are still battling the infestation by *Fusarium* and *Ulocladium* species at great expense (Fig. 8). Other cave art facsimiles have been established, and recently a facsimile of Chauvet Cave was constructed at the cost of US$50 million. The construction of Lascaux IV even cost US$70 million. The original Chauvet Cave is only entered by researchers. The cave art sites of France and Spain are now rigorously protected, and those of Australia are just as important and need to be preserved at a similar level.

Primary threats:

a. Inappropriate land use: cave art has survived for millennia in a specific natural environment, which implies that this provides the best conditions for its continued existence. Therefore, recent changes, e.g. in the vegetation regime (grazing, deforestation, pine plantations), can be detrimental and, in several cases, have been demonstrated to be so.
b. Uncontrolled visitation: the caves are visited by casual as well as regular visitors (e.g. cavers, cave divers), who are often unaware of the cave art or its heritage values. Unintentional wall damage and occasional graffiti have occurred.
c. Uncontrolled modifications to caves or their catchment areas: this can include aspects of land use but also misguided measures intended to protect the sites.
d. Changes to the hydrological regime affecting the cave: both surface runoff and phreatic aspects need to be considered.
e. Legislative protection: is inadequate and invites neglect.

Minor threats:

a. Animal action, especially by introduced species (e.g. foxes, livestock, bees).
b. Microbial action.
c. Modification of speleoclimate, e.g. through alterations to the entrance morphology.
d. Deposition of dust, airborne matter (spores, pollen etc.), aerosols.
e. Effects of researchers' activities.

Severity of threats

These threats and their relative severity differ according to the conditions faced by each site. However, the following generalisations can be listed, roughly in descending order of importance to the cave art's preservation:

a. Uncontrolled human visitation (physical damage, graffiti, the introduction of microorganisms and other biological elements, carbon dioxide level, relative air humidity, temperature change).
b. Changes to the site's hydrology or speleoclimate (through vegetation, entrance modification, alterations of water catchment area).
c. Inappropriate modifications to the site (management measures, excavations, deposition of refuse).
d. Changes to the cave's physical stability (penetration by tree roots, especially of *Pinus radiata*, change in aquifer level).
e. Alterations to external conditions impacting the cave (road construction etc.).

One of the most favourable conditions for the preservation of cave art sites in Australia is that the locations of most of them are not publicly available. They are not shown on maps, and academic publications discussing them provide no details on their locations in most cases. Many localities are only known to three or fewer people, which greatly adds to their protection. Some have challenging access or occur in relatively remote places, and their access involves considerable logistic efforts. These conditions augur particularly well for the continued survival of cave art.

Another favourable factor is that the views of the landowners and managers concerning the need to ensure the long-term survival of the cave art are generally positive. Guidance is required, however, on the best practices to provide the most favourable conditions.

Examples of interventions

8a. To illustrate the accommodating disposition of land managers, Ngrang Cave provides a good example. After the cultural and scientific importance of the site was brought to their attention, and the danger posed by the pine trees above the cave passage explained (pine tree rootlets are very effective in

penetrating through limestone in the search for moisture), the land managers (HVP Plantations) took the initiative of removing all pine trees above the cave passage and >20 m either side, creating a conservation reserve of over one hectare.

8b. Paroong Cave, in a grazing paddock owned by John Hunt, was subjected to extensive salvage operations to reinstate pre-colonisation conditions (the cave had been partly filled in; Bednarik 1988). Hunt not only allowed this work to proceed, but he also participated in AURA's recovery project and created a small reserve above the cave, fencing it and planting it with original vegetation.

8c. Access to Koonalda Cave had become impossible since the floor of the massive entrance sinkhole subsided, probably as long as 15000 years ago. Today, entry is by descending a steel ladder to which access is controlled. In addition, the site has always been well protected by its remote location on the Nullarbor karst plain. Nevertheless, vandalism has occurred recently in Koonalda (Rachwani 2022).

8d. Similarly, New Guinea 2 Cave is well-protected by its remoteness in dense bush country and by the installation of a substantial steel grille at the time of Paul Ossa's excavation campaign.

8e. At Prung-kart Cave, it was discovered that the roots of a pine tree above the cave had reached the cave art panel, and a network of fine rootlets was beginning to prise it away from the cave's ceiling. The land managers (South Australian Forestry Corporation) immediately removed the trees above the cave and also installed a lockable steel grid over the entrance, effectively monitoring access to the site.

8f. At Gran Gran Cave, a small reserve was created in the vicinity of the site, and the cave's entrance was closed by the Millicent Field Naturalists Society with a lockable grid. The South Australian Forestry Corporation also monitors access here.

8g. Malangine and Koongine Caves, located in a privately owned grazing paddock, were initially closed by a temporary barrier. Upon assuming responsibility for the important sites, the South Australian Department of Environment and Natural Resources installed electrified fences around the entrances, powered by solar panels. These protection features were not maintained and are now ineffective, exposing both sites to further neglect and vandalism (G. D. Aslin pers. comm. 2022).

9. Management strategy and policies

The aim is to establish a framework that will ensure the perpetual and sustainable preservation and protection of the cave art sites within the guidelines of internationally accepted conventions. The consensus is that rock art, irrespective of its location, is best preserved under strictly managed conditions and with controlled and limited visitation (e.g. Ray and Ramanathan 2002; Orbaşli 2013). As none of these sites is suitable for tourism, for various reasons, an essential element of their management is to keep human visitation to the lowest realistic levels.

The *Burra Charter*, the Australian instrument of determining management rationales for cultural monuments, emphasises the importance of the 'fabric' of the site, i.e. the totality of the physical material of the site (e.g. clauses 1.6 and 1.7), as does the Code of Ethics of the International Federation of Rock Art Organisations (e.g. clause 6.2). Therefore, the underlying rationale is the restoration of pre-European environmental conditions, where appropriate, and to maintain these as closely as possible.

Every cave is the outcome of long-term formation processes intimately related to the surface morphology, i.e. the surrounding landscape. Some of these contextual variables may have been affected by modifications postdating European occupation. For instance, roads or quarries may have been constructed in the vicinity, cave entrances may have been modified, caves may have been used as refuse depositories, and surface runoff and drainage patterns were frequently modified. The vegetation has, in most cases, been significantly altered, especially from indigenous bushland to grazing or pine plantations. Since all such changes are likely to affect the caves below ground, one fundamental management strategy is that in managing the landscape setting of the site, it should always be endeavoured to recreate, as closely as possible, the conditions believed to have applied at first European settlement (Bednarik 1988, 1991b).

Land-use policies are of crucial relevance to cave art preservation. In the vicinity of such sites, the following policies need to be observed:

a. Where the land use involves *Pinus radiata* plantations, all pine trees above the cave passages and within 10 m of them need to be felled. Pine trees are notoriously efficient in extracting water in bedrock and tend to develop fine rootlet systems in the speleothems of cave walls. This has already caused catastrophic exfoliation of rock art in one site (Prung-kart Cave).

b. Caves located on grazing land benefit from reinstating pre-colonisation vegetation regimes, especially where water runoff that was previously soaked up by flora now discharges into the cave (the Paroong Cave recovery provides the best example; Bednarik 1988) (Fig. 9). Where the entrance part of the cave permits the access of domestic animals, it needs to be secured by a fence or grid. Such installations must be designed to permit the passage of native fauna, especially bats.

c. The installation of protective fences and grids should be monitored by cave art conservation specialists to ensure compliance with all requirements of protecting the rock art.

d. Modification of caves, especially to their entrances, can have significant effects on cave climates (Bednarik 1988), which has, in one case, led to substantial exfoliation of laminar speleothems bearing rock art

Figure 9. *Paroong Cave protective structure.*

(Malangine Cave).

e. Many caves in the Mount Gambier karst contain significant deposits of refuse (household and industrial rubbish, remains of animal cadavers, fencing materials, construction debris etc.). Their possible impacts on cave art are to be evaluated. If no deleterious effects are detectable, for instance, on the speleoclimatic or microbiological regimes, removing such material is not a priority. It contributes to the protection of the sites by deterring visitors from entering, and the removal of large quantities of rubbish is likely to cause further damage to cave walls.
f. Where it is decided that the refuse deposits are hazardous to the cave art, their removal needs to be carefully planned. It must proceed by applying logistics and methods to protect the cave walls from physical damage.
g. Australian cave art sites are unsuitable for sightseers, casual visitors and tourists. Cave divers and speleologists need to be made aware that their equipment can damage cave walls and may be excluded in specific narrow spaces.
h. Any structures installed in cave art sites must comply with best international practices in design and material.
i. Any modifications made to cave art sites will only be undertaken after a careful review of all relevant factors and approval by the relevant Traditional Custodians.
j. The extent of the protection zone at each cave art site must be determined per local geology, geomorphology, known cave morphology and meteoric water drainage regime.

As noted above, five of the Australian cave art sites have been subjected to archaeological excavations. Although providing relevant background information, this work has resulted in definitive information about the rock art in only one instance, in Koongine Cave, where excavation demonstrated that the ceiling collapse that postdates the rock art occurred in the final Pleistocene (Frankel 1986; Bednarik 1989). Since it can be expected that the archaeological methods of future centuries will be more advanced than those of the present, it is preferable to limit excavations to projects with clear research designs that regard rock art as central rather than peripheral. The relevant Traditional Custodians and the cave art management agency will need to approve such archaeological work.

Future research at Australian cave art sites will be focused on forensic science-guided projects addressing specific questions about the rock art: its antiquity, how it was produced (Bednarik and Montelle 2012; Bednarik 2016), the tools used in its creation, how taphonomic processes have affected the cave art, and how to best conserve it. Archaeology is not well equipped to address such issues, and rock art only becomes an archaeological issue after its approximate age has been determined. Therefore, research in these sites should primarily focus on issues related to conservation and preservation, including those of speleo-microbiology, speleoclimate, diagenesis of speleothems, hydrology and general processes of speleogenesis. This may also include the research of management practices and may eventually involve the establishment of a 'laboratory cave' similar to the initiative taken in France.

Visitors of Australian cave art sites should be limited essentially to three categories:

1. Aboriginal people, especially descendants of local communities that once held the land on which the sites occur.
2. Researchers who are engaged in bona fide research involving cave art. Since the sites' exposure to humans needs to be reduced, the relevance of their proposals to the priorities of cave art management needs to be established.
3. Special interest groups are those who have a bona fide reason to want to enter the cave art sites without being either Indigenous custodians or researchers. These could include various possible groups, for instance, a film crew that works on a project requiring film material from a site or facsimile builders who will create a copy of the rock art. In all such cases, the cave art management agency should review such proposals, and final approval needs to be by the relevant Traditional Custodians.

The general public has a right to be informed about the cave art sites (subject to Aboriginal custodians' approval), and there are various options available to achieve this without cave tourism:

A. Popular books about this important Australian cultural heritage can and should be produced.
B. Film programs have been and should continue to be made to inform the general public about it.
C. The inclusion in the school curriculums of all rock art, not just cave art, in some form or other, needs to be improved.
D. Some cave art facsimiles are already on public display in the centre of Mount Gambier and should be followed by further examples and, ultimately, by full cave art replicas of the type created in France and Spain for mass tourism.

The relevant cultural heritage protection legislation needs to be reviewed to ascertain whether any of its provisions require revision to accommodate the particular prerequisites of cave art preservation. Where such needs are identified, supportive public officeholders should be petitioned to introduce the required legislative changes.

The primary responsibility for implementing this management plan should be with a specifically created cave art management agency chaired by Traditional Custodians.

10. Summary: proposed actions

a. *Site setting*: wherever possible, the environmental conditions previous to European settlement need to be reinstated. At sites located in pine plantations, the pine trees need to be replaced with original vegetation within the protection zone.
b. *Visitation*: will be limited to Traditional Custodians and cave art researchers. Other visitors need approval from the cave art management agency. Human visitation is to be restricted to the minimum frequency and minimum durations. Every visit will be followed by an adequate period (to be determined for each site) during which no visits will occur.
c. *Public programs*: school curriculum and tertiary program materials will be provided. The construction of cave art facsimiles in suitable centres should be encouraged. Required protection zones will need to be established for each cave art site.
d. *Legislation*: the need to introduce specific legislation relating exclusively to cave art in Australia will be reviewed in light of successful policies abroad.
e. *Site modifications*: any proposed modification affecting the cave's integrity, including road construction in the vicinity, land use, installation of protective fences or grilles, change to the aquifer level or hydrology etc. will be considered by the cave art management agency.
f. *Protective clothing*: synthetic material overalls to be worn when entering the cave need to be relatively free of microbiota and soil, and taken to the site packed in plastic. Clean helmets and gloves need to be used. Boots to be worn in the cave will arrive clean at the entrance. Sterility will be preserved as much as possible to preserve the cave's natural microbiological and atmospheric conditions.
g. *Replicas*: the cave art management agency will collaborate with and facilitate projects of creating facsimiles for tourism.

Acknowledgments

Special thanks are due to Traditional Custodians Ken Saunders, Damein Bell and Karen Glover for serving on the committee. Numerous other people have contributed to the efforts of designing a management plan for Australian cave art sites, but the following have been involved directly: Geoffrey D. Aslin, Peter Scott, Oisin Sweeney, Ruth Ryan, Adrian Lynch, Troy Horn, Dave Ryan, John Hunt, Kelvin Smibert, Greg Muller, Dr Akin Adetutu, Andy Spate and Dr Keryn Walshe.

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RAR 40-1416