

# Excavations at four prehistoric rock carvings on the Ben Lawers Estate, 2007–2010

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with contributions by Alex Brown and Rosemary Stewart

## ABSTRACT

*How were Neolithic rock carvings related to the areas around them? Were they associated with structures or deposits of artefacts, and did that relationship differ between landscapes with earlier prehistoric monuments, and places where they were absent? This paper discusses the results of excavation around four decorated surfaces at Allt Coire Phadairlidh on the National Trust for Scotland's Ben Lawers Estate. They are compared with fieldwork around two conspicuous rocks on the same site, neither of which had been carved. No monuments were present in the vicinity, although there was a 'natural' standing stone.*

*Excavation showed that all the decorated surfaces were associated with deposits of artefacts, some of them on top of the rocks and others at their base. The more complex carvings were associated with the largest collections, and the control sample of undecorated rocks was not associated with any finds. The excavated material included two pieces of Arran pitchstone, a worked flint, a beach pebble, and a substantial quantity of broken and flaked quartz. One of the decorated outcrops was associated with an area of cobbles containing a number of artefacts. Fossil pollen sealed by this deposit suggested that the surrounding area was used as upland pasture; similar evidence was obtained from another rock carving at Tombreck, 5 km away.*

*Some of the fragments of broken quartz were parts of broken hammerstones, but the distribution of these pieces showed little relationship to the hardness of the rocks where they were found, or the extent of the associated carvings. On the other hand, it was closely related to the composition of the stone. Carvings on epidiorite were not associated with many artefacts, but that did not apply to those created on mica schist which glitters in the sun and even in moonlight. It may be that the surfaces of these stones had been prepared by pecking or hammering in order to enhance this effect. If so, the selection of particular rocks for special attention may have been as important as the designs that were created there.*

## BACKGROUND TO THE PROJECT

Richard Bradley and Aaron Watson

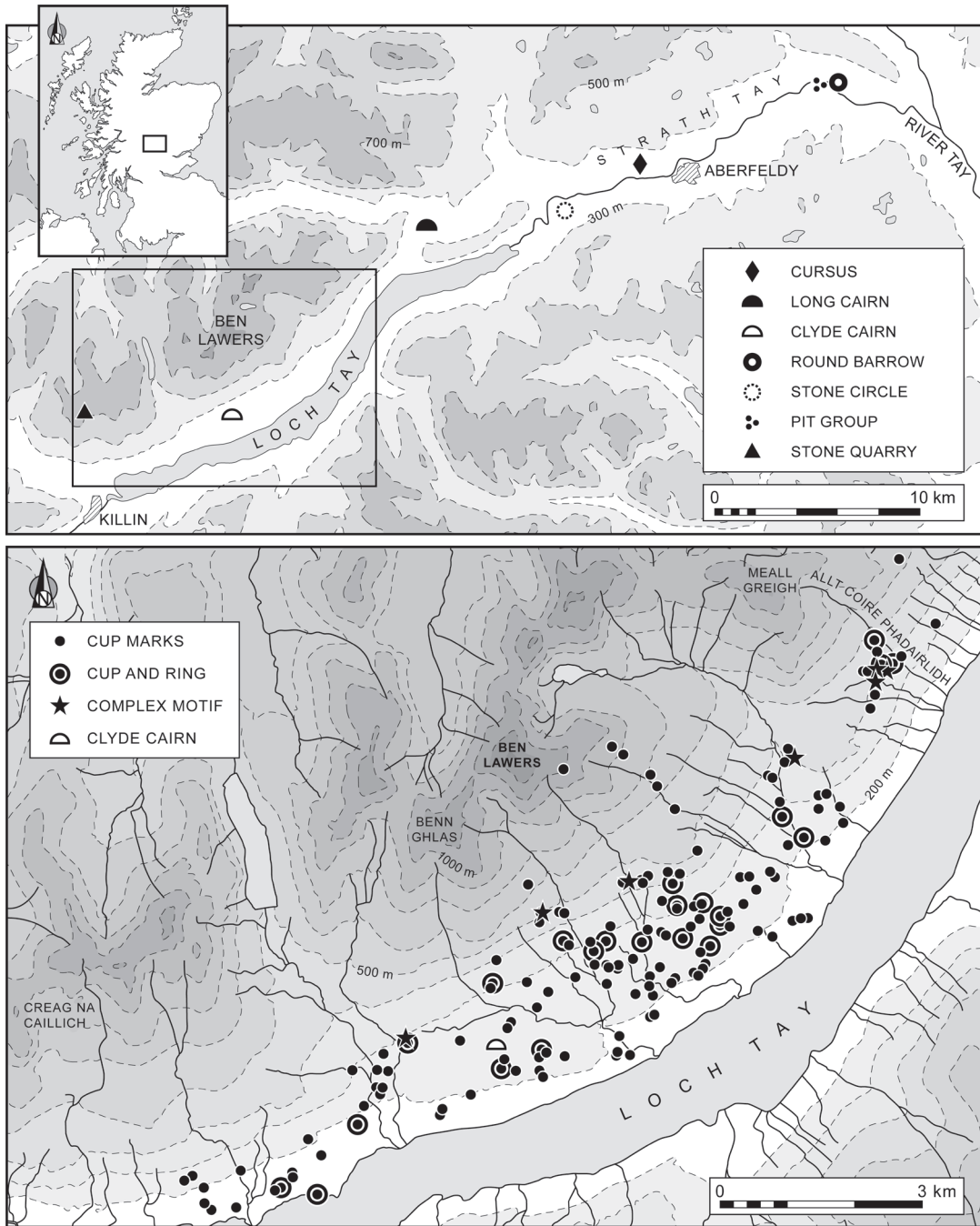
Until recently, British and Irish rock carvings had been investigated by field survey but not by excavation. The comparatively few that were located in cultivated land were not

associated with any artefacts, with the result that investigation had been limited to recording the designs and studying their positions in the landscape. Although this suggested that the more complex panels were created at viewpoints, it was impossible to test the idea using the methods of environmental archaeology. The settings of

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ILLUS 1 The siting of the rock carvings and other sites on the Ben Lawers Estate in relation to the distribution of Neolithic or Early Bronze Age monuments in Strath Tay

the decorated surfaces were difficult to judge, especially as there was little dating evidence. The only consensus is that certain sites were used, and sometimes reused, between about 3000 BC and 2000 BC. Thus their currency could have extended from the Late Neolithic period into the Early Bronze Age (Bradley 1997).

The situation has changed over the last 10 years. Excavation and geophysical survey at Drumirril in Ireland suggest that some of the complex carvings there had been associated with artefacts (O'Connor 2003). They may even have been located within small earthwork enclosures. Work at Hunterheugh in Northumberland has shown that a small cairn, presumably of Early Bronze Age date, had been superimposed on a decorated panel with a complex history of its own (Waddington, Johnson & Mazel 2005), and excavation in the Kilmartin complex demonstrated that a decorated outcrop at Torbhlaren was associated with a compacted surface interpreted by the excavator as a platform. There were deposits of worked and broken quartz similar to those found at cairns and stone circles in other parts of Scotland (Jones et al 2011).

Such developments have been welcome, but they do raise problems, for in every case excavation has taken place within or close to a group of monuments. It has long been argued that the rock art found in such areas has an exceptional character (Bradley 1997, chapter 7). That is why it was important to devise a similar programme of fieldwork in an area where such structures are absent. The rock carvings on the Ben Lawers Estate were ideally suited for such a study as nearly all the monuments of the same date are outside the distribution of decorated surfaces (Stewart 1961; Coles & Simpson 1961; Hale 2003).

## THE PREHISTORIC ROCK ART OF BEN LAWERS

The Ben Lawers Estate, Perth and Kinross, is managed by the National Trust for Scotland

and contains one of the most extensive and best recorded groups of prehistoric rock carvings anywhere in Britain. Some examples must have been removed by later land clearance, but at least 150 have been recorded to date, and more are still being found (illus 1; Hale 2003). They continue the well known concentration of rock carvings extending along Strath Tay farther to the east where several monuments of similar age are recorded (Stewart 1961; Phillips, Watson & Bradley 2002; Breadalbane Heritage Society 2005). The distribution of decorated surfaces is largely confined to the northern side of Loch Tay. The rocks themselves vary in size from enormous boulders that were deposited by glacial action to smaller stones that are easily moved; some are incorporated in field walls. The designs range from simple cup marks to more elaborate compositions that feature concentric circles. Many are located close to the shielings of the historical period, but others are some distance away, on higher or lower ground.

Ben Lawers provided the ideal setting for a new study as a comparatively large body of rock art still survives in situ. Its distribution is not as fragmented as it is in the farmland further to the east. Nearly all the decorated rocks were found during field survey by the Scottish Royal Commission (Hale 2003). Not only was this a comprehensive study, the designs themselves were recorded to a uniform standard. More recent discoveries have been made by George Currie, to whom we are grateful for access to his records.

The ground above Loch Tay has a distinctive profile (illus 2). To the north it rises gradually to about 200m. Then the gradient becomes steeper. At 400m, the land levels out to form a series of sheltered basins or terraces, separated from one other by the streams discharging from the upper slopes of the ridge. They are where most of the shielings are found and are cut off from the lower ground by the head dyke that separated the land farmed all year round from the areas employed for summer pasture (Boyle 2003). Above this zone the land rises steeply to the highest part



ILLUS 2 (*Upper*) The Ben Lawers range seen from the southern shore of Loch Tay. The picture shows the natural terrace above the modern fields and the head dyke. (*Middle and lower*). Views along Loch Tay from the carved rocks at Allt Coire Phadairlidh, showing the hills to its south reflected in the water

of the estate where there are two main peaks, Meall Greigh and Ben Lawers itself, at heights of 1,001m and 1,214m respectively.

The distribution of the carved rocks has been studied by Alex Hale (2003). Cup-marked rocks extend from the shore of the loch up the mountainside and include some of the highest motifs discovered in Britain. Similarly, rocks embellished with cups and rings span the entire distribution of the carvings. The decorated panels extend along a continuum from simple cup marks to ornate designs characterised by cups and rings and other, less standard motifs.

Four of the upland basins are associated with one exceptionally complex carving, while a fifth basin, to be described below, contains no fewer than three. In every case there are

other decorated surfaces nearby. Like most of the decorated rocks on the Ben Lawers Estate they overlook Loch Tay (illus 2), but they share the unusual characteristic that they are also in places where it is possible to glimpse one or more of the summits to the north. Complex designs were created on two different kinds of rock – mica schist and epidiorite - and the same applies to the simpler designs in the vicinity. The epidiorite forms rounded outcrops and the schist occurs as more angular formations. For the most part other kinds of stone were not selected.

On the high ground the decorated surfaces are scattered but are normally located inside the separate basins. Their survival is remarkable considering how much stone was used to

build shielings in the same areas. Lower down the mountainside the distribution of carved rocks is difficult to interpret because many examples could have been removed from areas of agricultural land (Boyle 2003). Even so the evidence from both areas suggests that concentrations of motifs – usually cup marks – follow the trails of boulders that accumulated beside the streams.

Two main issues were investigated by fieldwork between 2007 and 2010. Were those rock carvings which were well away from monuments associated with any deposits of artefacts, or did this apply only to groups in exceptional settings like Kilmartin? The second question was even simpler. Were there any structural features associated with the more isolated rock carvings, or was this something else that might be confined to monument complexes?

In order to answer these questions it was important to select a site where the carved rocks had not been disturbed. For that reason any examples near to later shielings were avoided. The ideal study area was located on the 400m contour beside a stream and waterfall, Allt Coire Phadairlidh, on the eastern boundary of the National Trust land. Not only was it separated

from the summer farms of the historical period, it contained a variety of different designs, extending from complex panels to very simple ones. Like other concentrations of rock carvings, they were within a shallow basin and enclosed on three sides by a rim of slightly higher ground (illus 3). They also featured carved rocks of both the raw materials described earlier.

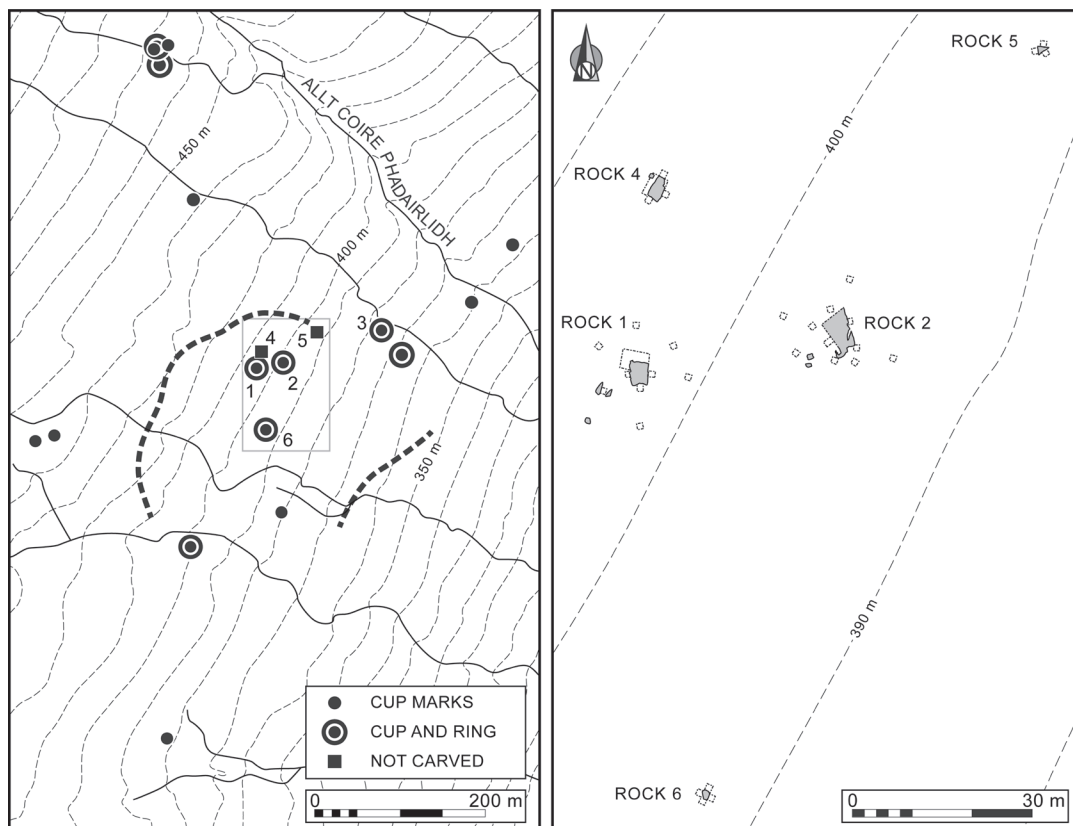
## THE CARVED ROCKS

Richard Bradley, Aaron Watson and Rosemary Stewart

Six rocks were investigated (centred on NGR NN 691428). They straddled the 400m contour just west of Allt Coire Phadairlidh and, like many others on the mountainside, they occupied a shallow basin. Because the differences of elevation are slight they could not be identified by a Geographic Information System. Instead the limits of the basin were mapped by recording the near horizon as it appeared to an observer standing beside Rock 2 (illus 4). That process involved two people, using mobile telephones and a hand-held Global Positioning System. It took little more than half an hour.



ILLUS 3 View over the shallow basin containing the rock carvings at Allt Coire Phadairlidh



ILLUS 4 (Left) The positions of the carved rocks at Allt Coire Phadairlidh in relation to the limits of the basin which are indicated by a dashed line. (Right) The locations of the test pits around Rocks 1, 2, 4, 5 and 6

Four of the rocks had been carved to different extents, whilst a fifth was completely undecorated and was investigated as a control sample. The remaining example was a block of schist which resembled a natural stranding stone. Again it had not been modified. They were numbered in the order in which they were investigated, and that system is retained in this account. For simplicity the largest rocks are described as ‘outcrops’ even though some of them may have been transported by glacial action.

Three of the rocks are mica schist which contains prominent quartz veins and a series of fissures from which similar material has been lost. As the name suggests, they are characterised

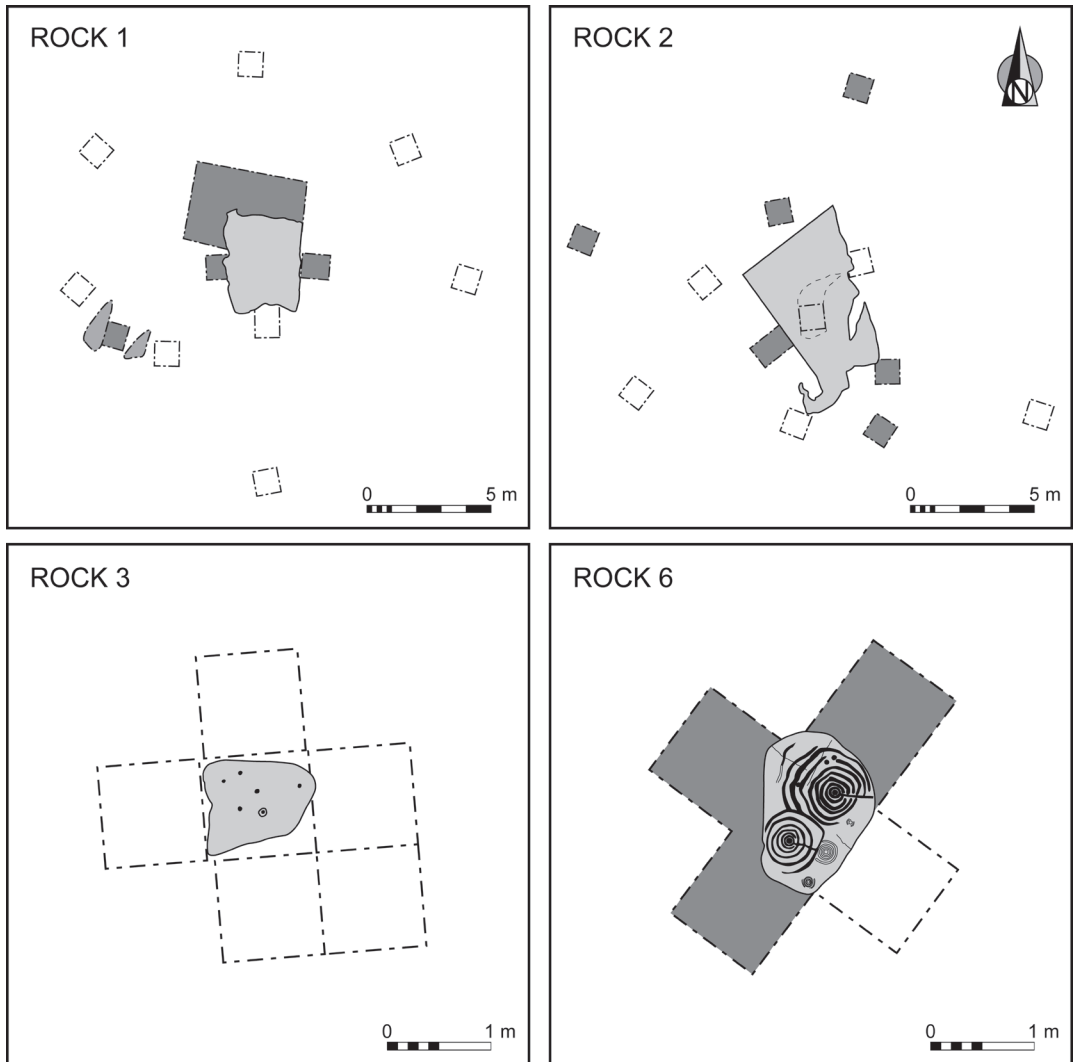
by large quantities of mica which means that they glitter when the surface is exposed to strong light. There were two large decorated outcrops (Rocks 1 and 2), and an undecorated example which had been incorporated in a glacial moraine by melting ice (Rock 5).

The other three rocks investigated in 2007–10 were epidiorite. This is a denser, more homogenous rock type and lacks the distinctive minerals visible in the schist. It would have taken more effort to create pecked designs on its surface, but the newly exposed grooves would have had a platy sheen. Two slabs of this material had been decorated, but to very different extents. Rock 3 included a few cup marks and a

single ring, whilst Rock 6 is probably the most elaborate design on the Ben Lawers Estate. Rock 4, on the other hand, was a conspicuous outcrop of similar size to Rocks 1 and 2, but its surface was entirely unmodified.

Other rocks in the basin featured a number of cup marks, but they were not investigated

in 2007–10. Some of them were so close together that it would have been impossible to establish whether there had been concentrations of artefacts beside the individual stones. In other cases it seemed possible that decorated boulders had been moved since the prehistoric period.



ILLUS 5 The methodology employed in the fieldwork. The shaded areas represent test pits with a density of more than 10 artefacts per square metre. The two small areas indicated by light tone to the west of Rock 1 represent boulders, one of them with a single cup mark

## EXCAVATION METHODOLOGY

Richard Bradley and Aaron Watson

It was important to work out whether those decorated rocks had been associated with any artefacts, and, if so, whether the assemblage would vary according to the character of the carved designs or the nature of the stone. The method employed in the field was quite straightforward (illus 4). Two circuits of metre-square test pits were excavated around the decorated surfaces. One group followed the outer edges of the stone; in principle, the other was located 5m away, although the scheme had to be modified where the bedrock was exposed or where there was standing water. Both groups were excavated through the peat to the surface of the glacial till. That method would establish whether the carvings were associated with any artefacts and, if so, whether the distribution of finds focused on the positions of the decorated panels. The results are summarised in illus 5. Four carved rocks were selected for this purpose: two of mica schist (Rocks 1 and 2)

and two of epidiorite (Rocks 3 and 6). The decorative motifs were by no means uniform, but three of the surfaces carried complex designs, whilst the fourth had only a few simple motifs. To complete the exercise, two other locations were investigated in the 2009 field season. A large uncarved outcrop of epidiorite (Rock 4) was examined by the same method, and that procedure was employed at the 'natural' standing stone (Rock 5). If deposits of artefacts really were restricted to the decorated rocks, they should not be found in those locations.

## THE RESULTS OF EXCAVATION

Richard Bradley and Aaron Watson

The work took place in three stages. In 2007, metre-square test pits were excavated around three of the decorated surfaces (Rocks 1, 2 and 3). Two years later the same procedure was followed at two undecorated rocks (4 and 5), and in the light of what had been found in the first season larger areas were excavated on and



ILLUS 6 The decoration on the highest point of Rock 1, together with a series of natural fissures



around Rocks 1 and 2. Preliminary examination of the artefacts found beneath the peat in the first two seasons raised some problems of interpretation, and in 2010 four test pits were opened around Rock 6.

#### ROCK 1

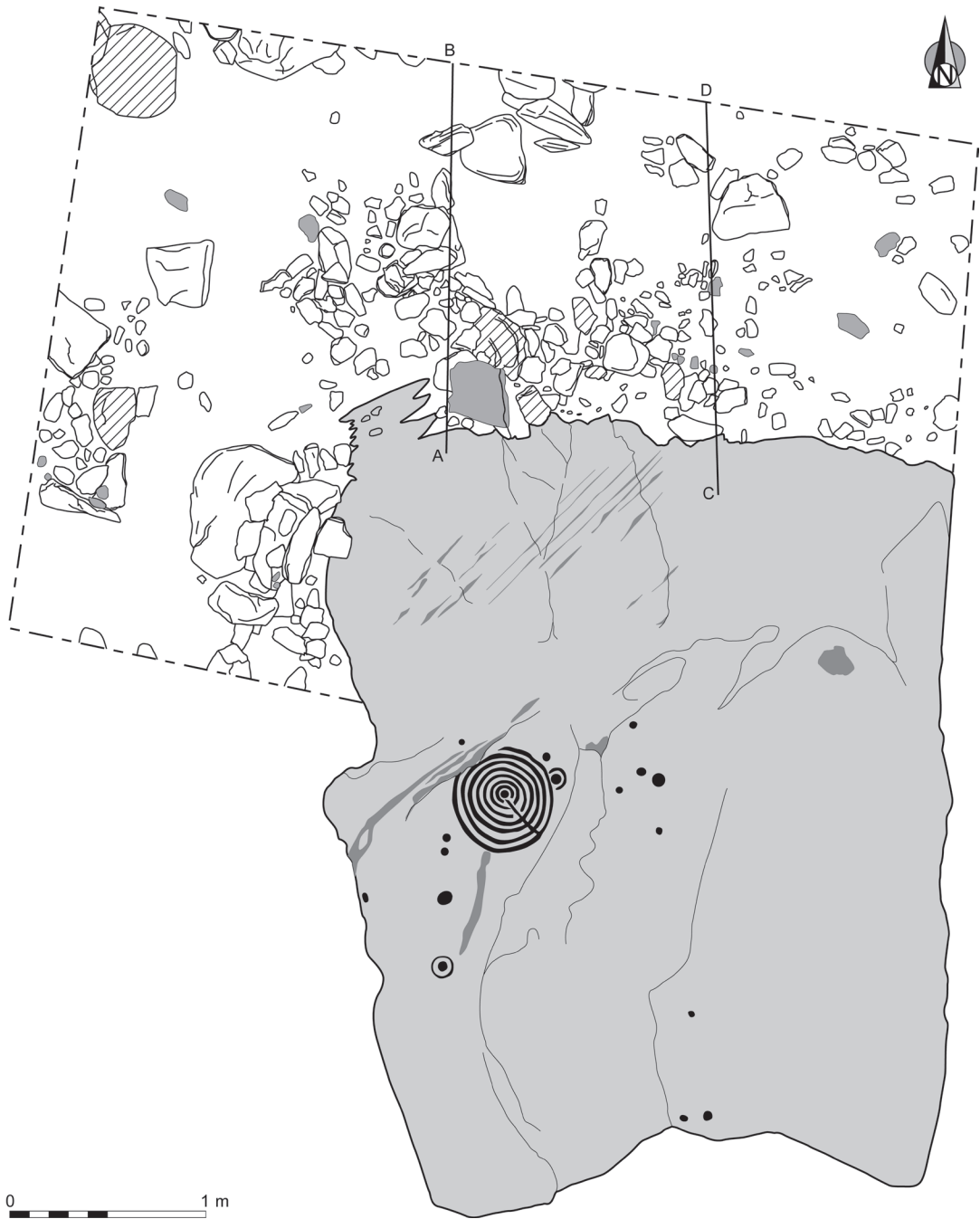
Rock 1 was a large domed outcrop of mica schist. The highest part of the rock was enclosed by seven concentric rings (illus 6). They surrounded a cup mark, which was joined to the surrounding area by a radial line. There was a much smaller circular design on top of the outcrop together with a scatter of cup marks. Excavation showed

that there had been another cup mark below the modern ground level on the western flank of the stone where there was a stream and the base of the rock was masked by between 50 and 90cm of peat. Initially, four test pits were excavated against the outcrop, supplemented by another eight approximately 5m away. Four fissures in the surface of the rock had originally contained quartz veins. They were also excavated.

The second season built on the results of the initial work. Two further test pits were excavated in between two small outcrops 5m south-west of Rock 1 where an unusual quantity of worked quartz had been found in the first season. A single cup mark was identified. More important,



ILLUS 7 Excavation beside Rock 1, showing the domed profile of the outcrop and a deposit of boulders in the foreground



ILLUS 8 Plan of the excavation beside Rock 1. Carved motifs are shown in black. Fissures in the rock are also indicated. Large pieces of quartz are indicated in light tone. Flat slabs are shown by diagonal hatching. AB and CD mark the sections shown in Illustration 9

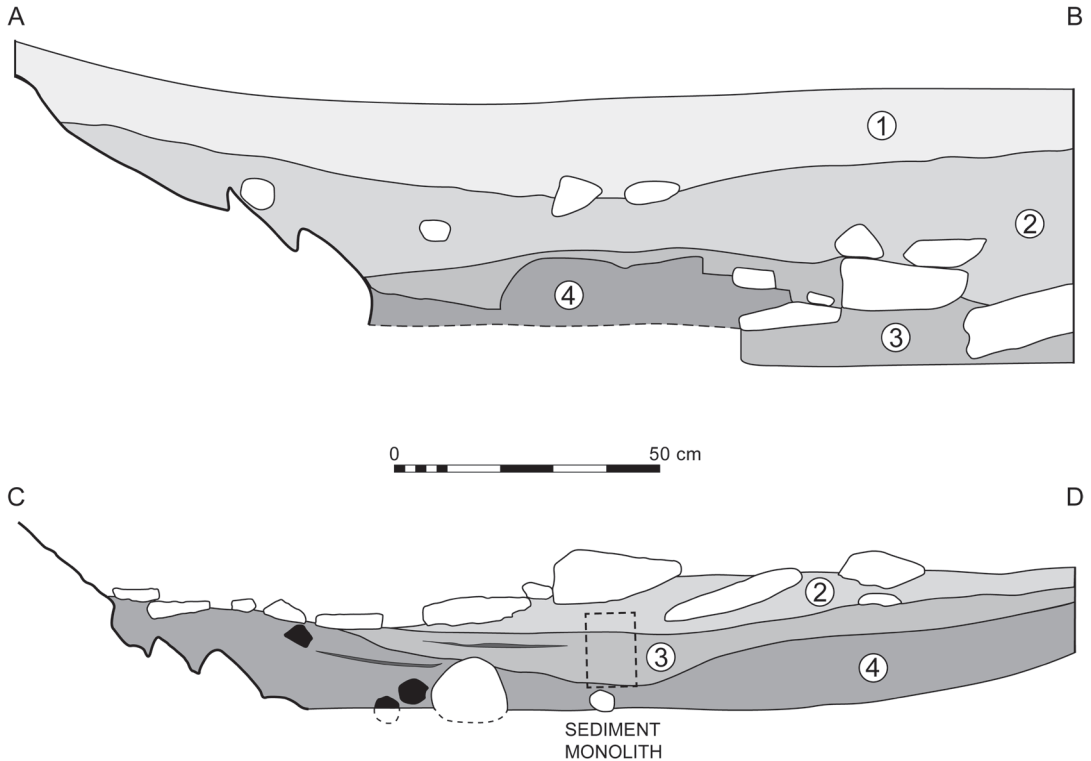
a test pit excavated to the east of Rock 1 in 2007 contained a deposit of rubble which required further examination. For that reason a larger area on this side of the outcrop was investigated two years later.

The artefacts found in the excavation will be considered in a later section of this paper, but at this point a few observations are important. Three of the fissures on the top and side of the rock contained lithic artefacts, including a small chip of flint. The test pits established that the highest densities of artefacts were on the surface of the glacial till against the base of the decorated rock where they were most abundant to its north and west. With the one exception, finds were much less common at a distance. Parts of six broken hammerstones were recovered along the edge of Rock 1. The test pit at its southern

limit also found an imported beach pebble and a pitchstone blade.

The northern flank of Rock 1 was completely exposed during the 2009 season (illus 7 and 8). This work identified a discontinuous level of rubble set into the sandy sediments that overlay the glacial till (Context 2). The stones also abutted the lower part of the decorated rock and were sealed by 50cm of peat (illus 9) (Context 1). The excavated area included an unusually high density of worked quartz which was directly associated with the layer of rubble and did not extend above or below it.

It is not easy to interpret this deposit, but certain points were apparent during excavation. The densest deposit consisted of a series of flat slabs which seemed to have been piled up against the base of the rock. It was supplemented



ILLUS 9 Sections through the deposit against the edge of Rock 1. Their locations are indicated in illustration 8. The dark symbols represent natural blocks of unworked quartz

by a number of large boulders and extended over at least four square metres, and possibly rather more. These pieces were quite friable and were not as rounded as the material carried down the mountainside by modern streams. Moreover, a small proportion of the stone may have been taken from the outcrop itself. Indeed the surface of this deposit included a large flat piece of banded schist identical to the material exposed on the northern flank of Rock 1. It could not have slipped into this position because its veins had a completely different orientation from those visible in the outcrop; it seemed to have been put there deliberately. It is less clear whether the same argument applies to the smaller stones embedded in the silts on the north side of Rock 1, for some might have accumulated through natural erosion, but even then there were occasional slabs that could have been placed there during prehistory.

At first this feature was interpreted as a platform. In the light of a more extensive excavation it is clear that it lacked a clearly

defined edge and for that reason it is better described by the neutral term ‘cobbling’. It remains the case that it was an artificial structure. 450 lithic artefacts were identified amongst this material, including parts of three hammerstones. Monoliths were taken for pollen analysis immediately above and below this structure.

#### ROCK 2

Rock 2 was equally conspicuous (illus 10). Again the stone was mica schist and, like Rock 1, its full extent had been masked by a deposit of peat. The highest part of the rock was covered with turf, but when this was removed it became clear that it had been the position of a substantial natural hollow about 2m in diameter with an opening towards the east where several boldly executed cups and rings had been identified (illus 11). As the sediments inside this feature were removed, a second series of designs was revealed. They consisted of a series of interlacing circles which had been lightly picked into the inner edge of



ILLUS 10. The natural hollow in Rock 2, looking north-eastwards along Loch Tay



ILLUS 11 Plan of the excavated area at Rock 2. Carved motifs are shown in black and quartz veins are indicated in light tone



ILLUS 12 The newly discovered designs on the inner edge of the hollow on Rock 2

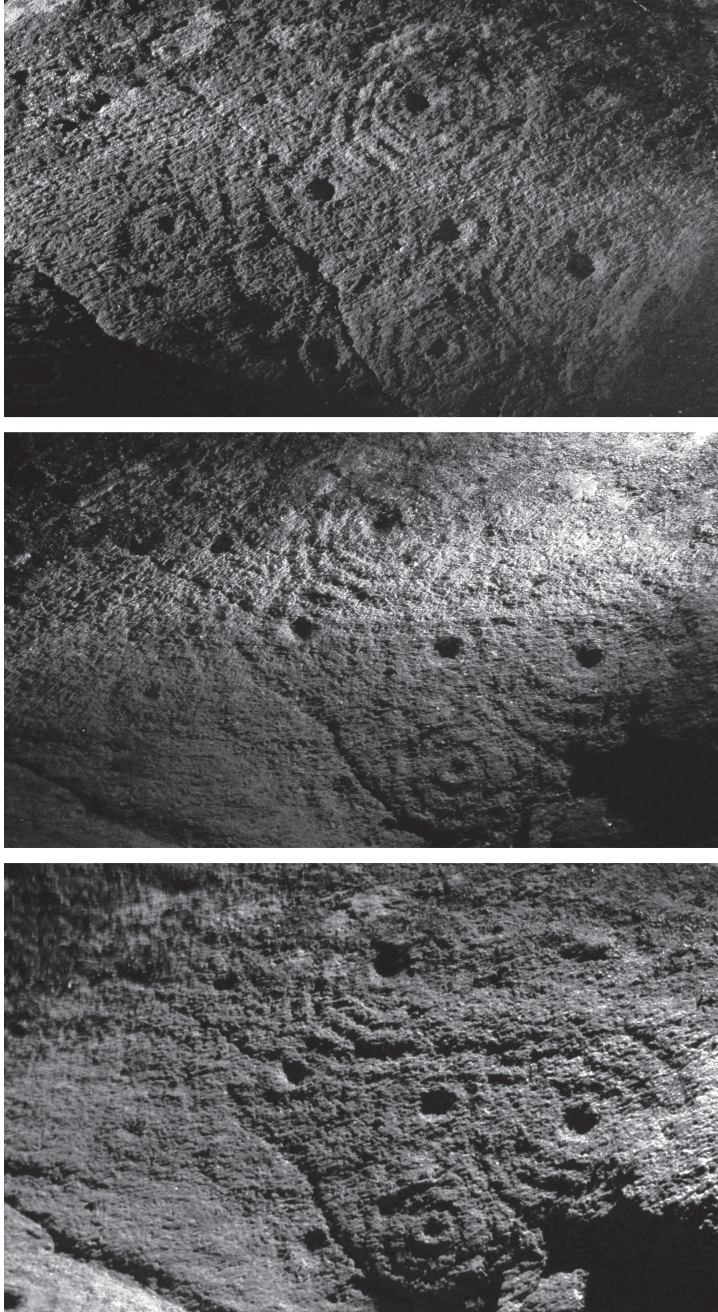
the hollow (illus 12). They were only visible in strong light and were hard to define. As a result of computer problems, photogrammetry was no help in capturing this design and illus 13 combines several different records made under different lighting conditions. It seems likely that this effect was intended and that the images were meant to be difficult to construe. They had been cut into an exceptionally brittle surface and would not have survived unless they had been covered over soon after they were made. There were scattered cup marks on the flat surface of the rock beyond the limits of the hollow, and another one was found in excavation on the south east face of the outcrop. Otherwise the most prominent feature was a natural quartz vein.

In 2007 seven metre-square pits were excavated against the base of the outcrop, with another circuit of four approximately 5m further out from the rock. The filling of the hollow was excavated and screened, and in the final season a larger area on top of the outcrop was stripped of turf and more cup marks were recorded.

A fissure like those associated with Rock 1 was investigated at the same time. Because it contained some artefacts, it could have been worked in prehistory, but that was impossible to prove.

Again the base of the rock was deeply buried, and the individual test pits reached depths of between 40 and 60cm before they reached the glacial till. A series of lithic artefacts were found at that level, but there was no sign of any structures like that associated with Rock 1. The highest densities of finds came from the northern, western and southern edges of the outcrop, but there does not seem to have been one continuous deposit in this area. They included parts of six hammerstones. Five metres north of Rock 2 a test pit produced part of another hammerstone and a similar concentration of worked quartz.

Many more artefacts were recovered on top of the rock. Like three of those on Rock 1, the excavated fissure contained pieces of worked quartz, whilst the filling of the decorated hollow included another 275 examples, as well as a pitchstone blade. The density of



ILLUS 13 The faint rock carvings inside the hollow on Rock 2 showing how their appearance changes under different lighting conditions

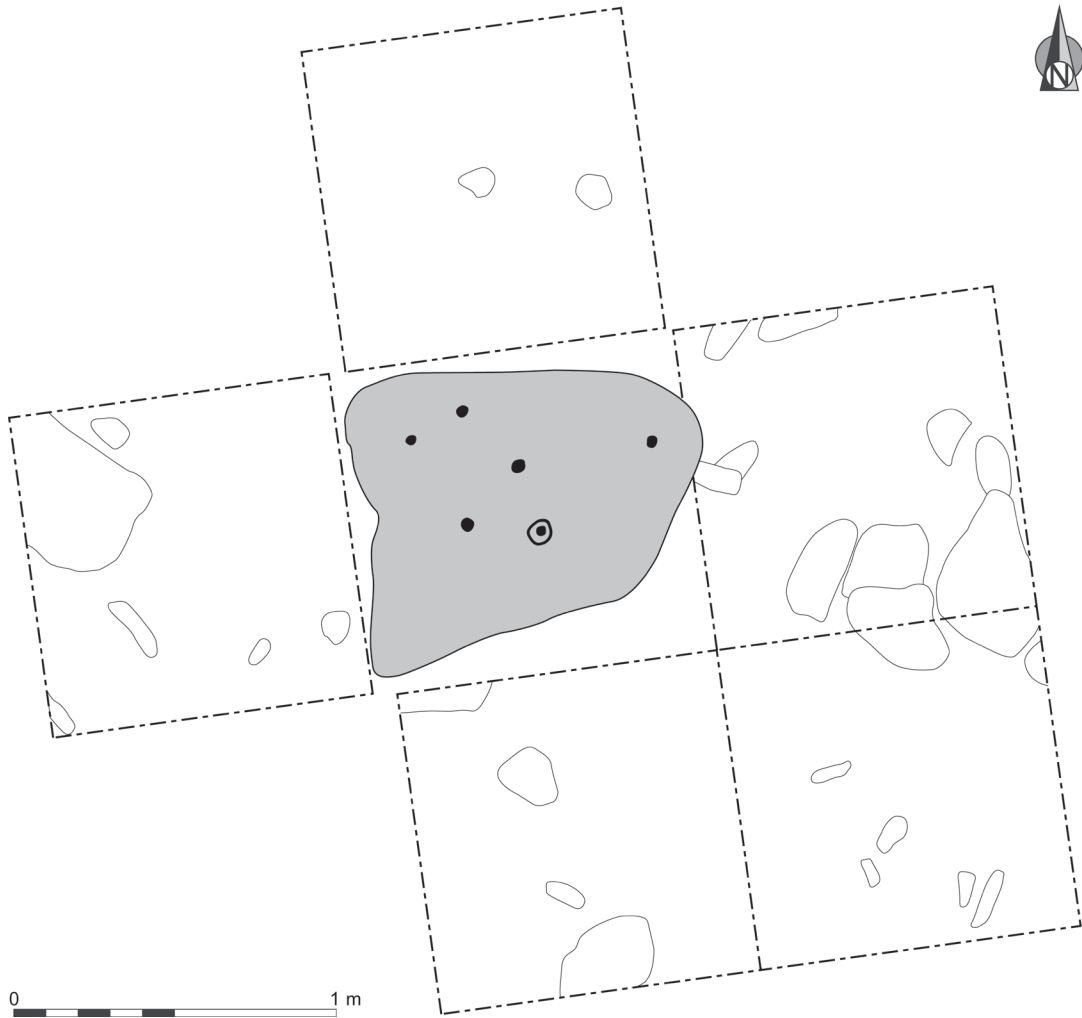
finds far exceeds that in the surrounding area and the distinctive topography of the rock means that all of them must have been deposited there during the prehistoric period. They were found just below the decorated panels.

#### ROCK 3

There is less to say about Rock 3 which was a roughly level slab of epidiorite on which a single ring and at least three cup marks had been pecked (illus 14). The rock lay flush with the ground and could not be recognised from a distance. The motifs themselves were shallow and difficult to identify. There was little sediment around it, perhaps because it was in an area where peat had been cut for fuel in the post-medieval period (Steve Boyle pers comm). Four metre-square test pits were excavated against the limit of the rock and two of them were linked together to investigate a patch of rubble which proved to form part of the glacial till. A very small quantity of worked quartz was found, most of which was on the uphill and downhill sides of the stone.

#### ROCK 4

Rock 4 was a conspicuous outcrop of epidiorite. It had a



ILLUS 14 The excavation of the lightly decorated Rock 3

smooth surface which would have been suitable for carving, but it was entirely undecorated. Its size and location compare with those of Rock 1, 25m away. The full extent of the stone was exposed by excavation and four metre-square test pits were excavated against its base (illus 15). They attained depths of between 50cm and 90cm in the peat. Although a large quantity of quartz was recovered, no artefacts of any kind were represented.

#### ROCK 5

Rock 5 was even more conspicuous and consisted of a massive triangular schist block perched on top of a glacial moraine. From a distance it resembles a monolith, but it was entirely undecorated. A metre-square test pit was excavated against its base on each side of the rock (illus 15). There was a natural deposit of rubble immediately under the turf and no artefacts were found.





ILLUS 15 Excavations at the control sample of uncarved rocks at Allt Coire Phadairlidh. (*Upper*) Excavation around the natural standing stone, Rock 5. (*Lower*) Excavation around an uncarved block of epidiorite (Rock 4)

#### ROCK 6

Rock 6 was the other decorated piece of epidiorite. Again it was a rounded slab which had obviously been transported by ice. It was perched on the lower end of a conspicuous moraine, and even after excavation the rock

could not be identified from far away (illus 16 and 17). It carried an elaborate design based on two sets of concentric circles, although one was more confidently executed than its neighbour and they may have been created on different occasions. This design overlay an older cup



ILLUS 16 Excavation in progress around Rock 6



ILLUS 17 Vertical view of the completed excavation of Rock 6



ILLUS 18 The fully uncovered Rock 6 in low sunlight. North is to the right of the image

mark. The carved lines were much deeper and broader than those on the other rocks at this site, and the entire composition seems to have been framed by a pecked border which followed the northern edge of the stone. The border was a new discovery in an area that had not been stripped of turf before (illus 17). Its outline mirrors the distant summit of Meall Greigh and it seems likely that the motifs were meant to be seen by a viewer looking uphill (illus 18)

Because Rock 6 was located at the lower end of the moraine, excavation was limited to its immediate surroundings; where the ground fell away, any artefacts would have been dispersed. Four metre-square test pits were excavated against the edges of the decorated stone (illus 19). There was more sediment than in the area around Rock 5, and in this case a quantity of worked

quartz was recovered. It occurred in a compact layer within the topsoil and significantly above the material of the moraine. It was most densely distributed on the north, south and, especially, the west sides of the stone. To the east, the test pit recovered only 9% of the artefacts from this excavation.

#### THE LITHIC ASSEMBLAGE

Hugo Anderson-Whymark

Excavations around six rocks on Ben Lawers yielded a substantial assemblage of worked and unworked quartz, two pitchstone blades and a chip of flint. Worked lithics were only recovered from the decorated rocks (Rocks 1, 2, 3 and 6; Table 1). The size and composition of



ILLUS 19 Plan of Rock 6 after excavation. The most prominent designs are indicated in back, and fainter motifs are shown in outline

the lithic assemblages from each of these rocks exhibited considerable variation, but a broad division can be drawn between the assemblages from decorated rocks of mica schist and those of epidiorite. The decorated boulders of mica schist (Rocks 1 and 2) yielded substantially larger

assemblages than those of epidiorite (Rocks 3 and 6), but most notably hammerstone were only found in association with the exposures of schist (illus 20). This pattern is potentially significant as one might suppose that epidiorite, the harder of the two rock types, would require more

effort to work, potentially generating a more substantial lithic assemblage and employing a larger number of hammerstones.

The schist boulders also provided evidence for the deposition of artefacts within fissures on Rocks 1 and 2 and in the natural bowl on top of Rock 2. The artefacts deposited on the rocks are broadly similar to those recovered from the area surrounding the rocks, but the assemblage from the central hollow on Rock 2 includes a high proportion of flakes, perhaps indicating that activities other than rock art production were undertaken there.

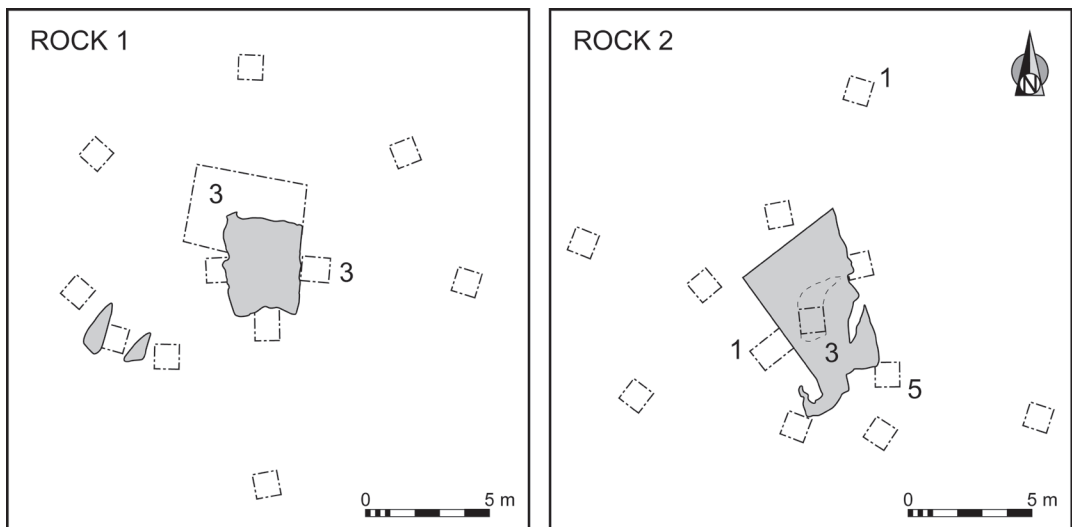
#### METHODOLOGY

The lithic assemblage was categorised following the methodology used at Torbhlaren, Argyll (Jones et al 2011: 62–87, chapter 6 and Appendix A) Raw materials were recorded following standard geological definitions, and quartz raw materials have been sub-divided following Ballin (2008, 46; Table 16). The worked lithic assemblage was classified on typological grounds into various artefact and

debitage types (Ballin 2008); unworked local quartz was not recorded. Due to the variability of fracture patterns among different forms of quartz no attempt was made to divide the angular ‘chunks’ of quartz into different forms. The flake category includes artefacts generated by platform percussion and bipolar percussion (eg ‘orange-segment’ flakes). Hammerstones with minimal use-wear were difficult to identify as the sub-angular pebbles employed in this way were obtained from streams and most exhibit some edge-damage from tumbling. Hammerstones with very little wear have only been tentatively identified and for clarity alternative identifications as unworked pebbles or other artefact types are also presented. The difficulty of identifying use-wear on hammerstones has been discussed at length in the Torbhlaren volume and is not repeated in this article (Jones et al 2011: 62–87 91–118 and chapter 6).

#### RAW MATERIALS

Quartz is a plentiful material on the slopes of Ben Lawers. Veins of various sizes, containing



ILLUS 20 The distribution (by number) of hammerstones around two outcrops of mica schist, Rocks 1 and 2

TABLE 1  
The lithic assemblage from Rocks 1–6 at Ben Lawers by raw material and artefact type

Raw material	Category type	Rock						Total No	Total Wt g		
		1		2		3				6	
		No	Wt	No	Wt	No	Wt			No	Wt
Quartz	Flake	1	6	7	74	3	6	2	26	13	112
	Blade	1	1							1	1
	Chip			1	1					1	1
	Split pebble	7	543	3	240			1	104	11	887
	Chunk	652	1501	491	1189	15	29	93	350	1251	3069
	Hammerstone			3	1110					3	1110
	Hammerstone/utilised flake			1	41					1	41
	Hammerstone?/chunk			1	211					1	211
	Hammerstone?/split pebble			2	143					2	143
	Hammerstone?/unworked pebble	6	1566	3	1763					9	3329
Imported unworked pebble	1	94							1	94	
Flint	Chip	1	1							1	1
Pitchstone	Blade	1	1	1	3					2	4
Grand Total		670	3713	513	4775	18	35	96	480	1297	9003

milky quartz, fine-grained quartz, coarse-grained quartz and small quantities of rock crystals frequently outcrop, and numerous streams have reduced the fragments to sub-angular pebbles and cobbles. The worked quartz from the excavations was exclusively of fluvial origin, and the presence of a wide variety of different types and sizes of quartz indicate that raw materials were not carefully selected. Indeed, the quartz raw materials may have been obtained within a few metres of each of the rocks.

One milky quartzite pebble found at the foot of Rock 1 was more rounded than the other pebbles and exhibits a smooth chattered surface. This surface condition suggests that this pebble originates from a high energy fluvial environment, such as a storm beach, and it is likely to have been imported to the site from a considerable distance. In the view of Professor John Allen FRS it is more likely to originate on the coast than the shore of Loch Tay (John Allen pers comm).

In addition to the quartz, two pieces of pitchstone and one piece of flint were recovered. The pitchstone originates from the Isle of Arran, *c* 115km to the south-west (Ballin 2009; Ballin & Faithfull 2009). The two pieces of pitchstone recovered originate from different sources, as the example from Rock 1 is spherulitic and the other, from Rock 2, is aphyric. Dr Torben Ballin has examined them and concludes that they 'are basically broad blades, and by comparison with other assemblages ... would suggest an age in the Middle or Late Neolithic' (pers comm). The chip of flint from a fissure on Rock 1 is light orangey-brown, indicating that the raw material originates from a secondary geological source, such as a beach pebble.

#### THE LITHIC ASSEMBLAGE

The lithic assemblage comprises 1,293 pieces of worked quartz (8,904g), one imported unworked quartzite pebble (94g), two pieces of pitchstone (4g) and one chip of flint (<1g) (Table 1). The worked quartz includes a small

number of regular flakes (13), one fortuitous blade and a small chip. The majority of these flakes were struck from platforms, but three 'orange-segment' flakes result from the reduction of pebbles using bipolar percussion. It is difficult to assign these flakes to an intentional reduction strategy as several hammerstones exhibit scars that result from detaching flakes during use.

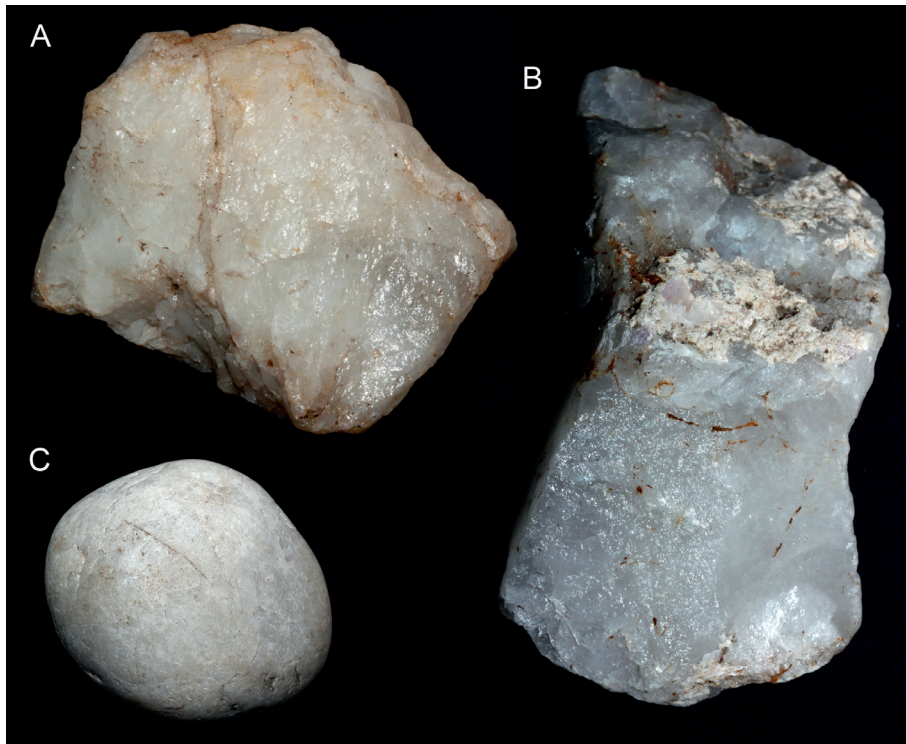
The quartz assemblage also included 11 split quartz pebbles weighing between 37g and 192g. These pebbles exhibited freshly fractured surfaces, but only one piece exhibited clear evidence of the mode of fracture. This pebble, from Rock 6, had been split by bipolar percussion. The breaks on the other pebbles were more ambiguous as the majority of pieces had split on internal planes of weakness.

The vast majority of the worked quartz assemblage has been categorised as amorphous angular chunks. In total, 1,251 chunks, weighing 3,069g were recorded. The majority of these pieces were of limited size and weight, with only 87 pieces having a maximum dimension over 25mm (the largest piece has a maximum dimension of *c* 75mm). The irregular form of these chunks results from the fracture of quartz pebbles along internal planes of weakness; they may have been created by attempts to reduce pebbles, or by the fracture of pebbles being used as hammerstones. Several of the excavated fragments could be refitted, demonstrating that the artefacts recovered from the surface of the cobbles beside Rock 1 and those from the hollow on Rock 2 may be considered in situ. The same applies to material found beyond the limits of Rock 2.

In addition to the struck quartz, four definite and 12 possible hammerstones were recovered. All of them were associated with the decorated outcrops of mica schist, Rocks 1 and 2; the absence of hammerstones from the decorated epidiorite Rocks 3 and 6 is notable. The hammerstones were all based on sub-angular pebbles of quartz, predominately milky quartz, and they varied in weight from 40g to 1050g

(mean = 302g; standard deviation = 281g). The majority of the use-wear, particularly on the larger pebbles, comprised slight battering on natural edges and points that probably result from pecking. This use-damage was occasionally accompanied by more distinct scars resulting from the removal of flakes, chips or chunks during use as a percussor. On three hammerstones (weighing 41g, 159g and 215g, respectively) flake scars form a sharp ridge that may have been used to create narrow lines or unusually detailed motifs (illus 21a and b). In addition, two small 'hammerstones' on split pebbles, weighing 40g and 103g, exhibit

abrasion on sharp prominent points; these points may have been used to incise or peck detailed designs. All the hammerstones that exploit sharp ridges and points were recovered from the elaborately decorated outcrop of mica schist, Rock 2. It is also noteworthy that the pitchstone blade from Rock 2 exhibited an exceptionally abraded edge and it is possible that this damage results from use against the rock. In contrast, the flake of pitchstone from the base of Rock 1, and the chip of flint from a fissure on the same outcrop exhibited sharp fresh edges and are not likely to have been employed in the production of rock art.



ILLUS 21 (a) Hammerstone. Milky quartz pebble. The corners of this sub-angular pebble exhibit signs of percussion, and two exhibit the scars of flake removals resulting from percussion. Weight 215g. Rock 2. (b) Hammerstone. Milky quartz pebble. The distal end of this pebble exhibits a sharp ridge created by the removal of flakes on each side. These flakes probably result from the use of the pebble as a hammer. Weight 159g. Rock 2. (c) Unworked imported quartzite pebble probably originating in a storm beach. Weight 94g. Dimensions: 50mm x 44mm. Rock 1



The well rounded imported milky quartzite pebble from the foot of Rock 1 (illus 21c) was clearly imported some distance to the site, but no traces of polish or wear were observed to suggest human modification or use. Aesthetically pleasing and tactile rounded pebbles are not uncommon in archaeological assemblages and comparable examples have been recovered from excavations on the Torbhlairen rock art site (Jones et al 2011: 107 and figure 4.10).

#### SUMMARY OF THE LITHIC ASSEMBLAGE FROM ROCKS 1 TO 6

##### *Rock 1*

The assemblage of worked quartz recovered from the base of Rock 1 was dominated by small angular chunks of quartz (515 pieces weighing 1,463kg), but seven split pebbles (543g), six hammerstones (1,566kg) and a fortuitous blade (1g) were also recovered. The virtual absence of regularly struck flakes indicates that the quartz was not being systematically worked and that the assemblage may have been generated by the fracture of hammerstones during use or the smashing of pebbles. A refit was identified between two chunks of quartz (combined weight 47g) from the surface of the cobbles. An imported but apparently unworked pebble (Plate 3) and a blade of pitchstone were also recovered.

In addition, 137 chunks of quartz (weighing only 38g), a quartz flake (6g) and a chip of flint (<1g) were recovered from fissures located on the surface of Rock 1. The quartz flake and one chunk from Fissure 1 were of particularly good quality quartz not observed elsewhere in the assemblage. It is possible that these artefacts were deliberately selected for deposition there. The presence of the only flint flake from the excavations in Fissure 4 may further highlight a selective pattern of deposition in these contexts.

##### *Rock 2*

Rock 2 is a schist outcrop with a natural bowl that contained elaborate decorative motifs. A series

of test pits around the rock yielded a substantial assemblage of struck quartz. This assemblage comprises 153 angular chunks (668g), seven hammerstone and possible hammerstones (1,441kg), three flakes (20) and one split pebble (98g). The natural bowl on top of the rock and a nearby fissure yielded a further 338 chunks of quartz (521g), three hammerstones (427g), four flakes (54g), two split pebbles (142g) and a chip (1g), plus a utilised pitchstone blade (3g; Table 1). The pitchstone blade found in the hollow is broken and heavily abraded. The plunging distal end of the blade exhibits extensive use-wear that may result from incising the surface of the rock.

A large number of the chunks in the natural bowl appeared to result from the reduction of a single pebble, and two pairs of refits were identified. Eight chunks and one chip of rock crystal were also present in the hollow and fissure, whereas only one chunk of rock crystal was recovered from the test pits. A refit was made between one split pebble and a chunk found in the hollow on Rock 2, indicating that these artefacts are broadly in situ. The same applies to two fragments of a pebble with a combined weight of 8g which came from the same context. There were other refits among the material around the base of the outcrop: two fragments of a pebble with a combined weight of 12g (from the outlying test pit south-east of Rock 2); and two pieces of a pebble possibly struck at the distal end with a combined weight of 73g (from the test pit immediately south of Rock 2).

##### *Rock 3*

Rock 3 was an epidiorite boulder that exhibited limited decoration. Test-pits around the stone yielded a very limited assemblage of quartz comprising three flakes (6g) and 15 angular chunks (29g). Two of the flakes were shaped like orange segments and result from bipolar percussion.

##### *Rock 4*

Rock 4 was not decorated and was located adjacent to a small stream. The test-pits produced

a large quantity of unworked sub-angular cobbles and pebbles that naturally accumulated around the rock due to fluvial action.

#### Rock 5

Rock 5, a natural standing stone, did not yield any worked or unworked quartz.

#### Rock 6

Rock 6, a highly decorated epidiorite boulder, yielded a small assemblage of quartz comprising two flakes (26g), a split pebble (104g) and 93 angular chunks (350g). In addition, a small number of unworked quartz pebbles of appropriate size for use as hammerstones were recovered, but none exhibited any evidence of use. The limited assemblage of worked quartz and the absence of hammerstones associated with this rock are particularly notable.

The wider significance of this study is considered together with the other evidence from the excavation in the closing section of this paper.

## POLLEN ANALYSIS

Alex Brown

Samples for pollen analysis were retrieved from two carved outcrops on the Ben Lawers Estate in order to determine the vegetation conditions pertaining both before, during and after the creation of the motifs. The pollen evidence from the sites, which are separated by 5km, sets the rock carvings in a wider landscape context and makes it possible to discuss the views from and towards these and other closely associated rock carvings.

## METHODS

Samples for pollen analysis  $c 1\text{cm}^3$  in volume were taken from monoliths BL1, BL2 and TB1 at 2cm intervals. Two *Lycopodium* tablets were added to enable calculation of pollen concentrations. Samples were prepared

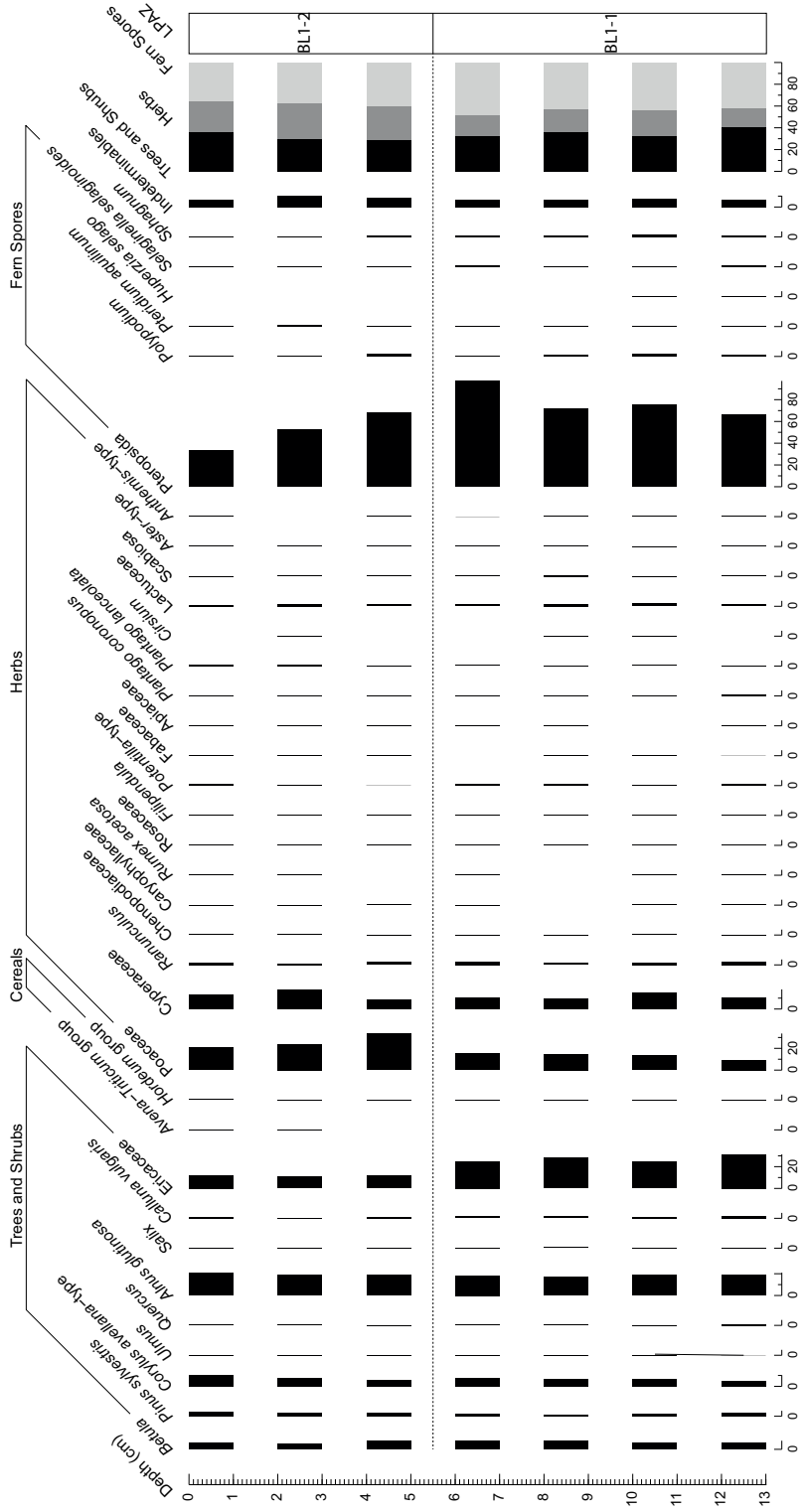
following standard laboratory techniques (Moore et al 1991) and mounted in glycerol jelly stained with safranin. A minimum of 1,000 pollen of terrestrial species were counted for each level. Pollen percentages are calculated based on terrestrial plants. Ferns spores, aquatics and *Sphagnum* are calculated as a percentage of terrestrial pollen plus the sum of the component taxa within the respective category. Identification of cereal pollen followed the criteria of Andersen (1979). Indeterminable grains were recorded according to Cushing (1967). The pollen diagrams were produced using Psimpoll version 4.10 (Bennett 2002).

### ALLT COIRE PHADAIRLIDH, ROCK 1

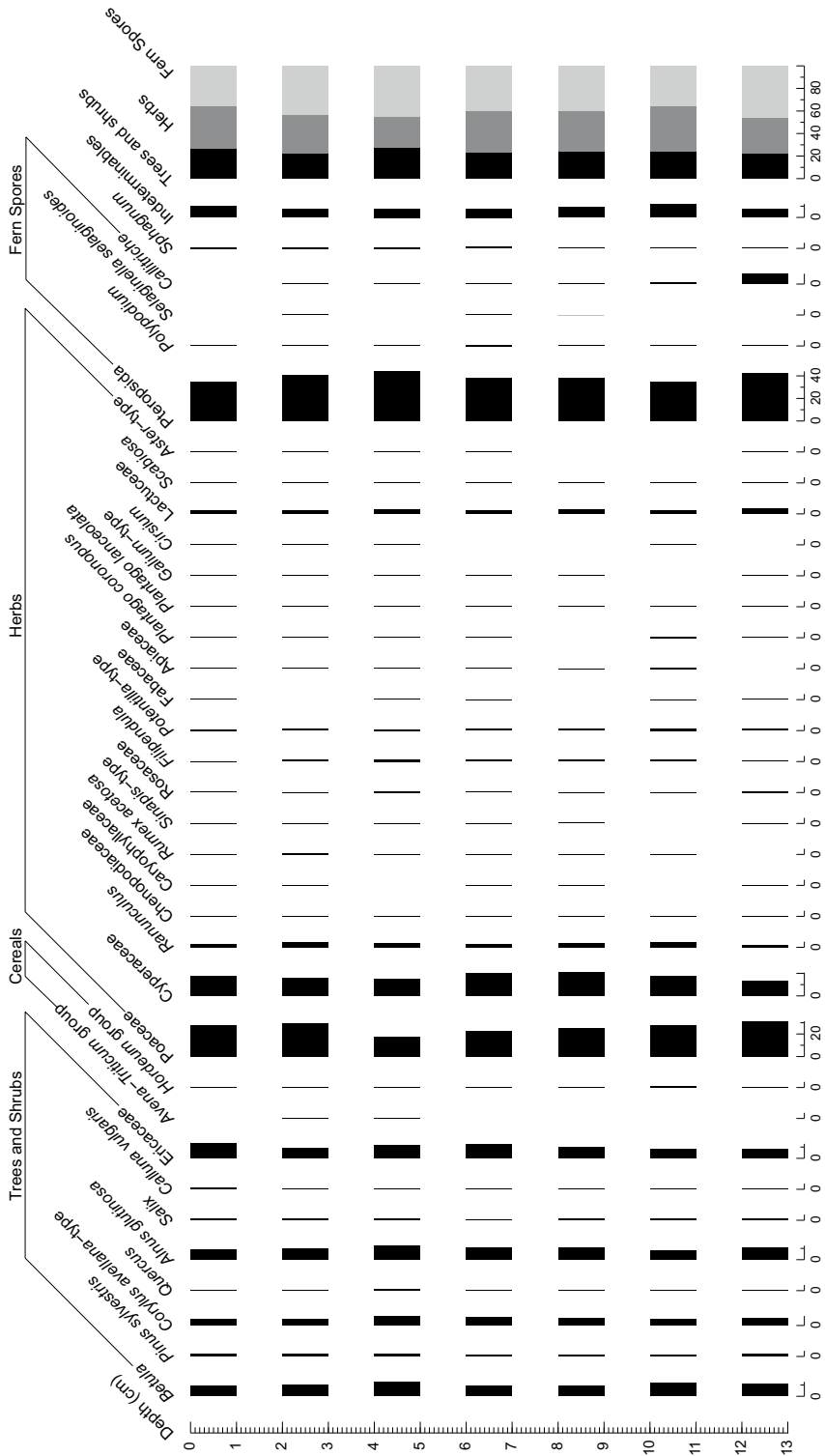
Two monolith tins were taken from below (BL1) and above (BL2) a discontinuous layer of cobbles containing a quantity of worked and broken quartz.

#### Monolith BL1 (below the cobbles)

High values for herbaceous pollen in zone BL1-1 (illus 22), including Ericaceae, *Calluna vulgaris* (Common Heather), Poaceae (Grasses), *Ranunculus* (Buttercups), *Plantago lanceolata* (Ribwort Plantain) and Lactuceae (Lettuces), suggest a predominantly open environment of montane heath and grassland surrounding the site, with stands of *Phragmites australis* (Common Reed, represented by Poaceae) and Cyperaceae (Sedges) growing, along with *Filipendula* (Meadowsweets) and *Potentilla* (Cinquefoils), in areas of impeded drainage (eg marshy/boggy areas) and alongside streams. Much of the arboreal pollen may derive from lower elevations, characterised by open *Betula-Corylus* (Hazel-Birch) woodland, with *Alnus glutinosa* (Alder) growing on wetter soils within the valley floor, but also at higher elevations in wetter areas (eg margins of rivers and bogs). The large values of Pteropsida spores (undifferentiated fern spores) may represent a range of species of



ILLUS 22 Pollen from the deposits beside Rock 1



ILLUS. 23 Pollen from the deposits beside a carved rock at Tombreck

ferns growing in both shaded/wooded habitats located at lower elevations, but more probably within open montane environments. Spores of *Huperzia selago* (Fir Clubmoss) and *Selaginella selaginoides* (Lesser Clubmoss) are likewise characteristic of upland heaths and grassland. Given the elevation, occasional cereal-type pollen grains of the *Hordeum* (Barley) group most probably reflect wild grasses growing in wet areas, rather than cereals. Zone BL1-2 is characterised by a reduction in pollen of Ericaceae (Heathers) and an increase in Poaceae, suggesting an increase in grassland over heath habitats below the cobbles. Cereal-type pollen of the *Avena-Triticum* (Oats-Wheat) group was recorded in the top 3cm of monolith BL1. Again these pollen grains may derive from wild grasses.

#### *Monolith BL2 (above the cobbles)*

Pollen from above the layer of cobbles (illus 22) is dominated by herbaceous types (Poaceae, Ericaceae, Cyperaceae, *Potentilla*, and *Filipendula*) characteristic, like zone BL1-2 below the cobbles, of grassland with areas of montane heathland and marshy/boggy ground. Values for arboreal pollen are lower above the platform, largely resulting from a reduction in *Alnus glutinosa*, with *Betula-Corylus* woodland at lower elevations. Cereal-type pollen grains of the *Hordeum* and *Avena-Triticum* groups are present throughout the monolith in small quantities, again deriving either from wild grasses growing in wet areas, or reflecting high-altitude cultivation of cereals.

#### TOMBRECK

It was important to look for other sites where a similar exercise could take place. In the last season of fieldwork all the elaborately carved rocks – those most likely to be associated with artefacts or broken hammers – were visited to look for adjacent peat deposits. The intention was to locate lenses of worked stone that could

be treated as marker horizons in pollen analysis. Areas with Scheduled Ancient Monuments were avoided, but, where suitable candidates were identified, the sediments at the foot of the outcrop were probed to establish the depth of deposit.

In the event the only suitable site was above Tombreck. Here a series of cup marks had been pecked into an exposure of quartz on the top and one side of a conspicuous block of schist (NGR NN 64153910). There was nearly a metre of sediment at its base. A test pit excavated against the east side of the outcrop produced a distinct horizon of small fragments of quartz which were likely to have accumulated during the formation of the carvings. A monolith tin (TB1) was inserted at 20–40cm depth to cover the quartz horizon.

#### *Monolith TB1*

Unfortunately pollen was only preserved in sufficient quantities within the top 10cm (20–30cm) of monolith TB1 (illus 23). Below this, only occasional, poorly preserved, pollen grains were present along with more resistant Pteropsida spores. However, pollen from 20–30cm, much like Allt Coire Phadairlidh, is dominated by herbaceous pollen, particularly Poaceae, Cyperaceae and Ericaceae, likewise indicative of grassland and heathland habitats. Arboreal pollen frequencies are similarly low, reflecting *Betula-Corylus* woodlands at lower elevations with *Alnus glutinosa* growing on wetter soils. Values for *Sphagnum* (Bog Moss) spores are much higher at Tombreck than Ben Lawers, suggesting a locally wetter environment. No cereal-type pollen grains were recorded.

#### DISCUSSION OF THE POLLEN RESULTS

The results of pollen analysis demonstrate convincingly that both rock carvings, and also by association other nearby rock panels, were located in a predominantly open landscape characterised by upland, most probably grazed,



ILLUS 24 Upland pasture at Allt Coire Phadairlidh viewed from the summit of Rock 1. The prehistoric environment may have possessed a similar character

grassland and heathland habitats. Although the pollen record suggests the nearby presence of trees, mostly of alder, these would have been growing on wetter soils, typically along the edges of the numerous streams that dissect the mountainside at regular intervals. It appears likely that carved panels would have commanded extensive views in much the same way as they do today (illus 24).

Although the rock carvings at Allt Coire Phadairlidh and Tombreck could not be dated, they seem to have been located in a different environment from the Neolithic axe quarry at Creag na Caillich by the west end of Loch Tay. Here woodland is recorded during both phases of activity. The first took place in the early third millennium BC, and the second towards its end. Although the local tree cover remained, there is also some evidence of grazing land during the latter period (Edmonds, Sheridan & Tipping 1992: 102–7).

## THE RESULTS OF THE PROJECT AND THEIR WIDER IMPLICATIONS

Richard Bradley, Aaron Watson and Hugo Anderson-Whymark

This study began with two questions. Would carved rocks that were not associated with monuments have similar characteristics to those investigated at sites like Torbhlaren and Drumirril? Would any prehistoric artefacts be found there, and would they be associated with structural evidence? The best way to investigate these possibilities was to compare the archaeological ‘signatures’ of a series of carved and uncarved rocks within a restricted area.

One answer was provided by test pitting around six decorated and undecorated rocks. The decorated surfaces were all associated with lithic artefacts, but they were completely absent from the control sample of uncarved rocks. Subject to what is said later, the extent

of the pecked motifs was more or less in proportion to the number of artefacts found there, so that Rock 3 with three cup marks and a single circular motif produced a very small assemblage, whilst larger quantities of worked quartz came from Rocks 1, 2 and 6.

A second question was whether the decorated surfaces might have been associated with features like the compacted surface beside a decorated outcrop at Torbhlairean. None was found with Rocks 2, 3 and 6, but there was a distinctive deposit of cobbles beside Rock 1 where it was directly associated with pieces of worked quartz. It is not clear how it was used, but it would certainly have consolidated an area of damp ground immediately in front of the outcrop. This was the only place from which the design on top of the rock could be seen and obviously provided a focus for activities on this site.

How were the carved rocks related to the landscape around them? A useful source of comparison is provided by the results of field walking in Strath Tay undertaken nearly 20 years ago (Phillips, Watson and Bradley 2002). There were not many surface finds, but one striking pattern was identified. The main concentrations of lithic artefacts were on the lower ground towards the River Tay where cup marked rocks are common. The density of surface finds decreased with distance up the valley side and reached a minimum around a series of cup and ring carvings whose distribution focused on a series of upland basins. Many of the artefacts found in the present project seem to have been a by-product of working the decorated rocks, but the few fine quality quartz flakes are similar to those found on the river terraces further to the east.

Some of the concentrations of carved rocks on the Ben Lawers Estate occupy sheltered upland basins, like those above Strath Tay. Their locations are similar to those of post-medieval summer farms. Is there any archaeological evidence of prehistoric land use in these areas? The results of this study offer

some new information. The layer of cobbles associated with the use of Rock 1 provided a horizon from which pollen samples could be taken. They demonstrated that the landscape was largely open at the time when the decorated panels were made and that the surrounding area could have been used as upland pasture, as it was in the historical period (Boyle 2003). It seems possible that the ground had been cleared of bracken before activity commenced. A few pollen gains might suggest the presence of cereals but, as Alex Brown points out, the evidence is ambiguous. A second set of samples from a rock art site at Tombreck also provides indications of open grassland and heathland. This evidence contrasts with the woodland setting of the quarry at Creag na Caillich farther to the west.

In common with many similar sites in Britain and Ireland the complex carvings at Rocks 1, 2 and 6 are located at viewpoints, but, as the introduction to this paper pointed out, little was known about the environment in which such designs were made. The pollen samples studied as part of this project show that the landscape was almost as open as it is today. It means that in the past Rock 1 would have commanded an unusually extensive view westwards along Loch Tay. It was a vista that could only have been seen by an audience located to the north east of the outcrop, where an area of cobbles was found. Rock 2 presents a total contrast, for the decorated panels are around the edges of a natural enclosure with its entrance facing east along the loch (illus 25). During the excavation it became obvious that the mica grains embedded in the schist sparkle when the morning sun enters the hollow in the stone and lights the unusually shallow carvings inside it. George Currie, who has visited the site at different times of year, suggests that this would probably not happen between November and January because the designs might remain in shadow (pers comm). Rock 1, which is also mica schist, exhibits a similar phenomenon, but in this case the decoration is illuminated when the sun is at its height towards the middle of the day. We



ILLUS 25 The view from the natural bowl in Rock 2 towards the position of the rising sun. Prominent cup marks and cups and rings are visible in the foreground and fainter but more complex carvings are visible towards the right

have observed that the decorated surfaces also glitter in moonlight.

If there were few trees on the mountainside, people visiting the carved rocks would have had a clear view of the sky. That may explain why there are so many decorated surfaces on the north shore of Loch Tay and comparatively few to its south. From the sites on the Ben Lawers Estate it is possible to observe the movement of the sun as it travels from east to west behind the lake. In good weather the hills above the opposite shore are reflected in the water. During the summer the sun moves beyond the end of the loch. Around the longest day of the year visitors to Allt Coire Phadairlidh could watch it setting behind the high ground on Meall Greigh (Douglas Scott pers comm). There were few places from which this phenomenon could have been observed, but Rock 6 is one of them. It is the only decorated surface on the site where the carved motifs seem to have been conceived in relation to an audience looking upslope (illus 26).

Like their counterparts elsewhere on the Ben Lawers Estate, the most complex rock carvings

were located in places where it was possible to see the ground on the far side of the loch reflected in the water, as well as the mountaintops to the north. The decorated surfaces were located in between them. In this case it is tempting to interpret their siting in terms of a three-tier cosmology. The plane on which people lived might have been located in between two other spheres represented by the sky and an underworld respectively. This perspective is often reported in traditional societies (Lewis-Williams 2010). It may explain the significance of the carved motifs on the land above Loch Tay where the reflections in the surface of the water could be interpreted as a subterranean world, but the study area is unusual in overlooking a large expanse of water and the idea cannot be extended to places where this does not occur.

The five decorated panels at Allt Coire Phadairlidh (two on Rock 2 and one on Rocks 1, 3 and 6) were very different from one another, but the character of the designs does not seem to have been influenced by the form of the stone. Whilst Rocks 1 and 2 were conspicuous





ILLUS 26 The siting of Rock 6. (*Left*) The decorated surface in relation to Loch Tay. (*Right*) The view looking uphill towards Meall Greigh, which is glimpsed in the top right corner of the photograph

outcrops, the same was equally true of Rock 4 which was entirely undecorated. Similarly, Rock 3 looked like Rock 6, but one featured what may be the most elaborate design on the Ben Lawers Estate, whilst the other carried three cup marks and a ring. It had more in common with smaller boulders that did not feature in this investigation. The positions of these panels in the landscape have been considered already, but did the placing of the designs on the rocks themselves have any significance?

Most studies of prehistoric rock art embark from the premise that the designs were intended to be viewed like pictures in a gallery, and in the case of Rock 1 at Allt Coire Phadairlidh there does appear to be a direct relationship between the location of a cobbled area beside the outcrop and the position from which the main design would have been visible. The excavation showed that other activities had taken place *on top of the rock itself*, for three of the four fissures in its surface contained worked quartz, as well as a piece of flint. Some of these artefacts could

have been a by-product of making the designs, but that hardly applies to the large assemblage excavated from the natural bowl on top of Rock 2 which included a few flakes comparable to those found during fieldwalking in Strath Tay. A few more pieces of worked quartz were found within a fissure in the surface of that stone. Such prominent outcrops might have acted like a stage on which special events took place. It is obvious that many of the lithic artefacts on rock art sites relate to the production of motifs (for instance hammerstones and associated debitage), but the flakes of flint, pitchstone and quartz found on Ben Lawers reflect a broader spectrum of activities. There is similar evidence from Torbhlaren, where groups of artefacts had been deposited in fissures or cracks on top of two carved rocks (Jones *et al* 2011).

Another activity has left a much clearer signature at the excavated sites on the Ben Lawers Estate where the carved rocks are associated with large amounts of broken quartz. The smashing of pieces of quartz against the

rock, and conceivably against one another, would have created a striking visual effect. When subjected to pressure, quartz crystals produce a charge known as piezoelectricity, one effect of which is the distinctive phenomenon of *triboluminescence*. The term describes the way in which pieces of quartz glow when they are struck or rubbed together. This can create a dramatic effect, but it is simply the result of the physical properties of the stone. For that reason there can be no doubt that people would have observed this phenomenon on Ben Lawers. How it was interpreted in the past is another matter. There is no way of telling whether these effects were endowed with a special significance, although ethnographic evidence shows that many societies believe that quartz possesses unusual powers (Whitley et al 1999; Jones et al 2011).

The distribution of worked quartz among the decorated stones at Ben Lawers raises another issue. Limited assemblages were associated with exposures of epidiorite (Rocks 3 and 6), compared to the substantial numbers associated with both the outcrops of mica schist (Rocks 1 and 2). Moreover, the presence of hammerstones on the decorated Rocks 1 and 2 seems to be anomalous when they were absent from Rocks 3 and 6. One might expect more hammerstones to be associated with the epidiorite due to the hardness of the material and an increased risk that they would fracture during use. It appears that Rocks 1 and 2 were intensively worked, yet both of them had less decoration than Rock 6.

Perhaps the surfaces of the mica schist Rocks 1 and 2 were modified to a much greater extent than we can see today. It seems possible that the surface of these rocks was struck or pecked to make them sparkle as the freshly exposed grains caught the light. The process of pecking would also create a significant quantity of dust that adheres to the surfaces and bodies with which it comes in contact. Indeed, a small quantity of 'glitter' remained on the washed finds and liberally covered one of the authors and his laptop during the analysis. The working of mica

schist boulders may have been as much about creating a substance that could be collected and used for ornamentation as it was about producing pecked designs. That may explain why the distribution of hammerstones did not reflect the positions of the carved surfaces on Rock 2. These artefacts may have been used on other parts of the outcrop.

Such evidence suggests that the rock art on Ben Lawers was more varied than is usually supposed. Epidiorite is a comparatively hard stone, and here the main effort may have been creating designs on such an intransigent material. Perhaps the outcrops of mica schist had a different significance. The surfaces of Rocks 1 and 2 may have been refreshed at intervals using quartz hammerstones until these prominent landmarks sparkled in strong light. In fact the hollow on top of Rock 2 may have been selected for embellishment precisely because it was in the right position to be illuminated by the morning sun. At the same time it is possible that the dust created by that process was collected for its special qualities. It may even have been incorporated in pigment. These can only be hypotheses, but they do recall accounts from different parts of the world which describe the unusual power of lustrous materials, and those that glitter and give off light (Whitley et al 1999; Saunders 2004; Lewis-Williams 2010; Conneller 2011, chapter 4). These effects can be compared with a distinctive phenomenon observed at Torbhlaren where the surface of the carved rocks may have been covered by a deposit of finely crushed quartz (Jones et al 2011: 197).

The implications of this analysis are obvious but a little unexpected. After 150 years of carefully recording rock carvings, it is time to pay equal attention to the material from which they were formed. The 'art' was obviously significant and so were the activities involved in creating, visiting and maintaining it, but the same may well have been true of the properties of the stone. They will require more attention from researchers over the next few years.

## ACKNOWLEDGMENTS

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