Arts **2014**, *3*, 156-174; doi:10.3390/arts3010156

OPEN ACCESS

arts

ISSN 2076-0752
www.mdpi.com/journal/arts

Review

Pleistocene Paleoart of Australia

Robert G. Bednarik

International Federation of Rock Art Organizations (IFRAO), P.O. Box 216,
Caulfield South VIC 3162, Australia; E-Mail: robertbednarik@hotmail.com;
Tel.: +61-3-95230549; Fax: +61-3-95230549

Received: 1 February 2014 / Accepted: 7 February 2014 / Published: 28 February 2014

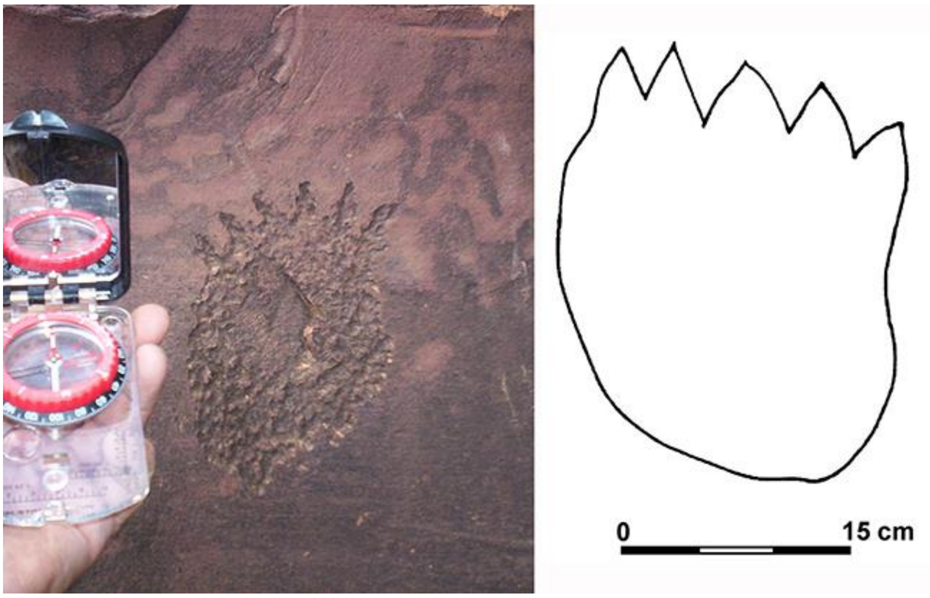
Abstract: Pleistocene rock art is abundant in Australia, but has so far received only limited attention. Instead there has been a trend, begun over a century ago, to search for presumed depictions of extinct megafauna and the tracks of such species. All these notions have been discredited, however, and the current evidence suggests that figurative depiction was introduced only during the Holocene, never reaching Tasmania. Nevertheless, some Australian rock art has been attributed to the Pleistocene by direct dating methods, and its nature implies that a significant portion of the surviving corpus of rock art may also be of such age. In particular much of Australian cave art is of the Ice Age, or appears to be so, and any heavily weathered or patinated petroglyphs on particularly hard rocks are good candidates for Pleistocene antiquity. On the other hand, there is very limited evidence of mobiliary paleoart of such age in Australia.

Keywords: rock art; portable paleoart; Pleistocene; bead; pictogram; petroglyph; Australia

1. Introduction

It has for a long time been suspected that rock art of Pleistocene antiquity occurs in Australia, but for much of the 20th century, 'conclusive proof' remained elusive. Herbert Basedow (1881–1933), a South Australian geologist and medical practitioner, who had also studied ethnology under Klaatsch prior to his return from Germany in 1910, presented the first cohesive arguments for this proposition. In commenting on the petroglyphs of the Yunta Springs (Olary district) and Red Gorge (Flinders Ranges) sites in South Australia, he noted that many are found in places where it would now be almost impossible to work, suggesting that major exfoliation of rock mass must have occurred since the designs were made (Basedow 1914) [3]. He also observed the presence of 'many tumbled blocks of rocks ... bearing part of a design, the other portion of which remained *in situ* on the cliff above'. As a geologist he realized that the dark rust-colored patina he observed on many petroglyphs had to be of some considerable age. Being familiar with the fossil megafauna found at Lake Collabonna, he further speculated that a track petroglyph could represent the extinct Diprotodon (Figure 1).

Figure 1. Petroglyph proposed to depict Diprotodon track, and Basedow's recording of it. The image is far too recent to be of that long extinct creature.



Much later, archaeologists rightly rejected the last proposition, and argued that he had made the right deduction only 'for the wrong reason'. In this they overlooked that Basedow, as a commensurate polymath, lacked their narrow vision and considered the totality of the evidence he perceived in a holistic framework. Most particularly, rock exfoliation or tectonic unloading effects are ongoing processes in geomorphology; they provide a relative chronological framework for a site. Ancient rock art can often be quite realistically slotted into such chronologies, and rough age estimates may well be more reliable than sophisticated dating attempts if they are based on a good grasp of the time-spans involved in geomorphological adjustments and the precipitation of accretionary mineral veneers.

Anthropologist, archaeologist and entomologist Norman Tindale (1900–1993) later also visited Yunta Springs and speculated that images of large bird tracks at Pimba, a site near Woomera, could be indicative of megafauna. He considered a series of such tracks, each about 45 cm long, to be of *Genyornis* (Tindale 1951) [95]. Similarly, Edwards (1965: 229) [47] contemplated the possibility that large macropod tracks on Tiverton Station, also in South Australia, could represent those of *Procoptodon*. Most Australian megafauna had disappeared by around 20 ka (20,000 years) ago, yet similar claims of depictions of extinct species have been made by several others since Basedow's initial suggestion. Mountford (1929; Mountford and Edwards 1962, 1963) [73,75,76] thought that a complex maze at the Panaramitee North site near Yunta depicts the head markings of a saltwater crocodile. That species has never existed in southern Australia, however, and Berndt (1987) [26] subsequently secured an indigenous interpretation of the complex petroglyph, which in fact depicts a magic object (Figure 2). Mountford and Edwards (1962) [75] also reported marine turtle and saltwater fish images from Panaramitee North and Yunta Springs, proposing that they must relate to a time when the sea was much closer to the area. They would have been referring to the retreating Eromanga Sea of the Late Cretaceous period (peaking about 115 million years ago) or the Early Eocene transgression (51 million years ago), as the three Early and Middle Miocene eustatic events of high mean sea levels (Haq *et al.* 1987; Miller *et al.* 1998) [59,70] were not of adequate magnitude to be considered. The Mountford and Edwards proposition is therefore absurd, as humans have only been in Australia for up to 60 ka. More recently there have been suggestions of the depiction of extinct megafauna in Cape York Peninsula (Trezise 1993) [97] and Arnhem Land (Murray and Chaloupka 1984) [79]. Further claims concerning *Thylacoleo* and *Genyornis* followed, but none of them stand up to any critical review (Bednarik 2013a) [22].

Figure 2. Petroglyph from Panaramitee North, supposed to depict a crocodile head, but in fact depicting a *yarida* magical object.

While it is not possible to conclusively exclude the possibility that Pleistocene Australians depicted now-extinct fauna, the likelihood of this is remote, primarily because we lack any convincing evidence that figurative depiction was used at the time most megafauna still existed. As will be contended below, no iconographic (figurative) Australian rock art can be securely attributed to the Pleistocene, whereas there is a great wealth of non-iconic petroglyphs of that period. Moreover, it is fundamentally inappropriate to use Western perception to determine iconic meaning of Aboriginal imagery, and Macintosh (1952, 1977) [65,66] has demonstrated, in the only ‘blind test’ ever conducted on this topic, that such pareidolia-induced identifications are the result essentially of autosuggestion. The only extinct Australian animal species whose identification in rock art can reasonably be accepted, at least in a number of clear enough cases, is the *Thylacine*. Its imagery has been reported from the Pilbara and Arnhem Land. However, before these matters can be considered, several misapprehensions about the antiquity of Australian rock art need to be examined.

2. Misconceptions

Determining or estimating the antiquity of rock art is of fundamental importance to archaeology, because without any notion of its age, rock art cannot be linked to archaeology and is simply not an archaeological resource. Mere co-occurrence with archaeological evidence is irrelevant to this issue, so the only testable common variable to link rock art with archaeology is *time*. Unfortunately, age estimation of both petroglyphs and pictograms remains difficult and generally experimental, and over-interpretation or misinterpretation of scientific dating pronouncements is rife among archaeologists (Bednarik 1996, 2002a; Watchman 1999) [11,16,102]. This applies in all parts of the world where rock art occurs, and is frequently evident in Australia. In some cases, previous statements have been misunderstood or even completely inverted, in others the information was misquoted. For instance Maynard (1979: 93) [69] has this to say about rock weathering and patination:

> Trendall's view [relating to dolerite from Depuch Island], that it takes one million years, seems a little extreme in these circumstances (1964: 88) [96]. In a similar situation in the Negev Desert, Iron Age engravings which are approximately 2,500 years old have not repatinated to match the surrounding rock (Edwards 1971: 361) [48].

This brief comment is crucial to several geomorphological aspects, yet it contains so many errors that untangling them demands detailed explanation. To begin with, Maynard confuses or conflates two issues here: that of *weathering front* formation and that of *patination rate*. Trendall's findings refer to his view of the depth of the weathering zone or 'weathering rind', which is the substrate that has been altered by weathering processes, such as hydration. His estimate was not only correct in terms of order of magnitude, it was even confirmed independently by the more precise work of Černohouz and Solč (1966) [28], whose determinations match those of Trendall (see Bednarik 1979) [5]. Therefore his view is not 'a little extreme'; Maynard has not understood it. Next she quotes Edwards' citation of a statement originally by Anati, concerning the time taken by the patination of a petroglyph. Unfortunately, Edwards misunderstood Anati's key statement, which was:

> In this region we know of no engraved surface from Style IV-B (Iron Age) to Style VII (recent) with a patination identical to that of the original rock surface. This seems to mean that in this area it took a minimum of 2,500 years to reach an "0" shade, the natural color of the patina on the surface of the rock (Anati 1963: 189) [1].

Edwards misrendered this carefully crafted, precise wording by stating that

> no engravings have re-weathered to match the natural dark rock surface. As some of them are associated with the Iron Age, Anati believes it takes a minimum of 2,500 years for a thin, initial surface patination to form in the region (Edwards 1971: 361) [48].

These misunderstandings are in addition to a previous failed attempt by an archaeologist of interpreting Trendall's very clear data (Crawford 1964: 50; see Bednarik 1979: 22 for correction) [31,5], and they have led to further misguided views and discussions, such as a debate concerning the effects of groove depth (or, more precisely, distance between groove bottom and weathering front) on patination rates (see Bednarik 2007: 223) [18].

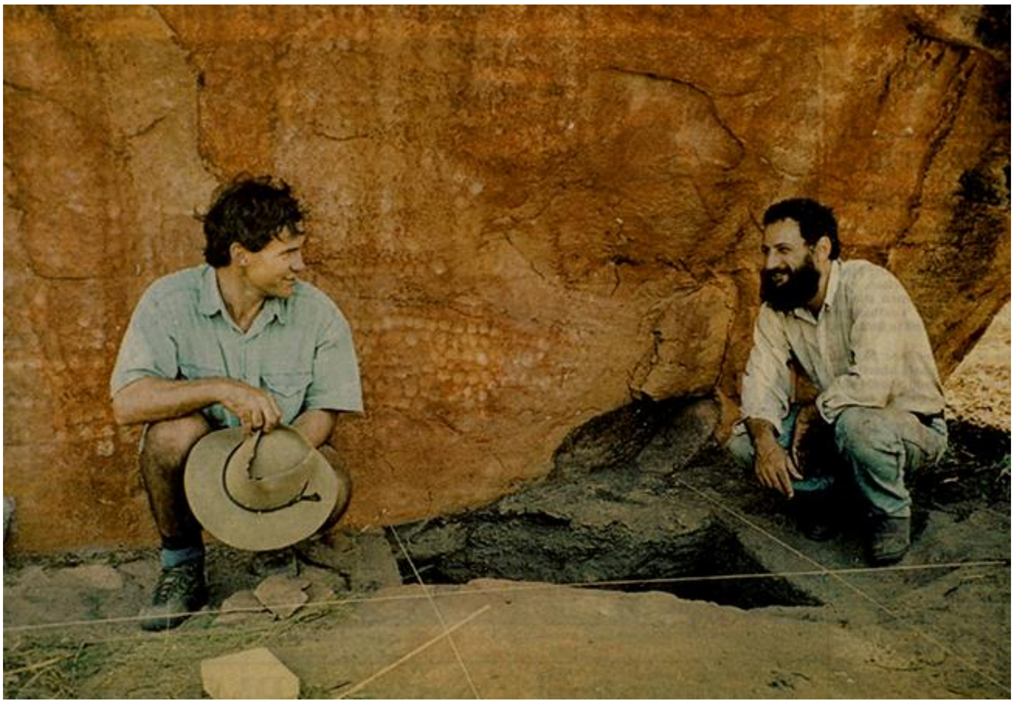
The level of understanding Australian archaeologists have applied to many scientific issues concerning rock art limits their ability to interpret rock art. Several have incorrectly claimed that Dragovich (1984a, 1984b, 1986) [44–46] has dated rock art at Eight Mile Creek, near Sturts Meadows, western New South Wales (e.g., Lourandos 1997: 121) [62]. Dragovich clearly states that her samples were from rock that was not engraved (Dragovich 1984a: 53) [44]. Another example is provided by Loy *et al.*'s (1990) [64] AMS carbon isotope results from what they claimed was blood hemoglobin at two sites, Judd's Cavern in Tasmania and Laurie Creek in Northern Territory. However, the principal analyst of that team, Earle Nelson, reported having second thoughts about these results and returned to Laurie Creek for more detailed analytical work. He found that the reported pigment layer was in fact naturally precipitated iron oxide, and that its organic content comprised no proteinaceous matter, *i.e.*, no blood residue (Nelson 1993) [80]. Although Loy (1994) [63] continued to claim that mammalian IgG was present at the sampling site, his view has been refuted by Gillespie's (1997) [56] subsequent research (see also Tuross and Barnes 1996) [98]. Loy's insistence that there was organic matter present is a meaningless factor, because practically all rock substrates contain natural organic compounds (Bednarik 1979) [5]. This questions also the credibility of Loy *et al.*'s (1990) [64] dating of a pictogram in Judd's Cavern to the final Pleistocene: unless it derives from a specific organic component in the paint residue, it needs to be regarded as a random figure.

The same issue of the ubiquity of organics in rock surface deposits also led to the many mistaken rock art datings by Dorn, in Australia and elsewhere (Dorn 1983, 1986, 1990, 1992, 1994; Dorn *et al.* 1992; Dorn and Whitley 1984; Nobbs and Dorn 1988) [32–36,40,41]. Dorn sought to estimate petroglyph ages by analyzing rock varnishes covering the rock art. He reasoned that weathering should remove the more soluble cations in the varnish more readily than the less soluble. In comparing the cations Ca and K with the supposedly more erosion-resistant Ti, Dorn tried to demonstrate that their ratio was a consistent function of time. To do this he had to calibrate the assumed change, for which he used the bulk carbon isotope ratios of similar varnish close to the sampling site. Although Bednarik (1979) [5] had already demonstrated that the carbon system of ferromanganeous mineral accretions was open to continued exchange of carbon, and that carbon seems to occur in all rock substrates, Dorn claimed for many years to obtain consistently credible age estimations from numerous sites. His sampling of petroglyphs in the Olary district of South Australia yielded spectacular results at several sites, ranging up to about 45,000 years (Dorn *et al.* 1992) [40]. However, an attempt to duplicate his results, using the same analytical methods on the same sites and motifs, produced entirely different results (Watchman 1992a) [99]. This eventually led to the retraction by Dorn of all his results after a 'change of perception' (see also Beck *et al.* 1998; Dorn 1996a, 1996b, 1997) [4,37–39].

Morwood attempted to provide a maximum age for the petroglyphs on a boulder he excavated in Ken's Cave, Queensland, but his illustration of the stratigraphy (Morwood 1981: Figure 7) [72] shows that he misinterpreted the section. ANU-2118 is not as he assumes a maximum age for the deposition of the boulder, it offers in fact a minimum date for that event. Clarke (1978) [29] attributed rock varnish covering many petroglyphs of the Dampier Archipelago to the Last Glacial Maximum, speculating that some might be over 17 ka old. His view was echoed by Lorblanchet (1992) [61], who constructed an elaborate chronology extending more than 18 ka. It was based on a single, questionable carbon isotope analysis of a surface seashell, which has no demonstrable relevance to the rock art. Both Clarke's and Lorblanchet's views are probably false, as there is no clear evidence of a Pleistocene component in the Dampier rock art. Most of it almost certainly relates to the present sea level and there is no occupation evidence older than 7 ka BP known in the archipelago (Bednarik 2007) [18]. Based on their patination, most Dampier petroglyphs are under 4 ka old (Bednarik 2002b, 2009: Figure 9) [17,20]. Nevertheless, recently Mulvaney (2010) [78] has revived the notion of Pleistocene rock art at Dampier, but again without presenting scientific data. For instance, the presumed depiction of *Thylacines* provides no support; the species survived in Western Australia at least until 3 ka ago.

Several other sensational claims concerning the age of Australian rock art have been rejected, such as those concerning the Jinmium petroglyph site in Northern Territory, in respect of both occupation and rock art (Fullagar *et al.* 1996) [51]. The early occupation proposal, of 176 ka, was three times the accepted range of the duration of human presence in Australia, and the petroglyphs were proposed to be 58 to 75 ka old (Figure 3). They are in fact of the Holocene, as is the entire sediment of the site (Gibbons 1997; Roberts *et al.* 1999; cf. Rothwell 1996) [55,86,92].

Figure 3. The cupules of Jinmium, Northern Territory, claimed to be older than the accepted human presence in Australia, but in fact of the late Holocene.



Another example of misconceptions concerns the Gwion pictogram tradition of the Kimberley (formerly called 'Bradshaw' tradition). Watchman *et al.* (1997) [105] produced preliminary data for radiocarbon contents of five paintings that suggested a mid- to late-Holocene age range of these spectacular rock painting traditions (range c. 1,400–4,000 years BP). Roberts *et al.* (1997) [89] applied a very different approach, extracting samples of quartz grains from the mud that had been used by mud-daubing wasps to superimpose a nest over a pictogram. An age of 23.8 ± 2.4 ka BP was proposed for the base of one wasp nest, but as Aubert (2012) [2] shows, only its much younger surface layer conceals the paint residues. Its paleodose is only 7% of that of the nest's earliest layer, suggesting that the age of the pictogram is within the range Watchman *et al.* (1997) [89] proposed. The reasons for this discrepancy are examined in Bednarik (2014) [25].

Also from the Kimberley is the report of an exfoliated rock fragment from Tangalma (the correct name of Carpenter's Gap Rockshelter 1), which is said to be covered with ochre and comes from spit 47, thought to be about 40 ka old (O'Connor 1995) [82]. That would make it one of the earliest known applications of ochre on rock, but the anthropogenic origin of the mineral coating has not been demonstrated (Bednarik 2000) [15].

Portable paleoart of the Pleistocene does occur in Australia, but remain relatively neglected, which in part seems to be attributable to its often sacred roles. There has been a research focus on the postulated 'engraved' limestone plaques from Devil's Lair (Dortch 1976, 1984) [42,43], described as such in numerous publications. Eventually the entire series of six stone slabs was microscopically examined and it was shown to bear taphonomic markings of several types: animal scratches, micro-pitting, exfoliation, kinetic incisions by quartz grains caused by trampling, and fine markings caused by toothbrushes when the specimens were cleaned (Bednarik 1998) [13]. A similar object has been reported from Koonalda Cave (Gallus 1971: 115) [53] which has also been identified as bearing typical animal claw marks (Bednarik 1991) [9].

The error of identifying animal scratches as anthropogenic incisions has occurred numerous times in Australian archaeology, and an early historical example has only come to light recently. Archaeological method is not able to determine the age of rock art, but in some cases has provided minimum datings. The first such result from Australia came from Ngaut Ngaut (Devon Downs on the lower Murray River), where Hale and Tindale (1930: 208–211) [57] distinguished three types of petroglyphs. They attributed the earliest, 'type A', to a technocomplex they called the 'Mudukian', which was later dated to around 3000 BP (Roberts *et al.* 2014) [84]. However, their type A markings consist of densely arranged, randomly orientated shallow grooves, which on close examination are not humanly made, but are claw markings of climbing possums.

3. Pleistocene Petroglyphs in Australia

A first valid minimum dating of Australian rock art was secured by Mulvaney (1975: 185) [77] when he dated the sediment containing petroglyph fragments at Ingaladdi in Northern Territory via radiocarbon to 4920 ± 100 BP (ANU-58) and 6800 ± 270 BP (ANU-60) respectively. Although the fragments were described as weathered, exfoliated sandstone clasts tend to weather below ground, but it is unlikely that the petroglyphs had been executed on rock already eroding at the time. Therefore these mid- to early Holocene dates could reasonably infer final Pleistocene ages of the rock art. However, the first credible evidence for a Pleistocene age of Australian rock art was yielded by Koonalda Cave in South Australia (Gallus 1968, 1971, 1986) [52–54]. There is no direct dating available from the extensive finger flutings in this large cave, but its occupation, mainly for the purpose of chalcedony and chert mining, appears to be limited to the period from about 31 ka to 15 ka. Subsidence of the entrance sinkhole's floor has rendered human access so difficult that there may have been no human presence in the cave during the Holocene. The one date from Koonalda that can be related directly to the finger flutings (there are also a few engravings in the cave) is V-92, around 20 ka BP, which must postdate the cave art by a very considerable margin: it was collected from the surface of the rock fall, but the flutings extend several meters below it.

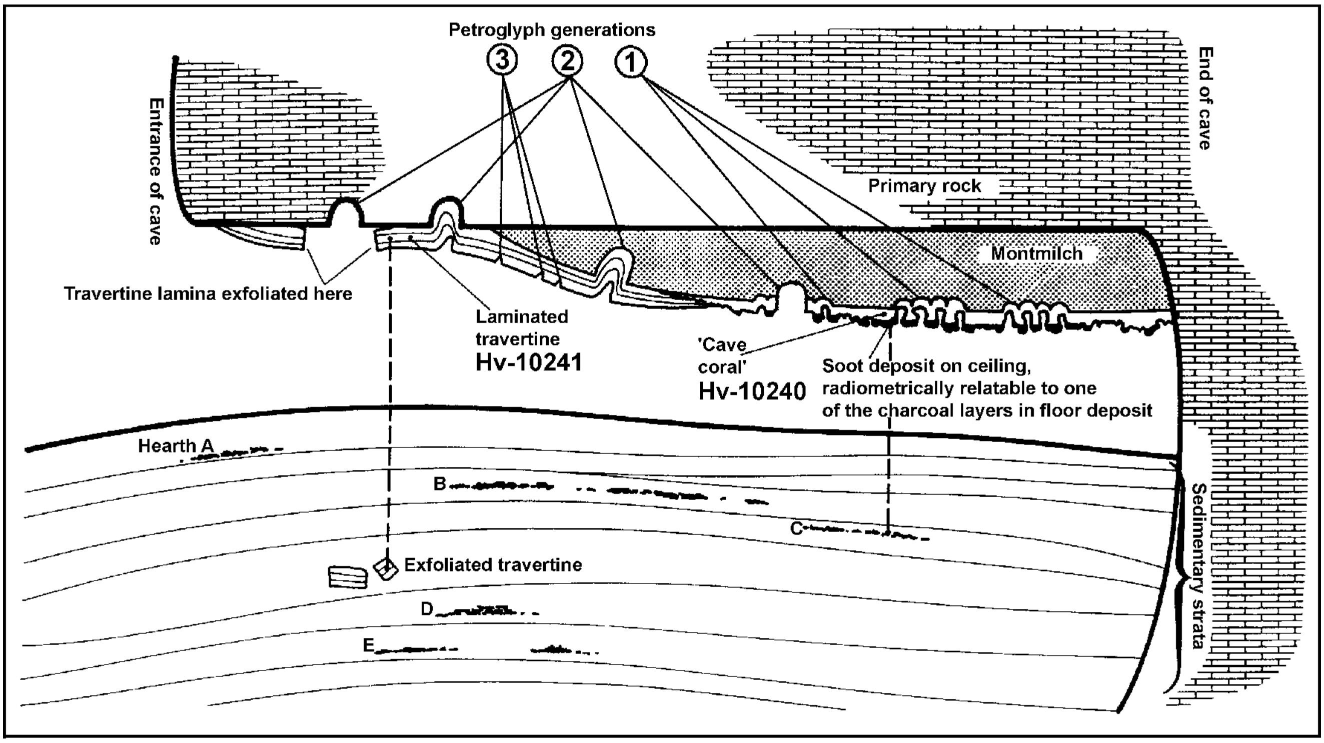
Finger flutings are made with fingers drawn over a soft white speleothem (reprecipitated carbonate), called moonmilk, that may subsequently harden and thus remain preserved (Figure 4). These markings range from simple sets to very complex arrangements forming patterned compositions measuring many square meters. Since the work in Koonalda Cave their Pleistocene age has since been demonstrated in several other Australian caves. The first 'direct dating' of rock art was attempted in 1980 in a site near Mount Gambier in South Australia, Malangine Cave (Bednarik 1984, 1995, 1999) [6,10,14]. The extensive decoration in this limestone cave comprises three widely separated cave art traditions, the earliest being finger flutings. Superimposed over them are deeply carved petroglyphs of a specific range of geometric motifs. In the entrance-near part of the cave, these became concealed by a laminar sheet of calcite speleothem of around 15 mm thickness. The site's third tradition, of shallow incisions, was placed on the surface of this ceiling deposit, thus postdating the cessation of the precipitate's build-up. A radiocarbon date extracted from the deposit of 5550 ± 55 years BP (Hv-10241) was contradicted by a uranium-series date of 28,000 ± 2000 years BP, taken from the same accretion. While carbon rejuvenation is to be expected in such speleothems, the implied magnitude came as a surprise and the issue of the true age remains unresolved. Be that as it may, the deeply executed petroglyphs are almost certainly of the Pleistocene, and the much earlier finger flutings are so undoubtedly (Figure 5).

Figure 4. Finger flutings in Koonalda Cave, Nullarbor Plain, probably between 15,000 and 31,000 years old.

The cave art sites of Australia (Bednarik 1990) [8], currently numbering fifty, provide more evidence of the Pleistocene antiquity of much of their paleoart. The early Holocene occupation deposit in Orchestra Shell Cave (Hallam 1971) [58] rests on a subsided floor that postdates the finger flutings in that cave, which are therefore most probably Pleistocene. Similarly, in Koongine Cave, next to Malangine, Frankel (1986) [50] has shown that the massive ceiling collapse in the cave is of the Pleistocene, and Bednarik (1989) [7] has demonstrated that the extensive surviving cave art precedes that rock fall. The cave art in New Guinea II Cave in Victoria appears to relate to the site's Final Pleistocene occupation, although here the evidence is not as clear-cut (Ossa *et al.* 1995) [83]. Of particularly great age are the complex finger flutings in Yaranda Cave, which precede claw markings attributed to *Thylacoleo* (Bednarik 2010) [21]. That genus is thought to have become extinct about

46 ka ago (Roberts *et al.* 2001; Rule *et al.* 2012) [85,93], and if this is correct the rock art is among the oldest known in the world, possibly dating from the earliest phase of human presence in Australia. It needs to be cautioned, however, that not all Australian cave art is of the Pleistocene; for instance the finger flutings in Prung-kart Cave are of the late Holocene (Bednarik 1999) [14], and the most recent of the three traditions in Malangine Cave also appears to be Holocene.

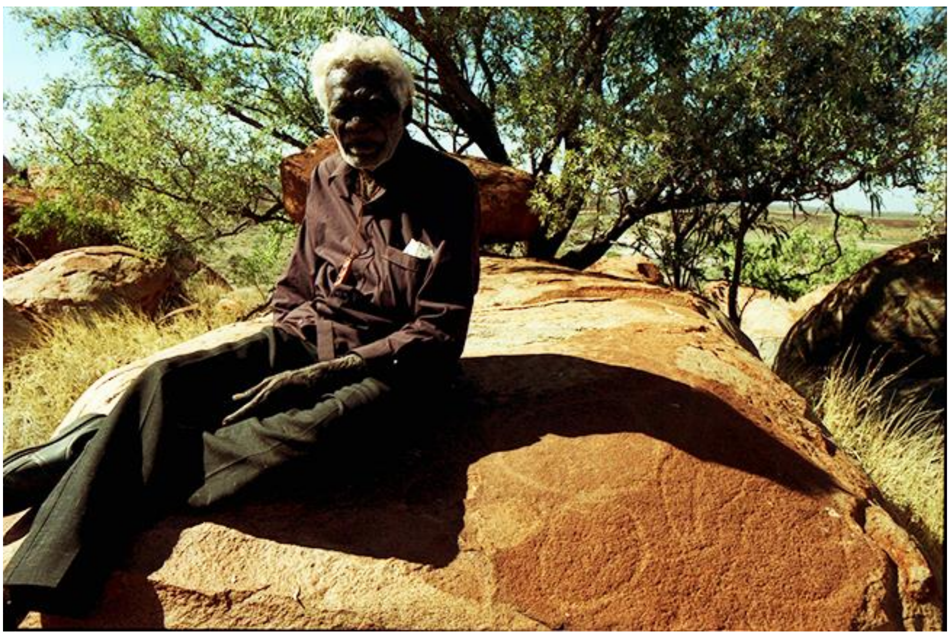
Figure 5. Schematic depiction of the dating evidence from Malangine Cave, South Australia (after Bednarik 1984).



The attribution of Malangine Cave petroglyphs to the Pleistocene coincided roughly with Rosenfeld's (1981) [91] minimum dating of some of the similar rock art in Early Man Shelter in Cape York Peninsula. Her work resulted in one of the twenty known archaeological minimum datings in the world when she excavated this sandstone shelter and determined that some of the rock art must predate 13 ka to 15 ka. This result has been queried by Cole and Watchman (2005) [30] but the established cave art sequence in the south of the continent tends to support it general terms. Another factor of relevance is the extreme similarity between the deep petroglyphs in the Mount Gambier caves, called the Karake tradition after Karake Cave, and the petroglyphs at many Tasmanian sites, especially Preminghana (formerly called Mt Cameron West). The age of the circulinear designs at that site remains unknown, although it is thought to have been covered by sediment about 1500 years ago, but if this very distinctive tradition was introduced from the mainland, this must have been in the Pleistocene: Tasmania was sundered from the mainland perhaps 12 ka ago by the rising sea level. It is certainly striking that Tasmanian rock art generally resembles mainland rock art that is thought to be of the Pleistocene, which is reinforced by the observation that all Tasmanian stone tools, like those of Pleistocene mainland Australia, are of Mode 3 technology (called Middle Paleolithic in Eurasia and northern Africa). Therefore the hypothesis that Tasmanian culture reflected the refugium of the island derives considerable support from its rock art, while at the same time providing insights into the probable nature of Pleistocene paleoart on the Australian mainland. The quintessential characteristics of the curvilinear, cupule and CLM (convergent lines motif) tradition are fairly readily identifiable.

This principle is of considerable help in spotting mainland petroglyphs that could potentially be of the Pleistocene or early Holocene, and predate the introduction of the small tools traditions and the dingo in mid-Holocene times. Care is required, however, because the conservatism of Aboriginal culture has facilitated the preservation of formal and stylistic elements over immense time spans, and their reuse and adaptation is evident throughout the Holocene, right up to the present. The following example shows this most aptly. Microerosion analysis, which is one of the most reliable methods of estimating the antiquity of petroglyphs directly (rather than indirectly), remained long unavailable in Australia because of the endemic dearth of monuments, structures, inscriptions and glacial striae of historically known ages that are required for calibration. But in 2000, a large series of engraved dates at a rock art site in the eastern Pilbara, a semiarid region of northwestern Australia, was analyzed and a calibration curve obtained. This enabled age estimations for the hundreds of thousands of petroglyphs in the region, and seven petroglyphs were selected randomly at three nearby sites. One of them was chosen by a senior Traditional Custodian, Monty Hale, who stated that he knew it was 'very old' and what the arrangement actually means (Figure 6). Consisting of a curvilinear maze it was found to be E19,376 + 7219/ - 3419 years old (Bednarik 2002b) [17]. Therefore either the meaning of the petroglyph (which cannot be disclosed as it is sacred-secret) was transmitted for around 20 ka, or the ancient motif has been re-interpreted by more recent societies. Be that as it may, the formal tradition has been maintained for all of this time, and similar petroglyphs were still made in the 20th century (Mountford 1976) [74]. A second motif, a small circle within a few meters of this motif, is even older: E26,753 +11,545/ - 3349 years BP, and other nearby petroglyphs were considered older again, although they were not analyzed.

Figure 6. Traditional Custodian Monty Hale with curvilinear maze in the eastern Pilbara of northwestern Australia that is about 20,000 years old.



Since these results were published, Cole and Watchman (2005) [30] have reported Pleistocene radiocarbon dates from oxalate accretions in two sites in Cape York Peninsula, Possum B and Sandy Creek Shelter 1. These provide minimum ages of up to about 25 ka for cupules and curvilinear petroglyphs, broadly confirming determinations elsewhere in Australia for these Pleistocene petroglyphs. Finally, microerosion analysis of a circle petroglyph at Sacred Canyon in the Flinders Ranges of South Australia yielded an age of roughly 6400 years BP (Figure 7). This places the adjacent, very complex curvilinear mazes, which are several times as old, soundly in the Pleistocene (Bednarik 2010) [21].

Figure 7. The lower and uppermost petroglyphs are of the Pleistocene, those on the exfoliation surface in the middle are of the early Holocene. Sacred Canyon, Flinders Ranges, South Australia.

4. Pictograms and Portable Paleoart

Hematite fragments bearing striations and ground facets occasioned by human modification occur in abundance practically from the time Australia is believed to have been first colonized (Jones 1985; Roberts *et al.* 1990, 1993; Thorne *et al.* 1999) [60,87,88]. Whether the red powder was used to paint bodies, artifacts or rocks, the resultant exograms are forms of paleoart, most of which can be safely assumed to exist no longer. Indeed, there is very limited sound evidence anywhere that rock paintings of the Pleistocene survived out of caves. Nevertheless, Watchman has shown that paint residues have endured within silica and oxalate accretions, even in mineral skins lacking any surface indication of pigment (Watchman 1992b) [100]. Stratified oxalate deposits containing within them pigment yielded carbon dates of up to about 24,600 years BP from Sandy Creek in Cape York Peninsula (Watchman 1993) [101]. Another site in northern Queensland, Walkunder Arch Cave, provided a sequence of ten carbon dates from a series of laminae measuring only 2.11 mm thickness, but containing three strata of paint residue (Watchman 2000; Watchman and Hatte 1996;) [103,104]. The dates placed two of the three painting events firmly in the Pleistocene, and the third at the Pleistocene-Holocene interface. While the nature of these pictogram motifs is unknown, the evidence shows that paintings were produced in Australia for tens of millennia.

The first application of radiocarbon analysis of Australian rock paintings targeted charcoal pigments at Gnatalia Creek and Waterfall Cave in New South Wales (McDonald *et al.* 1990) [68]. It resulted in controversial results at the first site, where a large lattice design was sampled repeatedly, and two samples yielded significantly different results although they were collected only about 10 cm apart and from the same motif. One result was 6085 ± 60 years BP (AA-5850), the other 29,795 ± 420 years BP (AA-5851). Both are at odds with the view that the region's rock art is mostly under 2000 to 3000 years old, and obviously they are at considerable odds with each other. Even less credible are the claims concerning purported pictograms at Laurie Creek and Tangalma, or the painting in Judd's Cavern, as described above.

Portable paleoart objects from Australia have remained relatively neglected, and as noted above, the 'engraved plaques' from Devils Lair and Koonalda Cave have been found to bear taphonomic markings. However, Devils Lair has also provided paleoart objects, in the form of three bone beads, a perforated marl pendant with microscopic wear from the supporting string, and a perforated sliver of a bird bone (Bednarik 1997; Dortch 1984) [12,43]. Mandu Mandu Creek Rockshelter on the Northwest Cape in Western Australia has yielded twenty-two perforated *Conus* shells, thought to have been used as beads, from a sediment believed to be approximately 32 ka old (Morse 1993) [71].

Of interest are also the cylcons of the central eastern region of Australia, particularly the Darling River basin (Black 1942; Ethridge 1916) [27,49]. These 'cylindrical-conical' stones can be up to a meter long, although most are considerably smaller (Figure 8). Around one half of them are decorated with geometric linear motifs and there is little reliable ethnographic information about them. Several dissimilar uses have been proposed and it is widely believed that they derive from Pleistocene traditions (McCarthy 1967: 63–64) [67] and had magico-religious functions, but later acquired different roles in society. Preferably made from argillaceous sandstone, but also found on basalt, slate phyllites and quartzite, they were also made from fired clay, just as the tjuringa (also tjurunga, churinga, atywerrenge) may be made of stone or wood. The latter's function is better understood: those of stone are believed to have been made by the original ancestors themselves. Both types can externalize totemic ancestors, among other entities, and are extremely sacred. In contrast to cylcons, they are relatively recent phenomena.

Figure 8. Two views of a cylcon from western New South Wales.

5. Discussion

It is evident from the dating of the eastern Pilbara petroglyphs mentioned above that two of seven randomly chosen petroglyphs in one location date from the Pleistocene, and it has been estimated that in the order of 10% of all surviving Australian petroglyphs may be of that period (Bednarik 2010) [21]. This is on the basis of the weathering resistance of the support rock, its patination, degree of weathering, and the formal characteristics of the motif. Pleistocene petroglyphs in Australia appear to be exclusively non-figurative and of a quite specific motif range, dominated by a great number of variations of circles and circular patterns or mazes, CLMs with from two to five 'toes', and the ubiquitous cupules, supplemented by parallel grooves and similar archaic forms. Where such motifs are found on granite, quartzite or similarly hard rocks, are heavily weathered or patinated, and occur in arid environments, they are prime candidates for Pleistocene antiquity. Where they are found in deep caves such age is highly likely. Bearing in mind that there are estimated to be more than 10 million petroglyphs in Australia, a few fundamental predictions can be made:

1. The number of Pleistocene rock art motifs of Australia massively exceeds that of Europe.
2. All of those in Australia are of Mode 3 traditions and are non-figurative, whereas nearly all of those in Europe (with one exception, La Ferrassie) are thought to be of Mode 4 traditions (*i.e.*, of the Upper Paleolithic, although this is now debatable).

3. Notwithstanding the severely limited state of knowledge about Asia and Africa (Bednarik 2013b, 2013c) [23,24], it is self-evident that there is far more surviving 'Middle Paleolithic' than 'Upper Paleolithic' rock art currently known in the world.

These testable predictions clash significantly and irreconcilably with the dominant dogma about paleoart origins, which has focused on the now redundant replacement hypothesis of 'modern humans' (Bednarik 2008) [19], and that incongruity is underscored by the Pleistocene paleoart evidence from Africa and Asia (Bednarik 2013b, 2013c) [23,24]. Clearly the Eurocentric view of the origins of paleoart and symbolism, through exograms, is contradicted by the evidence available from three other continents.

Conflicts of Interest

The author declares no conflict of interest.

References

1. Anati, E. *Palestine before the Hebrews*; Alfred A. Knopf: New York, NY, USA, 1963.
2. Aubert, M. A review of rock art dating in the Kimberley, Western Australia. *J. Archaeol. Sci.* **2012**, *39*, 573–577.
3. Basedow, H. Aboriginal rock carvings of great antiquity in S.A. *J. R. Anthropol. Inst.* **1914**, *44*, 195–211.
4. Beck, W.; Donahue, D.J.; Jull, A.J.T.; Burr, G.; Broecker, W.S.; Bonani, G.; Hajdas, I.; Malotki, E. Ambiguities in direct dating of rock surfaces using radiocarbon measurements. *Science* **1998**, *280*, 2132–2135.
5. Bednarik, R.G. The potential of rock patination analysis in Australian archaeology—Part 1. *Artefact* **1979**, *4*, 14–38.
6. Bednarik, R.G. Die Bedeutung der paläolithischen Fingerlinientradition. *Anthropologie* **1984**, *23*, 73–79.
7. Bednarik, R.G. Perspectives of Koongine Cave and scientistic archaeology. *Aust. Archaeol.* **1989**, *29*, 9–16.
8. Bednarik, R.G. The cave petroglyphs of Australia. *Aust. Aborig. Stud.* **1990**, *2*, 64–68.
9. Bednarik, R.G. On natural cave markings. *Helictite* **1991**, *29*, 27–41.
10. Bednarik, R.G. Karst in siliceous rocks: The speleothem medium of finger flutings and its isotopic geochemistry. *Int. J. Speleol.* **1995**, *24*, 55–66.
11. Bednarik, R.G. Only time will tell: A review of the methodology of direct rock art dating. *Archaeometry* **1996**, *38*, 1–13.
12. Bednarik, R.G. Pleistocene stone pendant from Western Australia. *Aust. Archaeol.* **1997**, *45*, 32–34.
13. Bednarik, R.G. Microscopic analysis of 'engraved plaques' and other objects from Devil's Lair. *J. R. Soc. West. Aust.* **1998**, *81*, 165–175.
14. Bednarik, R.G. The speleothem medium of finger flutings and its isotopic geochemistry. *Artefact* **1999**, *22*, 49–64.
15. Bednarik, R.G. Pleistocene Timor: Some corrections. *Aust. Archaeol.* **2000**, *51*, 16–20.

16. Bednarik, R.G. The dating of rock art: A critique. *J. Archaeol. Sci.* **2002a**, *29*, 1213–1233.
17. Bednarik, R.G. About the age of Pilbara rock art. *Anthropos* **2002b**, *97*, 1–15.
18. Bednarik, R.G. The science of Dampier rock art—Part 1. *Rock Art Res.* **2007**, *24,* 209–246.
19. Bednarik, R.G. The mythical Moderns. *J. World Prehist.* **2008**, *21*, 85–102.
20. Bednarik, R.G. Experimental colorimetric analysis of petroglyphs. *Rock Art Res.* **2009**, *26*, 55–64.
21. Bednarik, R.G. Australian rock art of the Pleistocene. *Rock Art Res.* **2010**, *27*, 95–120.
22. Bednarik, R.G. Megafauna depictions in Australian rock art. *Rock Art Res.* **2013a**, *30*, 197–215.
23. Bednarik, R.G. Pleistocene palaeoart of Africa. Special issue 'World rock art', ed. R.G. Bednarik. *Arts* **2013b**, *2*, 6–34; Available online: http://www.mdpi.com/2076-0752/2/1/6
24. Bednarik, R.G. Pleistocene palaeoart of Asia. Special issue 'World rock art', ed. R.G. Bednarik, *Arts* **2013c**, *2*, 46–76; Available online: http://www.mdpi.com/2076-0752/2/2/46
25. Bednarik, R.G. Mud-wasp nests and rock art. *Rock Art Res.* **2014**, *31*, in press.
26. Berndt, R.M. Panaramitee magic. *Rec. South Aust. Mus.* **1987**, *20*, 15–28.
27. Black, L. *Cylcons: The Mystery Stones of the Darling River Valley*; Lindsay Black, Leeton, N.S.W. 1942.
28. Černohouz, J.; Solč, I. Use of sandstone wanes and weathered basaltic crust in absolute chronology. *Nature* **1966**, *212*, 806–807.
29. Clarke, J. *Rock Patination and the Age of Aboriginal Engravings at Dampier*; W.A. Unpubl. Report to the Department of Aboriginal Sites, Western Australian Museum: Perth, Australia, 1978.
30. Cole, N.; Watchman, A. AMS dating of rock art in the Laura region, Cape York Peninsula, Australia—Protocols and results of recent research. *Antiquity* **2005**, *79*, 661–678.
31. Crawford, I.M. The engravings of Depuch Island. In *Report on the Aboriginal Engravings and Flora and Fauna, Depuch Island, Western Australia*; Ride, W.D.L., Neumann, A., Eds.; Western Australian Museum Special Publication 2: Perth, Australia, 1964; pp. 23–63.
32. Dorn, R.I. Cation-ratio dating: A new rock varnish age-determination technique. *Quat. Res.* **1983**, *20*, 49–73.
33. Dorn, R.I. Rock varnish as an indicator of aeolian environmental change. In *Aeolian Geo-Morphology*; Nickling, W.G., Ed.; Allen and Unwin: London, UK, 1986; pp. 291–307.
34. Dorn, R.I. Rock varnish dating of rock art: State of the art perspective. *La Pint.* **1990**, *17*, 9–11.
35. Dorn, R.I. A review of rock varnish dating of rock engravings. *Int. Newsl. Rock Art* **1992**, *2*, 10–14.
36. Dorn, R.I. Dating petroglyphs with a three-tier rock varnish approach. In *New Light on Old Art*; Whitley, D.S., Loendorf, L.L., Eds.; Institute of Archaeology, University of California: Los Angeles, CA, USA, 1994; pp. 13–36. Monograph 36.
37. Dorn, R.I. A change of perception. *La Pint.* **1996a**, *23*, 10–11.
38. Dorn, R.I. Uncertainties in ^{14}C ages for petroglyphs from the Olary province, South Australia. *Archaeol. Ocean.* **1996b**, *31*, 214–215.
39. Dorn, R.I. Constraining the age of the Côa valley (Portugal) engravings with radiocarbon dating. *Antiquity* **1997**, *71*, 105–115.

40. Dorn, R.I.; Clarkson, P.B.; Nobbs, M.F.; Loendorf, L.L.; Whitley, D.S. New approach to the radiocarbon dating of rock varnish, with examples from drylands. *Ann. Assoc. Am. Geogr.* **1992**, *82*, 136–151.
41. Dorn, R.I.; Whitley, D.S. Chronometric and relative age determination of petroglyphs in the western United States. *Ann. Assoc. Am. Geogr.* **1984**, *42*, 308–322.
42. Dortch, C.E. Two engraved stone plaques of late Pleistocene age from Devil's Lair, Western Australia. *Archaeol. Phys. Anthropol. Ocean.* **1976**, *11*, 32–44.
43. Dortch, C.E. *Devil's Lair, a study in prehistory*. Western Australian Museum, Perth.
44. Dragovich, D. 1984a. Desert varnish as an age indicator for Aboriginal rock engravings: A review of problems and prospects. *Archaeol. Ocean.* **1984**, *19*, 48–56.
45. Dragovich, D. Minimum age for desert varnish in the Broken Hill area, N.S.W.: A preliminary estimate. *Search* **1984b**, *15*, 113–115.
46. Dragovich, D. Minimum age of some desert varnish near Broken Hill, News South Wales. *Search* **1986**, *17*, 149–151.
47. Edwards, R. Rock engravings and incised stones: Tiverton Station, north-east South Australia. *Mankind* **1965**, *6*, 223–231.
48. Edwards, R. Art and Aboriginal prehistory. In *Aboriginal Man and Environment in Australia*; Mulvaney, D.J., Golson, J. Eds.; Australian National University Press: Canberra, Australia, 1971; pp. 356–367.
49. Ethridge, R. The cylindro-conical and stone implements of western New South Wales and their significance. In *Memoirs of the Geological Survey of New South Wales*, Ethnological Series 2; 1916; pp. 1–41. Publisher unknown, Sydney, Australia.
50. Frankel, D. Excavations in the lower southeast of South Australia: November 1985. *Aust. Archaeol.* **1986**, *22*, 75–87.
51. Fullagar, R.L.K.; Price, D.M.; Head, L.M. Early human occupation of northern Australia: Archaeology and thermoluminescence dating of Jinmium rock-shelter, Northern Territory. *Antiquity* **1996**, *70*, 751–773.
52. Gallus, A. Parietal art in Koonalda Cave, Nullarbor Plain, South Australia. *Helictite* **1968**, *6*, 43–49.
53. Gallus, A. Results of the exploration of Koonalda Cave, 1956–1968. In *Archaeology of the Gallus Site, Koonalda Cave*; Wright, R.V.S., Ed.; Australian Institute of Aboriginal Studies: Canberra, Australia, 1971; pp. 87–133.
54. Gallus, A. Comment on R.G. Bednarik, 'Parietal finger markings in Europe and Australia'. *Rock Art Res.* **1986**, *3*, 56–59.
55. Gibbons, A. Doubts over spectacular dates. *Science* **1997**, *278*, 220–222.
56. Gillespie, R. On human blood, rock art and calcium oxalate: Further studies on organic carbon content and radiocarbon age of materials relating to Australian rock art. *Antiquity* **1997**, *71*, 430–437.
57. Hale, M.M.; Tindale, N.B. Notes on some human remains in the lower Murray valley, South Australia. *Rec. South Aust. Mus.* **1930**, *4*, 145–218.
58. Hallam, S.J. Roof markings in the 'Orchestra Shell' Cave, Wanneroo, near Perth, Western Australia. *Mankind* **1971**, *8*, 90–103.

59. Haq, B.U.; Hardenbol, J.; Vail, P.R. Chronology of fluctuating sea levels since the Triassic (250 million years ago to present). *Science* **1987**, *235*, 1156–1167.
60. *Archaeological Research in Kakadu National Park*. Jones, R., Ed.; Australian National Parks and Wildlife Service: Canberra, Australia, 1985.
61. Lorblanchet, M. The rock engravings of Gum Tree Valley and Skew Valley, Dampier, Western Australia: Chronology and function of the sites. In *State of the Art: Regional Rock Art Studies in Australia and Melanesia*; McDonald, J., Haskovec, I.P., Eds.; Occasional AURA Publication 6, Australian Rock Art Res. Association: Melbourne, Australia, 1992; pp. 39–59.
62. Lourandos, H. *Continent of Hunter-Gatherers*; Cambridge University Press: Cambridge, UK, 1997.
63. Loy, T.H. Direct dating of rock art at Laurie Creek (NT), Australia: A reply to Nelson. *Antiquity* **1994**, *68*, 147–148.
64. Loy, T.H.; Jones, R.; Nelson, D.E.; Meehan, B.; Vogel, J.; Southon, J.; Cosgrove, R. Accelerator radiocarbon dating of human blood proteins in pigments from Late Pleistocene art sites in Australia. *Antiquity* **1990**, *64*, 110–116.
65. Macintosh, N.W.G. Paintings in Beswick Creek Cave, Northern Territory. *Oceania* **1952**, *22*, 256–274.
66. Macintosh, N.W.G. Beswick Creek Cave two decades later: A reappraisal. In *Form in Indigenous Art*; Ucko, P.J., Ed.; Australian Institute of Aboriginal Studies: Canberra, Australia, 1977; pp. 191–197.
67. McCarthy, F.D. *Australian Aboriginal Stone Implements*; V.C.N. Blight: Sydney, Australia, 1967.
68. McDonald, J.; Officer, K.; Jull, T.; Donahue, D.; Head, J.; Ford, B. Investigating ^{14}C AMS: Dating prehistoric rock art in the Sydney Sandstone Basin, Australia. *Rock Art Res.* **1990**, *7*, 83–92.
69. Maynard, L. The archaeology of Australian Aboriginal art. In *Exploring the Visual Art of Oceania*; Mead, S.M., Ed.; University of Hawaii: Honolulu, HI, USA, 1979; pp. 83–110.
70. Miller, K.G.; Mountain, G.S.; Browning, J.V.; Kominz, M.; Sugarman, P.J.; Christie-Blick, N.; Katz, M.E.; Wright, J.D. Cenozoic global sea level, sequences, and the New Jersey transect: Results from coastal plain and continental slope drilling. *Rev. Geophys.* **1998**, *36*, 569–601.
71. Morse, K. Shell beads from Mandu Mandu creek rock-shelter, Cape Range Peninsula, Western Australia, dated before 30,000 bp. *Antiquity* **1993**, *67*, 877–883.
72. Morwood, M. Archaeology of the Central Queensland Highlands: The stone component. *Archaeol. Ocean.* **1981**, *16*, 1–52.
73. Mountford, C.P. A unique example of Aboriginal rock engraving at Panaramitee North. *Trans. Proc. R. Soc. S. Aust.* **1929**, *53*, 245–248.
74. Mountford, C.P. *Nomads of the Australian Desert*; Rigby: Adelaide, Australia, 1976,
75. Mountford, C.P.; Edwards, R. Aboriginal rock engravings of extinct creatures in South Australia. *Man* **1962**, *62*, 97–99.
76. Mountford, C.P.; Edwards, R. Rock engravings of Panaramitee Station, South Australia. *Trans. Proc. R. Soc. S. Aust.* **1963**, *86*, 131–146.
77. Mulvaney, D.J. *The Prehistory of Australia*; Pelican: Melbourne, Australia, 1975.

78. Mulvaney, K.J. Murujuga Marni—Dampier petroglyphs: Shadows in the landscape echoes across time. Ph.D. Thesis, University of New England, 2010. Unpublished.
79. Murray, P.F.; Chaloupka, G. The dreamtime animals: Extinct megafauna in Arnhem Land rock art. *Archaeol. Ocean.* **1984**, *19*, 105–116.
80. Nelson, D.E. Second thoughts on a rock-art date. *Antiquity* **1993**, *67*, 893–895.
81. Nobbs, M.F.; Dorn, R.I. Age determinations for rock varnish formation within petroglyphs: Cation-ratio dating of 24 motifs from the Olary region, South Australia. *Rock Art Res.* **1988**, *5*, 108–146.
82. O'Connor, S. Carpenter's Gap Rockshelter 1: 40,000 years of Aboriginal occupation in the Napier Ranges, Kimberley, WA. *Aust. Archaeol.* **1995**, *40*, 58–59.
83. Ossa, P.; Marshall, B.; Webb, C. New Guinea II Cave: A Pleistocene site on the Snowy River, Victoria. *Archaeol. Ocean.* **1995**, *30*, 22–35.
84. Roberts, A.; N. Franklin, I. Campbell and the Mannum Aboriginal Community Association Inc. 2014. Ngaut Ngaut (Devon Downs) petroglyphs reconsidered. *Rock Art Res.* 2014, *31*, 36–46.
85. Roberts, R.; Flannery, T.; Ayliffe, L.; Yoshida, H.; Olley, J.; Prideaux, G.; Laslett, G.; Baynes, A.; Smith, M.; Jones, R.; *et al*. New ages for the Australian mega fauna: Continent-wide extinction about 46,000 years ago. *Science* **2001**, *292*, 1888–1892.
86. Roberts, R.G.; Galbraith, R.F.; Olley, J.M.; Yoshida, H.; Laslett, G.M. Optical dating of single and multiple grains of quartz from Jinmium rock shelter, northern Australia: Part II, results and implications. *Archaeometry* **1999**, *41*, 365–395.
87. Roberts, R.G.; Jones, R.; Smith, M.A. Thermoluminescence dating of a 50,000-year-old human occupation site in northern Australia. *Nature* **1990**, *345*, 153–156.
88. Roberts, R.G.; Jones, R.; Smith, M.A. Optical dating at Deaf Adder Gorge, Northern Territory, indicates human occupation between 53,000 and 60,000 years ago. *Aust. Archaeol.* **1993**, *37*, 58–59.
89. Roberts, R.; Walsh, G.; Murray, A.; Olley, J.; Jones, R.; Morwood, M.; Tuniz, C.; Lawson, E.; Macphail, M.; Bowdery, D.; *et al*. Luminescence dating of rock art and past environments using mud-wasp nests in northern Australia. *Nature* **1997**, *387*, 696–699.
90. Roberts, R.G.; Bird, M.; Olley, J.; Galbraith, R.; Lawson, E.; Laslett, G.; Yoshida, H.; Jones, R.; Fullagar, R.; Jacobsen, G.; *et al*. Optical and radiocarbon dating at Jinmium rock shelter in northern Australia. *Nature* **1998**, *393*, 358–362.
91. Rosenfeld, A. Excavations at the Early Man Shelter. In *Early Man in North Queensland*; Rosenfeld, A., Horton, D., Winter, J., Eds.; Terra Australis 6, Department of Prehistory, Research School of Pacific Studies, Australian National University: Canberra, Australia, 1981; pp. 5–34.
92. Rothwell, N. Politics etched in stone. *The Australian*, 23 September1996, pp. 1 and 4.
93. Rule, S.; Brook, B.W.; Haberle, S.G.; Turney, C.S.M.; Kershaw, A.P.; Johnson, C.N. The aftermath of megafaunal extinction: Ecosystem transformation in Pleistocene Australia. *Science* **2012**, *335*, 1483–1486.
94. Thorne, A.; Grün, R.; Mortimer, G.; Spooner, A.A.; Simpson, J.J.; McCulloch, M.; Taylor, L.; Curnoe, D. Australia's oldest human remains: Age of the Lake Mungo 3 skeleton. *J. Hum. Evol.* **1999**, *36*, 591–612.

95. Tindale, N.B. Comments on supposed representations of giant bird tracks at Pimba. *Rec. South Aust. Mus.* **1951**, *9*, 381–382.
96. Trendall, A.F. Examination of rocks with Aboriginal engravings. Appendix. In *Depuch Island*; Ride, W.D.L., Neumann, A., Eds.; Western Australian Museum Special Publication 2: Perth, Australia, 1964; pp. 83–88.
97. Trezise, P. *Dream Road: A Journey of Discovery*; Allen & Unwin: Sydney, Australia, 1993.
98. Tuross, N.; Barnes, I. Protein identification of blood residues on experimental stone tools. *J. Archaeol. Sci.* **1996**, *23*, 289–296.
99. Watchman, A. Investigating the cation-ratio calibration curve: Evidence from South Australia. *Rock Art Res.* **1992a**, *9*, 106–110.
100. Watchman, A. Re-painting or periodic-painting at Australian Aboriginal sites: Evidence from rock surface crusts. In *Retouch: Maintenance and Conservation of Aboriginal Rock Imagery*; Ward, G.K., Ed.; Occasional AURA Publication 5, Archaeological Publications: Melbourne, Australia, 1992b; pp. 26–30.
101. Watchman, A. Evidence of a 25,000-year-old pictograph in northern Australia. *Geoarchaeology* **1993**, *8*, 465–473.
102. Watchman, A. A universal standard for reporting the ages of petroglyphs and rock paintings. In *Dating and the Earliest Known Rock Art*; Strecker, M., Bahn, P., Eds.; Oxbow Books: Oxford, UK, 1999; pp. 1–3.
103. Watchman, A. Micro-excavation and laser extraction methods for dating carbon in silica skins and oxalate crusts. In *Advances in Dating Australian Rock-Markings*; Ward, G.K., Tuniz, C., Eds.; Occasional AURA Publication 10, Australian Rock Art Res. Association Inc.: Melbourne, Australia, 2000; pp. 35–39.
104. Watchman, A.L.; Hatte, E. A nano approach to the study of rock art: The Walkunders, Chillagoe, north Queensland, Australia. *Rock Art Res.* **1996**, *13*, 85–92.
105. Watchman, A.L.; Walsh, G.L.; Morwood, M.J.; Tuniz, C. AMS radiocarbon age estimates for early rock paintings in the Kimberley, N.W. Australia: Preliminary results. *Rock Art Res.* **1997**, *14*, 18–26.