KEYWORDS: ***Groove – Gritstone – Pennine – Anthropogenic marking – Petroglyph***

STRANGE GROOVES IN THE PENNINES, UNITED KINGDOM

David Shepherd and Frank Jolley

Abstract. This paper presents an account of grooved markings found on sandstone surfaces in the Pennine upland of Yorkshire, United Kingdom, of other single examples in Scotland and the U.S.A., and of numerous unsuccessful attempts to secure an archaeological or geological explanation for them. Of particular interest are the cases where cupules and grooves appear in juxtaposition. There is a concluding discussion of some aspects which may inform a practical aetiology.

Introduction

The South Pennines comprise a dissected plateau rising to over 400 m, underlain by Namurian rocks of the Millstone Grit series of the Carboniferous period, in a gentle, anticlinal form; the area did not bear moving ice during the Late Devensian (final Pleistocene). The outcrops tend to fringe the upland edges.

During fieldwork to locate and record examples of rock art (Shepherd and Jolley 2011) a number of features were identified that did not fit within the conventional canon of rock art (Figs 1 to 4). These were formally recorded and further enquiries made. It transpired (E. Vickerman pers. comm.) that similar features had been noted some years before, a little to the south of the currently-examined area, by Arthur Quarmby (1985) (Figs 5, 6 and 7). All told, some thirty instances of grooved surfaces have been found in around 600 square kilometres of South Pennine upland.

The Quarmby archive (WYAAS n.d.) contained a partial reference to a similar feature found on Orkney (Fig. 8).

The Orkney example was found during peat-cutting at Drever's Slap on Eday and was reported to the RCHAMS and subsequently placed on the Orkney Historic Monuments Record (RCHAMS 1981). A site visit by D. Fraser, Department of Archaeology, University of Glasgow, noted that '[t]he incised grooves on the stone present no readily-identifiable pattern. Nevertheless, the general impression given by the incisions is that the design is not haphazard and is intended to be representational' (ibid.: 2).

An extensive Internet search produced only one

Figure 1. *Withens Clough, note the cupule in the middle of the grooves; the scale is in 25 cm segments in all photographs (photo: D. Shepherd).*

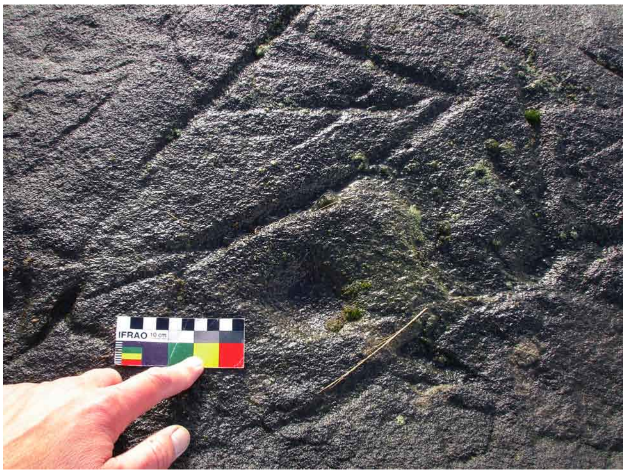

Figure 2. *Withens Clough, detail of Fig. 1 (photo: F. Jolley).*

Figure 3. *Withens Clough, stitched image with grooves, and cupules between natural erosion hollows (photo: D. Shepherd).*

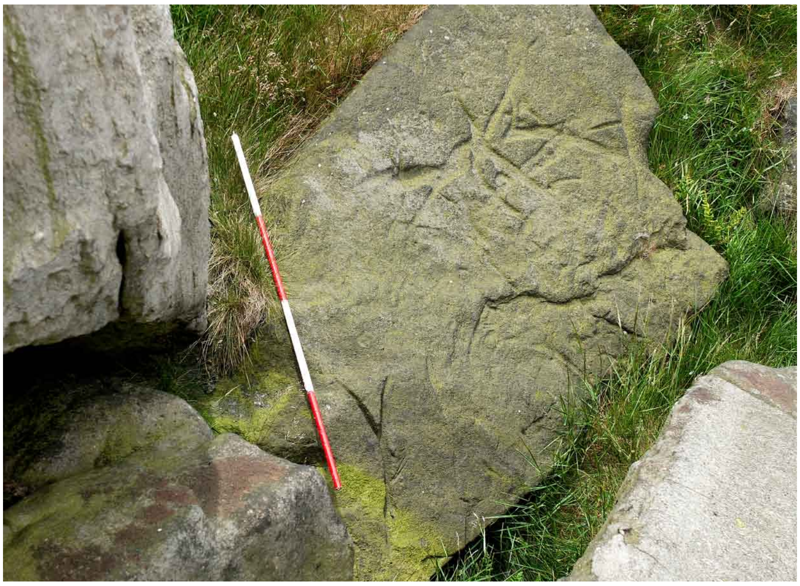

Figure 6. *Another of the West Nab examples (photo: D. Shepherd).*

Figure 7. *Detail from Fig. 6 (photo: D. Shepherd).*

Figure 4. *On-site tracing of the panel in Fig. 3. The image is 1.75 m wide (photo: D. Shepherd).*

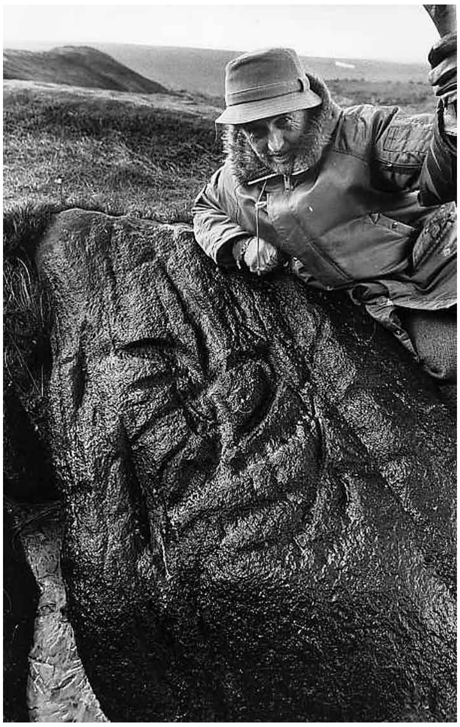

Figure 5. *Arthur Quarmby at West Nab (photo: A. Quarmby).*

further example, from Raptor Ridge in the Chuckanut Mountains, Washington State, U.S.A. (Fig. 9). Local geologists felt that the feature was the product of an interaction between the rock and the acid produced by tree roots, and a further example was supplied (D. Tucker pers. comm.).

Description

Most of the marks noted are grooves between 10 cm and 50 cm long and from 1 cm to 4 cm wide; cross-sections are essentially parabolic segments. These latter two elements can vary along the length of the groove and the termini show a gradual diminution of the feature rather than an abrupt stop. Many grooves are simple straight lines whilst others exhibit curves at oblique angles up to approximately 110°, although some more acute changes of direction have been noted.

There are single grooves and others that split or conjoin, some show a 'dendritic' or 'antler-like' form. There are instances where grooves cross or overlie each other, sometimes with variations of dimensions in the area of intersection. Most grooves noted are on flat, exposed bedding-plane surfaces but they have also been recorded curving around boulders and on curved, previously-eroded surfaces of larger outcrops.

The grooves are not confined to one stratum but have been recorded on Lower Kinderscout Grit and Guiseley Grit in the South Pennines, on Lower Brimham Grit at Brimham Rocks to the north, and on Rough Rock at West Nab, above Meltham, to the south. All these are comparable medium to coarse-grained sandstones deposited in similar riverine/estuarine conditions in the Carboniferous typical of the 'millstone grits' of the Pennines; they are feldspathic sandstones classified as quartz arenites and subarkoses. The Chuckanut Formation in Washington State consists of fine to medium-grained Eocene sandstones deposited in varying lacustrine conditions, similar to but younger than the South Pennine strata. On Orkney, the Middle Eday Sandstone Formation is a medium-grained arenite exhibiting crossbedding, ripple lamination and dewatering structures. Although older, Devonian, it has many physical similarities to the Namurian sandstones of the South Pennines although the manner of original deposition was essentially shallow marine.

Figure 8*. Eday; the camera is looking vertically down into the peat-cutting. The image is approximately 1 m wide (photo: RCHAMS).*

Figure 9. *Chuckanut, U.S.A.; note the grooves crossing the glacial striation (photo: D. Tucker).*

Siting and dating

Examples of conventional petroglyphs in the South Pennines, almost exclusively cupules, are typically found on level, or nearly-level, exposures of bedrock with a viewshed including expansive views from (broadly) south-east through south to south-west. The more northerly skyline is usually very close and vision is restricted in this direction. This is not the case for the panels exhibiting grooves. Most have been found on exposed surfaces but these are not all approaching the horizontal and some grooves curve around boulders and over the rounded edges of outcrops. The viewsheds show no defensible commonality. However the instances where cupules are present on the same panel do conform to the 'conventional' rock art siting outlined above.

The South Pennine locations detailed above were not glaciated in the Devensian, but this is not the case with Eday or Chuckanut, and Quarmby has recorded some Pennine examples in areas that were under moving ice. Similarly, examining the distribution of grooved surfaces in terms of complexity of content or frequency of occurrence has not yielded a discernible pattern.

Although cupules do appear on some panels no intersections have been noted, so deductions about *termini ante* or *post quem* are not possible. However, the Eday example was found during digging for fuel, at the base of the peat-bed. The sequence of peat formation in the Orkneys is not clear but it is possible to infer a pre-Historic timing since the bulk of peat development is Historic, following climatic deterioration. In his description of Raptor Ridge, Tucker points out that the grooves there are on rock that also bears glacial striations so, again, there is an argument for a broadly pre-Historic origin. Finally Roberts (1989), writing in relation to Europe and eastern North America, describes the restricted response of flora at the end of the Devensian. The boreal advance dates from only around 10 000 years BP, but was then extremely rapid. This makes it possible to infer that rock surfaces would have remained unobscured by vegetation until the commencement of the Holocene.

***Figure 10. The** Scorsdale rock marking (photo: P. Abramson).*

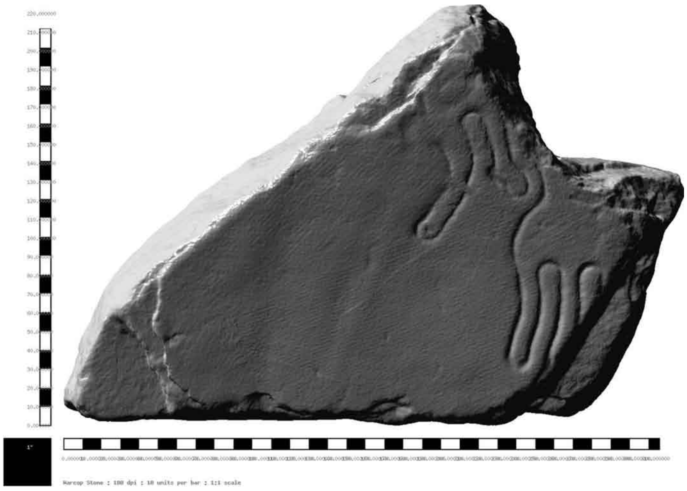

***Figure 11.** Scorsdale: laser scan of the same panel (photo: P. Abramson).*

Investigation

Clearly the central consideration revolved around the geological or anthropogenic origin of the grooves, and consultations with specialists developed along both geological and archaeological strands, with sets of images being distributed and invitations to make site visits extended. The grooves have been included in talks given to local historical, archaeological and geological societies and an article was provided to a popular geological periodical (Shepherd and Jolley 2014).

A number of geological opinions have been sought, from the Huddersfield Geology Group, West Yorkshire Geological Trust (A. Tymon et al. pers. comms), the British Geological Survey (N. Aitkenhead, C. Waters pers comms), and from the visiting professor in the Department of Earth Sciences at University of Bristol (M. Tucker pers. comm.), through photographic review and subsequent field visits. These consultations have helped to exclude the possibilities of fossil creatures or plants, trace fossils, aberrant current bedding, glacial scarring, drag marks and unusual erosion patterns. In essence no conclusive explanation was forthcoming; although instances were provided when natural features have been mistaken for rock art, the geologists found they did not resemble previously-seen features and suggested severally that the grooves might have an anthropogenic origin.

Opinions have similarly been sought from specialists in rock art, but it seems that these marks have not been noted more widely (S. Beckensall, R. Stroud, T. Laurie, K. Boughey, E. Vickerman, pers. comms). The suggestion was that the marks might have a geological or geomorphological explanation.

The possibility of the grooves as a form of polissoir marking was explored but discounted by a leading exponent of stone tool manufacture (John Lord pers. comm.) and by observation and comparison with definite polissoir stones. Plough-scarring, the marks left by the passage of tracked vehicles, by trials bikes or mountain bikes, the marks left by the impact of small-arms fire or mortar rounds, and chisel, plug-and-feather or drill scars from small-scale quarrying have all been explored. Clear, documented examples of these have been located and compared. None resemble the marks as observed.

Tree-root exudates include organic acids and this was offered as a possibility by the geologists consulted by P. Tucker regarding the Chuckanut example. However, researchers at the Department of Plant and Animal Science, University of Sheffield pointed out that such mechanisms involve very weak acids and operate at a microscopic scale, so were unlikely to have produced such gross marks in stone surfaces. That said, the feeling was that the appearance of the grooves did suggest a biogenic cause (J. Quirk pers. comm., and Quirk et al. 2014).

During a landscape survey of the Warcop Military Training Area, at Scorsdale in Northumberland, a sandstone slab was found in a dry stream-bed. The slab bore a series of grooves that obviously had originally extended beyond a broken edge (Figs 10 and 11). The survey group comprised geologists, archaeologists and environmental specialists, and it is instructive to note their difficulty in arriving at a consensual interpretation of the stone. Eventually, after a 3D scan had been circulated more widely, a tentative description emerged. It was felt that the stone was a fragment of a figurative carving, possibly late pre-Historic or early Historic, although a degree of dissent remained (Abramson 2006).

In some respects the stone is similar to the subjects of this paper, although the incisions appear more regularly defined and purposive.

The stone found in the peat-cutting on Eday, which does bear a close resemblance to the South Pennine examples, was described by D. Fraser (RCHAMS 1981: 2) as appearing to show representational intent. Arthur Quarmby, apparently the first person to note and record these features, spent a great deal of time in visual analysis and concluded that he could discern a series of 'bird' and 'dancer' motifs amongst others.

The marks do indeed impel the viewer towards attempts at sense-making in representative terms and it may be that this very human trait was present also in the pre-Historic people who saw them and then added cupules.

Figure 12. *Dean Head Stony Edge: cupules adjacent to small grooves (photo: D. Shepherd).*

Figure 13. *Dean Head Stony Edge: a closer view of the possible intersection (photo: D. Shepherd).*

Conclusion

Clearly then, contrasting conclusions might be drawn from this account. The grooves may represent a natural process acting in a previously unrecognised way upon medium-grained sandstones. With caveats about the incomplete knowledge of overall distribution it may be significant that the rock types are similar although differing in age. This might support a case for a process or mechanism affecting the rock surface post-formation and post-exposure. Though, again, post-exposure conditions have varied between sites, not least in respect of the Devensian glaciation and periglacial and paraglacial conditions. Alternatively the features may be a previously unrecorded type of anthropogenic rock marking. Thus far no definitive interpretation has emerged from extensive consultations, although some indications may be educed.

Three panels contain both cupules and grooves, although the lack of any physical intersection precludes chronological theorising. The examples at Dean Head Stony Edge (Figs 12 and 13) do seem to show some coincidence but the grooves are shorter and more abrupt than that which might be seen as typical. This opens an argument that the grooves as described do not in fact form one coherent type of rock marking. Some are more fluid and braided than others and examples vary in their complexity, perhaps an indication of episodes of activity. Possibly there are natural, albeit unexplained, marks on rock that have been mimicked or elaborated in pre-History.

The examples of modern sense-making outlined above may inform conjecture of how pre-Historic people might have regarded the grooves they saw. Beyond the scope of this initial paper there may be a connection to other incidences of nuanced interventions in natural landscape features (Bradley 1993, 2000; Shepherd 2013; Tilley 1994, 2004). In a sense, of course, the surprisingly persistent difficulty in securing an explanation for the grooves could have engendered a somewhat restricted frame of reference, such that they have become a discrete category of inquiry. This is entirely appropriate to conventional scientific investigation but may be a distraction from working towards their import in a pre-Historic context. There is a modern dissociation between that which we know/suspect to be natural and that which we find acceptably anthropogenic in origin. Uncommon marks on rocks would not be perceived in the same dichotomous manner in pre-History, where (say) grooves, fossils, clasts, inclusions, exogenic fulgurites, cross-bedding, slickenside, mineral veins and so on could not be rationalised in the same way.

The use of cupule-marked slabs in cist construction is well documented in other areas, and further evidence supporting the suggestion above is beginning to emerge in the South Pennines. During excavations at Stanbury Hill a (presumed) funerary cairn had cobbles bearing fossils (stigmaria) and slickenside included in the kerb; a cup-and-ring marked cobble was found to be included in another cairn; and the interpretation of a panel of rock art included the observation that a portion appeared to have been removed and cup-and-ring decoration re-pounded on the fresh surface (Brown et al. 2012). On the shore of Ringstone Reservoir a cist was found recently which bears a fossil branch on an interior surface (Howcroft 2015). A very similar fossil has been found in a similar position on a collapsed cist on the shore of Lower Gorple Reservoir — this is yet to be published. Finds at very recent excavations of a series of small standing stones above Hebden Bridge have included a small slab of crinoidal limestone, the nearest source being 15 km away, and a possible grooved cobble (Shepherd and Jolley in prep). It is hoped that further study of the grooves described in this paper may help to illuminate the perceptions of people in pre-History, using a different suite of conceptual metaphors in negotiating their relationships with their surroundings.

Further fieldwork in the South Pennines is proceeding, and the authors would welcome reports of grooves on sandstone noted in other areas, further suggestions about their possible formation, and any records of anthropogenic marking associated with them.

Acknowledgments

We are indebted to Arthur Quarmby for his continued interest, encouragement and the use of his archive. Indeed, we are grateful to everyone who has taken the time and trouble to give consideration to our efforts to make sense of these enigmatic features.

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WYAAS (West Yorkshire Archaeology Advisory Service) n.d. The Arthur Quarmby archive. (Digital version; the original photographs are archived at the Tolson Museum, Huddersfield, West Yorkshire.)

RAR 33-0000

COMMENT

The aetiology of the Pennines rock grooves

By ROBERT G. BEDNARIK

In response to the invitation by David Shepherd and Frank Jolley (henceforth 'the authors') to report further occurrences of 'enigmatic' grooves similar to those they describe, and to clarify their nature, I offer the following observations. Their report is admirably clear and thoroughly informative, providing a well-defined picture of the mysterious rock markings and their context. Moreover, the authors have left no stone

Figure 1. *Two examples of rock grooves caused by the kinetic effect of tree roots, near the peak of Mt Michael (779 m), north-eastern Tasmania.*

unturned in their quest to solve this puzzle; they have consulted many eminent geologists, archaeologists, rock art specialists and others. The 'surprisingly persistent difficulty in securing an explanation for the grooves' they describe from thirty sandstone locations in the Pennines region of Yorkshire and a couple more sites further afield poses an interesting question, and a salutary lesson for rock art researchers: how to discriminate between natural and artificial rock markings.

The outcome of the authors' investigations is that the geologists could not match the grooves with any of the many rock marking phenomena they were familiar with, such as fossils, current bedding, glacial scarring, drag marks and unusual erosion patterns, so they tended to favour an anthropogenic cause. At least one archaeologist viewed the grooves at one site as representational, while rock art researchers seem to prefer placing the issue at the feet of the geologists. The explanations as plissoirs, plough marks, small-arms fire or mortar round marks were, quite reasonably, discounted. The determination of the Sheffield Department of Plant and Animal Science that organic acids 'exuded' by plant roots are 'very weak acids and operate at a microscopic scale' is quite correct. Such effects are well known only from carbonates, which are particularly susceptible to the respiratory CO_2 of mycorrhizal microbiota, forming weak carbonic acid in the presence of moisture. This process would not affect siliceous sandstones, nor have chemically induced marks by plant roots, such as those found on ivory (dentine) and other carbonates (Bednarik 1992, 1993), been reported from sandstones.

So what can be said about the grooves under investigation? They are not confined to a single stratum, so they seem not to be peculiar to a particular facies. The 'antler-like' or 'dendritic' arrangements are a distinctive feature, and their ends are generally not abrupt but the grooves become shallower as they fade out. While there seems to be a preference for bedding plane surfaces, the grooves have also been seen wrapping around boulders and curved surfaces. At three of the sites, they co-occur with cupules, and at one American site they are said to postdate glacial striae. I must confess that I cannot see the latter in Figure 9, but this is not an issue related to the identification of the grooves under investigation. These are very similar, if not identical, to the rock markings reported from a number of Australian sites, most of them also of sandstone, such as that of the Cape York Peninsula in north Queensland or of the Sydney region:

> A tree … is likely to hug the rock for support with its roots. Every time it sways in the wind, there is a minute movement in its main roots just below the ground, and this, together with soil and fine sand acting as an abrasive, is sufficient to produce quite deep grooves on the rock, which in turn improve the tree's hold on its support. Over a tree's life time, such grooves can become up to 10 cm deep. After the tree disappears and the soil erodes, the grooves remain (Bednarik 1994: 35; cf. 2007: 26).

However, the same kinetic effect has since been observed also on granodiorites and muscovite biotite granites on north-eastern Tasmania (Fig. 1):

> Typically, these grooves have been described as sometimes undercut, they are usually not very long, may meander over the rock and include branching. Their randomly orientated, rounded furrows often resemble petroglyphs, but their identification presents no difficulty to the rock art scientist (Bednarik et al. 2007: 166).

In 1989, the connection between a tree and the grooves it had produced on sandstone was demonstrated by direct observation. A eucalypt tree had been uprooted by the wind in Ku-ring-gai Chase National Park near Sydney, exposing a set of grooves clearly matching the morphology of the tree's roots. Several similar markings had been observed in the vicinity. This confirmed my explanation of a phenomenon that I had observed especially in locations where trees had been exposed to the full force of winds (e.g. near peaks or on escarpments). In some cases in Cape York Peninsula I had observed deep grooves on the edge of rock platforms, about 2 m above the present soil, i.e. in places where no tree could grow today. Without the context of their production, the rock markings are, as the authors demonstrate, difficult to explain as they have no obvious cause.

The precise process of their formation is a subject of tribology, the science of interacting surfaces in relative motion, and the technology of related subjects and practices (see article on the forensic science of cupules, this issue of *RAR*). In this case, millimetre or sub-millimetre movements in the main roots of trees, in combination with sand or silt-grade fractions acting as abrasive, effect a forensic transfer (cf. Locard's Exchange Principle; Miller 2003: 172) of material. The root endeavours to constantly fill the developing recess, because its grip on the rock it uses to anchor itself needs to be as tight as possible, and this in turn leads to more kinetic wear (a process leading to the loss of material) in a self-perpetuating process. This affects especially trees that have a precarious hold on the ground, which their root systems seek to optimise by fastening onto bedrock or large clasts. It leads to the formation of faithful moulds of the roots so affected, at the time of the tree's death. This results precisely in the 'antler-like' or dendritic morphologies described by the authors, be they on flat surfaces or wrapping around curved panels. There can be hundreds of such arrangements at a single location, and they may remain preserved for millennia, but once the sediment has been removed, for whatever reason, their aetiology may be far from obvious. Another observation I can contribute is that at a given locality, most if not all the grooves may derive from one single tree species that optimises its foothold in a characteristic way, which may add to the morphological consistency of the phenomenon.

As the authors note, the marks do indeed 'impel the viewer towards attempts at sense-making in representative terms and it may be that this very human trait was present also in the pre-Historic people who saw them and then added cupules'. It is certainly correct that there 'is a modern dissociation between that which we know/suspect to be natural and that which we find acceptably anthropogenic in origin', a point that cannot be emphasised enough in rock art studies. It is instructive to recall that Australian Aborigines, who have provided most of the world's credible ethnographic information about rock art, traditionally do not distinguish between natural and anthropogenic rock markings. To them, both of these were created when the rocks were soft, an interesting notion that derives from the ethno-scientific observation that rocks must have once been ductile. As I have said before, if I would have claimed this in Europe just a few centuries ago, I probably would have found myself tied to a stake to be burnt alive. Yes, in science Australians were always ahead of Europeans: they knew since time immemorial that humans descend from other animals.

The possibility that pre-Historic people observed natural rock markings, were intrigued by them and sometimes added petroglyphs to them, such as cupules, is very real as has been demonstrated at numerous sites. Their societies can be assumed to have been better attuned to 'reading the signs of nature' than modern Westerners, who would have lost most such abilities. It is well known from Australian ethnography that Aboriginal people incorporated natural markings in their lore. Thus the speculations of the authors in that respect are fully justified. They are also correct in stating that any human beholder of random rock grooves or other unexplained markings is tempted to divine meaning from them via pareidolia.

What other observations can I offer to the authors? The short grooves in their Figure 13 are probably anthropogenic abraded features, although to be sure I would have to view them. The caption of Figure 3 illustrates the great care the authors have taken; many archaeologists would not have been able to discriminate between the cupules and the erosion pans, both of which are indeed present on this panel. This provides another example of a human reaction to pre-existing natural rock markings, and has been observed on many occasions (e.g. Bednarik 2008). Concerning the possibility that the rock markings were caused by small-arms fire I offer two examples of such markings (Fig. 2). I have observed such features at numerous rock art sites, for instance in Saudi Arabia and the U.S.A.

Finally, there is the Scorsdale rock marking the

Figure 2. *Bullet impacts at (a) Gondershausen, Germany, possibly of World War 2; and at (b) Mérida, Spain, said to be of the Napoleonic period.*

authors present, which differs significantly from the other material they describe. Its nature could certainly be determined, but not by laser scan. What is required is field binocular microscopy of the kind I have conducted at over a thousand rock art sites since the 1970s.

Robert G. Bednarik
Editor

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REPLY

Further notes on grooves

By DAVID SHEPHERD and FRANK JOLLEY

We are most grateful for Bednarik's detailed and insightful comments on our paper. Perhaps we have been poring over these grooves for too long, but it does seem remarkable that they have not been noted and recorded more generally. In part this may be because of their lying outside the commonly-construed frames of reference of both geologists and rock art specialists. Since we submitted the paper we have sent images to a leading expert on natural woodland, Professor Ian Rotherham, Department of Environmental Geography, Sheffield Hallam University. He found them fascinating and quite unfamiliar, and suggested Bronze Age rock art. We are awaiting his more detailed comments.

There are two main strands to the thrust of the paper. One concerns the mechanism or process that produced the grooves, and your kinetic model seems attractively plausible although there are some unresolved aspects: wood being softer than stone the likely direction of abrasion from wind-rock must be in doubt; roots will surely seek moisture, nutrients and security by exploring cracks and fissures in rock rather than prospecting across blank areas. These are first reactions and may well be superficial, there is a need for more precise exploration of the model, which may well be more nuanced. We are searching amongst tree-throws for signs of incipient grooves, as these may inform the model more appropriately than working from remnants anything from three to twelve thousand years old. Our search for examples of grooves has been assiduous but those found cannot really be regarded as a representative sample, notwithstanding this they are distributed very sparsely over a large area with many outcrops of identical elevation and aspect showing nothing and this might point toward one particular dispersed species of tree. Such would certainly be needed to support the kinetic model as it stands. Frankly, we are not specialists in this field and cannot approach the issues raised with sufficient informed rigour. We hope, quite fervently really, that some readers may be able to take the matter further.

The other strand relates to the way that the three instances of added cupules might begin to inform our understanding of the way that some pre-Historic people regarded the rock outcrops around them and, beyond that, their relationship with stone — their perceptions of the occurrence of less-than-common features, grooves, fossils, inclusions and so on. Bednarik picked up on the suggestion that because some grooves are sinuous and braided whilst others are abrupt and straight the category 'grooves' may be false. Conceivably some panels may be mimics of pre-existing/natural ones, and that some natural panels have anthropogenic additions. A ready parallel exists with propped stones and *uppallade stenar* (upheld/propped stone) that reflect natural erratic boulders — and may well precede proto-dolmens and boulder graves. Whilst we can distinguish between cupules and erosion hollows/gnammas, it might be defensible to infer the same notion of mimicry/replication in the past.

This response is becoming rather close to kite-flying now, and we await readers' reactions with great interest. Thank you once again for giving us the opportunity to publicise this vexing problem.

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