The Spiral that Vanished: The Application of Non-Contact Recording Techniques to an Elusive Rock Art Motif at Castlerigg Stone Circle in Cumbria.

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abstract.

This article describes the recording of stone 11 of the Castlerigg stone circle in Cumbria through two different non-contact techniques: laser scanning and ground-based remote sensing. Despite the unproblematic recording of modern graffiti, neither technique was able to document the spiral photographed and rubbed in 1995. It is concluded that the spiral was most probably painted and has since faded away due to natural events. The discovery and loss of of the spiral motif in Castlerigg is seen as a cautionary tale. In particular, it seems to suggest that it is time to take advantage of the novel technologies based on the digitisation of 3D surfaces with millimetre and submillimetre accuracy such as laser scanning and ground-based remote sensing. They offer many advantages to the recording of prehistoric carvings. In addition to avoiding direct contact with the rock surface eliminating the preservation concerns raised by other techniques, both produce high quality images (laser scaning offering a greater potential for this, but at higher cost) having a much higher level of objectivity, and precision and accuracy far beyond those of traditional recording methods such as wax rubbings and scale drawings.

Keywords.

Rock art recording, laser scanning, megalithic art, spiral.

The finding of the spiral motif and its invisibility.

The stone circle of Castlerigg (SMR 3000, NMR 22565, NTNMR 20131), set in the heart of the English Lake District in Cumbria attracts thousands of visitors every year, and is perhaps the best known prehistoric monument in Britain after Stonehenge and Avebury. Despite avid interest from the public, the site has received little attention from professional scholars, and it is only in the last ten years that a number of carvings, potentially of prehistoric origin, have been identified on the stones which make up the circle. One particular motif found in 1995, a spiral, is the focus of this article. The 'Spiral Stone' is located at the eastern side of circle, in position 11 using the SMR notation. It is situated in the main circle, but also forms part of the eastern end of a rectangular enclosure (fig. 1). The stone is approximately 1.5m high and 1m wide and is believed to be an erratic boulder originating from the Borrowdale volcanic series. It has a number of parallel linear geological features running diagonally across the smooth, vertical inward facing surface, and it was on this panel here that the spiral was detected, abutting the most pronounced linear feature; it had a diameter of approximately 0.5m (based on Beckensall's drawing) and a clock-wise direction.

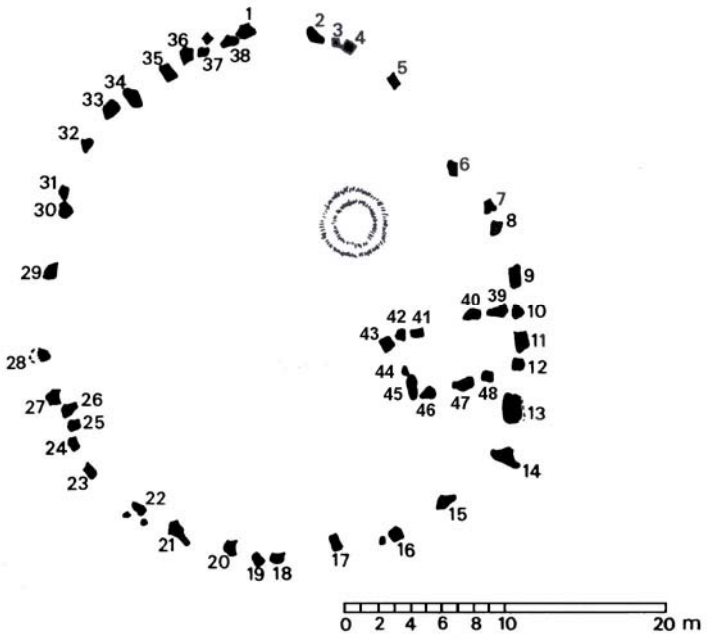


Fig.1 Sketch map showing the location of stone 11 at Castlerigg stone circle after Waterhouse [22, fig. 4.1]

The spiral motif was recorded on three different occasions soon after its initial identification. It was firstly photographed in winter, in late afternoon, by Nick Best and Neil Stevenson, then Newcastle University students [2, plate 18]. A copy of this photograph is now held by Clive Waddington (pers. comm. 23.4.05). Months later, a few days before the Autumn Equinox, it was again photographed by Hanna Casement of Eskdalemuir [2, fig. 82]. She provided a description of the discovery which was reproduced by Beckensall. Because of the details provided, we have considered it worth transcribing part of it once again:

> We decided to wait for the sunset, and as it began we were facing away from the stone watching the setting sun. It was purely by chance that I glanced behind me towards the stone, and saw that it appeared to be glowing orange and had this huge spiral coming out of the rock. It was absolutely unbelievable, as it had not been apparent all day. It seemed that it was only visible as the setting sun hit the rock. We were all completely amazed at the way this spiral seemed suddenly to appear, and tried to see if we could feel it carved into the rock. We couldn't feel anything very definite, but we could definitely see it, and took photographs to prove it. I have returned to the circle many times since to try to see the spiral again, but have never seen again what I saw that day. Nor have I been sure that I could feel the outline of it. But the memory of that extraordinary experience and discovery will remain with me forever, as the spiral seemed to be glowing out of the rock as the sun hit it.
> [2, p. 70-1].

Informed about the discovery, the well-known rock art researcher, Stan Beckensall, promptly went to the site to record it using his wax rubbing technique. In his book of Cumbrian rock art he explains that "the spiral was revealed after many attempts at rubbing the surface gently with wax on thin, strong newsprint, although the motif remained unseen. I have made other rubbings since, with the same result" [2, p.74]. "One of many rubbings made of the spiral", as the caption explains, is portrayed in figure 85, alongside a photograph of the recording process in which another well-known rock art avocational archaeologist, Paul Brown together with another person, hold the rubbing paper [2, fig. 85 and unnumbered in p. 75] (fig. 2). Beckensall also identified other motifs on stones 5 and 23, and lozenge shapes on stones 10 and 27 whose analysis will form part of a different study [12]. In his 1999 *British Prehistoric Rock Art*, however, Beckensall explained that 'there has been a real problem with this spiral. I have made a time-consuming wax rubbing of it, the spiral appeared, but I have not been able to see it on the rock itself!' [3, p.125].

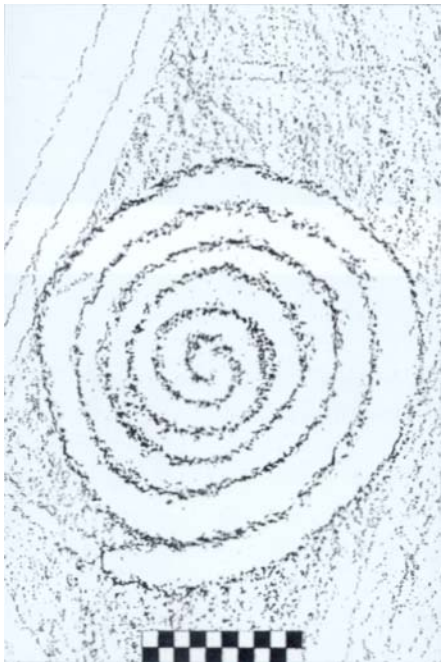


Fig. 2. Rubbing of the spiral published in Beckensall [2, fig. 85].

Since 1995, the spiral has never been seen again. As described in her letter, even one of the discoverers, Hanna Casement, was perplexed because of its invisibility after the first and only view of it. Everybody after her who knew about the spiral was also unable either to see or to feel it. In early June 2004, during the fieldwork related to our project, a group of blind and partially-sighted tourists visiting the stone circle were invited to feel the surface for any patterns but none were able to detect any carving. It was noted, however, that at this time the area where the spiral had been photographed was covered in lichen growth of various species. This contrasts with the colour photograph taken by Stevenson [2, plate 18] where the stone seems to be much cleaner.

Castlerigg circle has many visitors. We calculated that between 100 to 500 people visited each day that we were at the circle laser scanning the stones). As with many stone circles, the site is particularly popular during the period of the summer solstice and several accounts on popular web sites such as the megalithic portal (www.megalithic.co.uk) describe the awe aroused by the experience. The search for the spiral is also discussed on the Modern Antiquarian web site (www.themodernantiquarian.com). In April 2003 a contributor to this web site named Chris Collyer confessed that he had been unable to find the “elusive spiral carving”. In August 2003 he again admits defeat: “I was here this time to look at the carvings on the stones particularly the elusive spiral – second attempt, second failure. I managed to find the other 4 known marks, 2 of them are very faint and none are spectacular. There are several other stones that *may* have carvings that have yet to be recognised but the geology of the rock makes imagining cups, rings and grooves on their surface too tempting”. In April

2004 another contributor, ‘Hob’, discloses his own method to drive away visitors and mentions the spiral again:

> If you ever find yourself despairing of getting this circle to yourself, but can't get there when there's no-one else about, try the following: Put a blanket over your head, get a 1500kW rechargeable lamp, and hop about from stone to stone, whilst trying to angle the lamp in just the right way to find the spiral carving, mutterring 'No.... Nope, nope, not this one either...' to yourself as you go. (…) If you want to actually find the carving, check out Stan Beckensall's info, or that on the Rock Art in the British Landscape website. I wish I'd done that, then I'd have seen the spiral, but it wouldn't have been as much fun...
> (in www.themodernantiquarian.com).

In late June 2004 a test using artificial illumination with oblique light was undertaken by our research team using powerful 1000 watt lamps. No spiral motif was apparent, however these conditions did reveal modern graffiti in approximately the same area, close to the natural parallel markings (fig. 3).

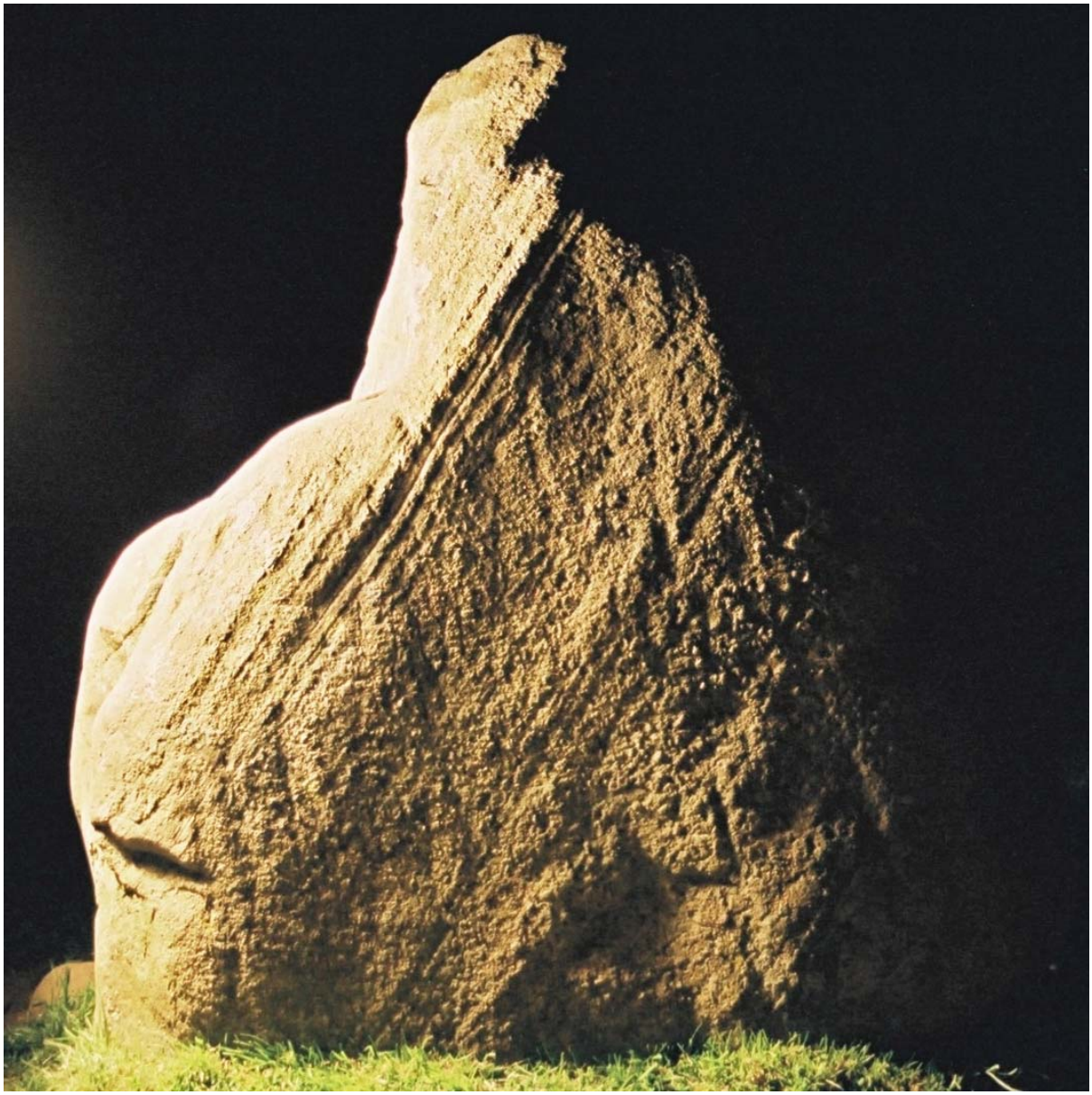


Figure 3.a Stone 11 in daylight; b. Stone 11 with oblique lighting; c. Modern grafitti highlighted by oblique lighting. Photogaphs by M. Díaz-Andreu.

Prior to the identification of the Castlerigg spiral, the distribution and significance of spiral motifs in British rock art was explored by Van Hoek [21]. Following its identification, rock art scholars integrated the spiral motif at Castlerigg into on-going debates. Frodsham [15] reproduced it on page 112 and published later by Evans and Dowson [14]. Despite the fact that the spiral motif is most frequently associated with the Irish (and Welsh) passage graves, they are also found on both outcrops (as at Morwick in Northumberland, and Achnabreck in Argyll) as well as on cist slabs, other burial monuments, and also on different types of material culture such as carved stone balls, mace heads and pottery. Locally, spiral designs are present on the standing stone of Long Meg[1]; on a stone in the cairn circle at Little Meg; and on a stone in the kerbed cairn at Glassonby. Examples of spirals on the uprights of stone circles are rare: only two others are known, and one of these is questionable. Van Hoek [21, p. 29] lists one at the Kiltierney stone circle, Fermanagh as bearing a spiral design although this is not reflected by the catalogue compiled by Shee Twohig [19, p. 224]. The second,

[1] Beckensall [2, fig. 70] recorded spirals on three other stones at the Long Meg circle but only one could be ascertained by the recording undertaken under our project, in the Long Meg pillar itself [11]. Our project did not include the laser scanning of the stones of the circle itself and therefore we are not in the position to give an opinion about them.

much clearer example is found at the Templewood southern stone circle in Kilmartin where a complex, triple ‘horned’ spiral design is located on the northernmost upright [18]. The spiral motif at Castlerigg has been mentioned as one of several features suggesting prehistoric connections between Cumbria, Ireland and Scotland [23]. Indeed, the spiral motif of stone 11 was one of the main features that inspired our project “Breaking through megalithic rock-art recording” (BTRAR), funded by the AHRB innovation awards, from which this article results. The application of highly accurate recording techniques such as the innovative technique of laser scanning seemed ideal for stone 11, for the spiral at Castlerigg was no longer visible to the naked eye and had not been photographed since 1995.

The laser scanning recording of stone 11.

The main bulk of the laser scanning of all the stones of the Castlerigg stone circle was undertaken by a team from the Computer Science Department at Bristol University under the direction of Dr Alan Chalmers in June 2004. The data set was acquired with a Minolta 910 laser scanner and consisted of roughly 21.6 Gigabytes of data. For most of the stones they also undertook the trimming of unwanted data and merging the individual scans into a 3D surface by joining the individual elements together (as described in [1]). All the individual standing stones were processed by Michael Rainsbury. Some of the results obtained by the laser scanning can be seen in the rock art web page of the Prehistoric Rock Art Interest Group of the Durham University (www.dur.ac.uk/prehistoric.art/). The data related to standing stones 1-10 and 12-48 will be the focus of a different article [12].

The results obtained on stone 11 presented particular challenges. Because of the importance held by stone 11, its scanning was undertaken at a high resolution. This resulted in more than 205 separate scans and 3.9 Gigabytes of data. The sheer quantity of data led to previously unforeseen difficulties in acquisition and merging. The quantity of data meant that a full visualisation of the scan of the whole stone was not possible and so data coverage of the northern edge of the stone is poor. Sets of individual scans were merged together and decimated before in turn being merged with other decimated scans so building up the image of the stone. This manner of construction allowed the huge volume of data to be handled efficiently. Initial visualisation failed to find any carved spiral on the stone. However the data set had been heavily decimated to be able to view it in 3D. Individual scans over the location of the spiral were assembled and processed at lower degrees of decimation. These were then passed on to Nick Rosser for processing at little to no decimation through software available in the Department of Geography, Durham University.

The data was processed using firstly Demon3D (Archaeoptics Ltd) and then ENVI RT 4.0 (RSI) (for more details on the method see [11]). The result is seen in figure 4. Several features can be observed. The natural bedding of the rock is evident as oblique striation. It is particularly obvious in the upper left hand side third of the stone. An example of graffiti is clearly recorded in the upper part of the figure. It became clear that no spiral, or part of a spiral, is to be seen. In order to double check this, several cross sections were extracted from the dataset using the Demon software. These are shown in figure 4g. Again, no positive results are found. If lines had been carved in the surface, a see-saw profile should be seen.

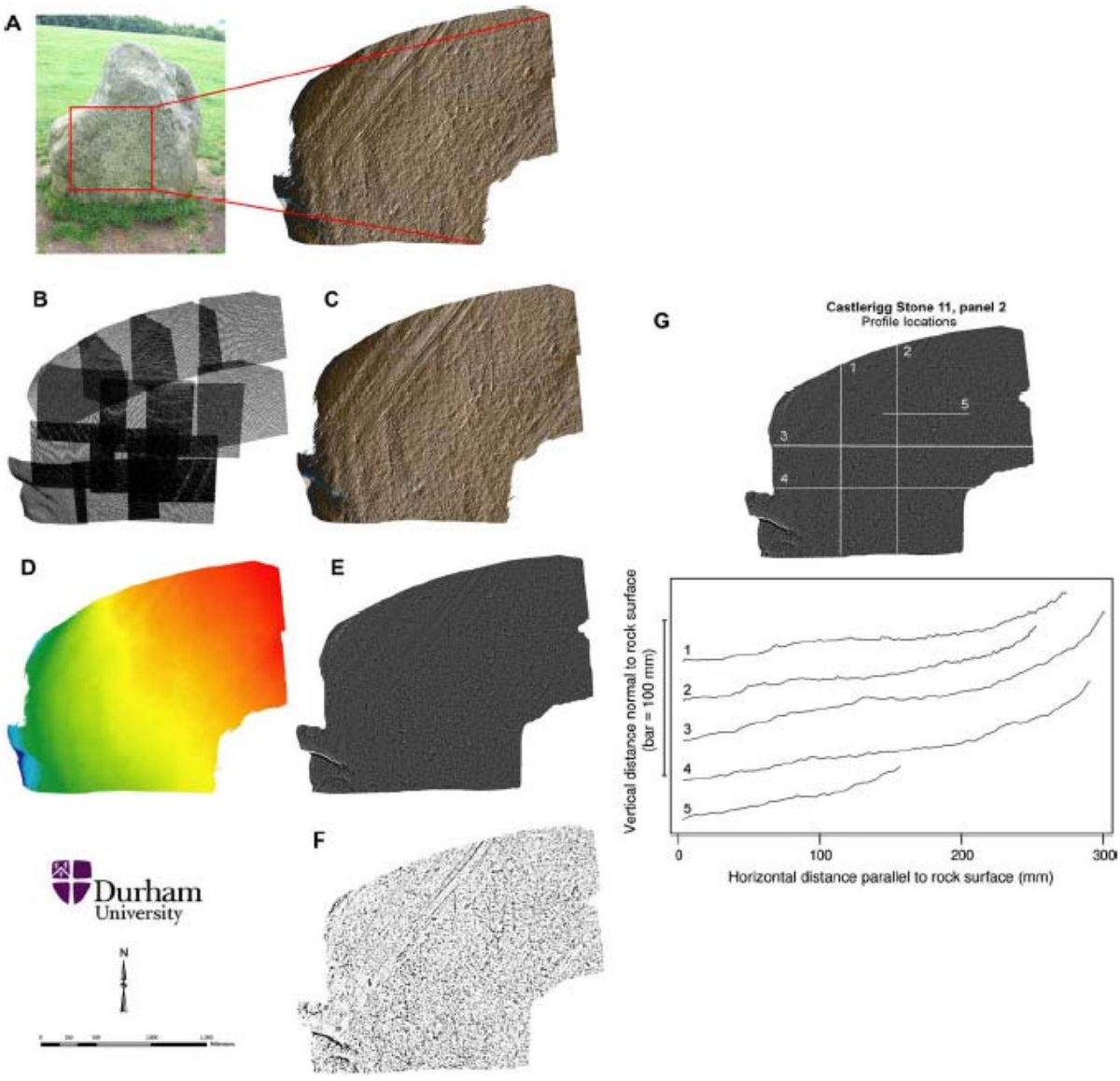


Figure 4a. Stone 11. Photograph of the stone with demarcatin of scanned area.
4b. Raw point cloud data, showing the overlap between the individual laser scans
4c. Mesh generated using view dependant triangulation, displayed with coloured directional lighting, processed in Demon3D

4d. Height model of rock surface, where the transition from red to blue represents increasing distance from the viewpoint
4e. Result of processing the laser data using a high pass convolution filter processed in ENVI RT 4.0 to examine surface texture.
4f. Image derived from using a threshold filter on the image displayed in 4e to emphasise surface textures.
4g. Cross-sections.

Ground-based remote sensing survey.

The lack of results from the laser scanning made the team wonder whether erosion was a possibility. Chris Brooke, an expert on ground-based remote sensing survey, was contacted. Remote Sensing is an established science that is well described in the literature [16]. Ground-based remote sensing, adapted from aerial and orbital methods of survey, offers a nondestructive toolkit that employs precise methods of remote, electromagnetic examination capable of revealing archaeological and natural features in buildings and objects that are not visible to the unaided human eye [4, 5, 8]. Techniques, using laser surface profiling (not to be confused with laser scanning, which is an entirely different process), and contrast enhancing illumination, have been developed that are capable of revealing very faint incisions and surface decoration on eroded and damaged monuments [6, 7].

Five methods of ground-based imaging were employed in the examination of the Castlerigg stone: Multispectral imaging; CEI (Contrast/Contour Enhancing Illumination); MASS (Multiple Angle Surface Saturation); LASP (Laser Surface Profiling); and Ultraviolet fluorescence. The resulting imagery was digitally processed using the following broad categories of analysis: Histogram stretching and ROI/zonal equalization; Noise removal and smoothing; Density slicing, pseudocolourization, and gradient profiling; Multispectral image registration; Morphological operations (minimization convolutions and region growing); Cluster analysis (k-means and segmentation); Edge detection (Sobel, Robinson, Prewitt, Canny, Laplace, and custom); Fast Fourier Transform (FFT) filtration (2D, frequency domain) and signal amplification using ideal and custom filters.

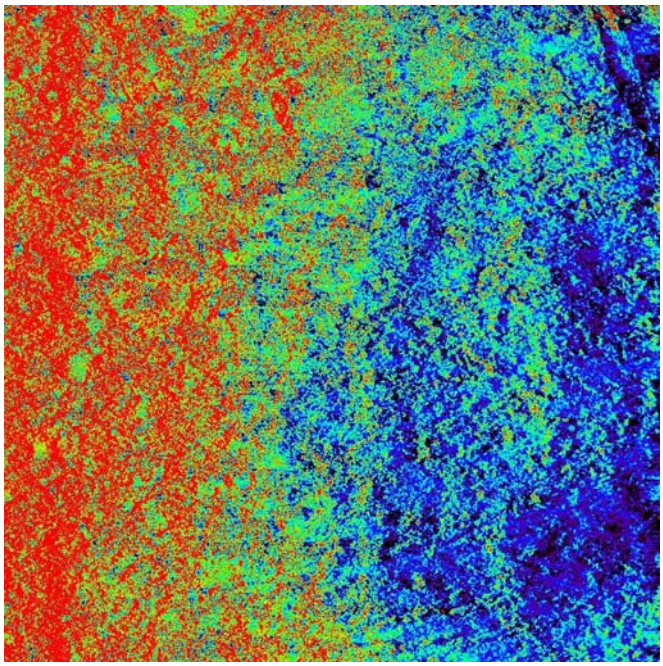
The object of the examination was to determine if any evidence of incised or surface decoration could be discerned: a) in non-visible regions of the electromagnetic spectrum (near ultraviolet, monochromatic notches in the visible region, red-edge, and near infra-red), b) by visible fluorescence when excited by UV radiation, c) by imaging fractional surface variations under extreme angular illumination (CEI) and saturation of the outer surface

(MASS and LASP) using Xenon discharge and He-Ne laser sources with absence of background radiation (< 1lm m^{-2}). Although the surface was, in part, obscured by lichen and bryophyte growth, and was in itself highly irregular in form, useful results were obtained from the remote sensing survey.

Visual results showed that that no detectible fluorescence resulted under 50 W UV illumination, concluding that the surface vegetation did not exhibit any significant fluorescence using the selected excitation wavelengths (0.32 – 0.4 μM), nor was there any apparent signal from the rock surface. However, it must be noted that any surface decoration (as opposed to incised decoration) might be obscured by the lichen/bryophyte covering.

Images taken in the near infra-red (0.69 – 0.9 μM) show typical variations in the thallus covering and an anomaly in the form of a dark, elliptical feature, probably in the lichen/bryophyte structure, that may be echoing a surface anomaly of roughly circular form on the stone beneath (figure 5). The position of this anomaly does not match that of the earlier photographs showing the 'spiral'; its origin and nature are unknown and may be due to natural effects. Imagery produced in other bands – ultraviolet and monochromatic notches - reveal distinctive vegetation and geological traits, but no man-made structures are evident (figure 6).

Figure 5. Extract of an area of the stone, above where the 'spiral' was seen, that shows an anomalous elliptical feature. Filtered using a cross extraction custom filter in the frequency domain. Produced by: Dr Christopher Brooke.



(ALTERNATIVELY USE THIS FIGURE

Figure 5. Extract of an area of the stone, above where the ‘spiral’ was seen, that shows an anomalous elliptical feature. Filtered using a cross extraction custom filter in the frequency domain with applied density slice Produced by: Dr Christopher Brooke.)

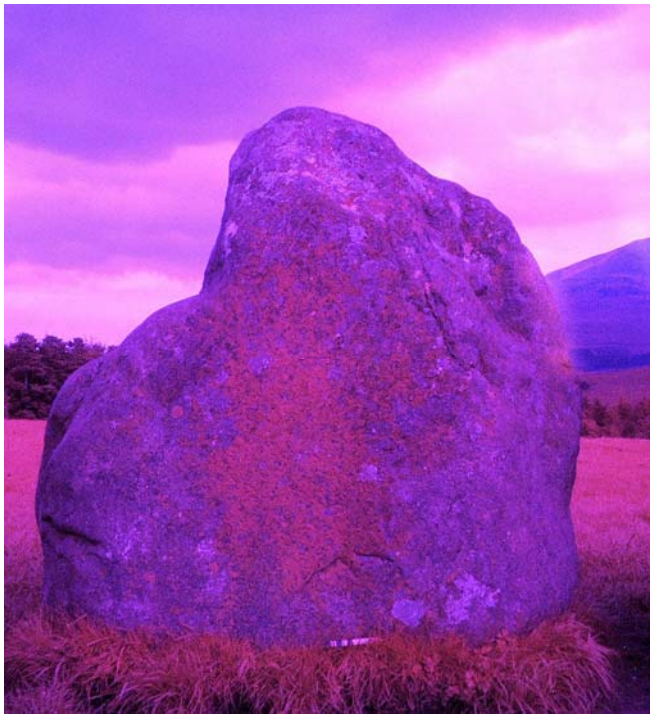


Figure 6. False-colour UV-IR image of the stone face (blue= ultraviolet 0.32 – 0.4 µM; red = near infra-red 0.69 – 0.75 µM). Produced by: Dr Christopher Brooke.

The use of CEI, MASS, and LASP provides a good indication of the geological form and

shape of the stone and of the probable natural erosion markings on its inner face (figure 7). Very fine pitting and scratch marks are evident and if any man-made incision was present it ought to be visible in these images. The LASP imagery shows possible delamination and the rough nature of the surface caused by the extensive lichen and bryophyte growth, but the only man-made incision revealed is an apparent area of graffiti with the possible name ‘Kelly’, undoubtedly of modern origin.

Figure 7 – Figure 29: Contrast/Contour Enhancing Illumination (CEI) image, revealing natural erosion and geological features on the face of the stone.

‘The Emperor’s New Clothes’.

All the different analyses undertaken during the “Breaking Through Megalithic Art Recording” project point to the same result: there is no carved spiral on stone 11 at Castlerigg. Neither the oblique artificial illumination, the laser scanning, nor the ground-based remote sensing survey have been able to corroborate the existence of rock art on the stone. Yet, there are two photographs taken by two completely independent parties that seem to prove that in 1995 there was indeed a spiral present. Interestingly, in the description provided by Hanna Casement, she explains that, even at the time when the photograph was taken, neither her companions nor she could feel “anything very definite” carved on the rock. In our analysis of the problem, we concluded that this comment opened the possibility of the spiral having been painted, and not carved, on the stone. With this in mind we contacted Tom Errington, an artist colleague of one of the authors of this article, Chris Brooke. Errington

wondered whether the definition of the spiral as seen in Stevenson's photograph was formed by the colour of the lichen. It seemed that the spiral had been painted onto the stone at some point but when the photograph was taken it was no longer present. The lichen seemed to have rubbed off due to natural events. Errington suggested that one of the possible substances the spiral could have been made with was yoghurt (Errington, pers.comm. 3.10.2004). Its final disappearance could be due to natural causes.

The discovery and loss of the spiral motif in Castlerigg is a cautionary tale. Both professional and avocational archaeologists and other enthusiasts could perhaps be associated with the emperor in 'The Emperor's New Clothes' childrens' story: all of us have been too eager to believe what we could not see. Not all of the story is, however, relevant: we do not want to imply here that the spiral was made purposely as a fake. Most probably, whoever created the spiral on stone 11 never forsaw the consequences. Perhaps they remain unaware of them even today. For professionals there is perhaps another lesson to learn from the vanishing spiral on stone 11: the techniques traditionally used for recording rock art in Britain are clearly fallible. With a few exceptions, the majority of recordings currently available have been produced by enthusiasts with basic tools, often under difficult conditions in the field. The most frequently employed techniques have been free hand drawing, tracing, and the most popular in the last two decades, rubbing[2]. These all present some problems: they document in two-dimensions what are essentially three-dimensional surfaces and volumes, and both tracing and rubbing are invasive, potentially affecting rock art preservation. This is especially true of rubbing when carried out with acid paper such as that used for the production of newspapers [10, 17].

The techniques traditionally used in Britain to record prehistoric carvings also involve a high degree of subjectivity; so recordings undertaken on separate occasions may vary. At Castlerigg only a set of rubbings, perhaps undertaken in the same day, had been produced before the start of our project. The one published clearly showed a spiral. Because nobody else has been able to record stone 11, no comparison can be made. In our experience during our many attempts to see the spiral we found that intense scrutiny of the stone resulted in our beginning to see a variety of circular patterns. This was perhaps due due to the nature of the stone, composed, as Beckensall himself explains, of "tiny pinpoints of minerals", combined with the natural tendency of the human brain to seek patterns in these small variations of colour and depth. This need of the human psyche to create sense from chaos introduces a highly subjective element into the recording process and is yet another reason for the adoption, where possible, of the new, more controlled recording methods.

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[2] Other techniques such as casting and photography have been mainly used for illustration rather than for recording (although see [13]).

Projects such as “Breaking through rock art recording: three dimensional laser scanning of megalithic rock art” [11, 20] have been able to demonstrate that novel technologies based on the digitisation of 3D surfaces with millimetre and submillimetre accuracy such as laser scanning and ground-based remote sensing – as well as others based on the use of photogrammetry (see [9] – offer many advantages to the recording of prehistoric carvings. In addition to avoiding direct contact with the rock surface, eliminating the preservation concerns raised by other techniques, both produce high quality images (laser scaning offering a greater potential for this, but at higher cost) having a much higher level of objectivity, and precision and accuracy far beyond those of traditional recording methods such as wax rubbings and scale drawings. It is time to move forward.

Acknowledgements

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References

[1] T. Barnett, A. Chalmers, M. Díaz-Andreu, G. Ellis, P. Longhurst, K. Sharpe & I. Trinks 3D Laser Scanning For Recording and Monitoring Rock Art Erosion, *International Newsletter on Rock Art (INORA)* 41 (2005) 25-29.

[2] S. Beckensall, *Prehistoric rock art in Cumbria. Landscapes and monuments*, Stroud,

Tempus, 2002.

[3] S. Beckensall, *British Prehistoric Rock Art*, Stroud, Tempus, 1999.

[4] C.J. Brooke, *Ground-Based Remote Sensing*, Technical Paper No 7, Birmingham, The Institute of Field Archaeologists, 1989.

[5] C.J. Brooke, Ground-Based Remote Sensing of Buildings and Archaeological Sites: Ten Years Research to Operation, *Archaeological Prospection* 1 (2) (1994) 105-119.

[6] C.J. Brooke, 'Their Name Liveth': A Remote Sensing Survey to Decipher the Illegible Inscriptions on St Mary's War Memorial, Nottingham, *Industrial Archaeology Review* 17 (1) (1994) 75-78.

[7] C.J. Brooke, MASS and LASP: Two Ground-based Remote Sensing Techniques for Recovering Illegible Carved Detail, *Graphic Archaeology* (1995) 19-22.

[8] C.J. Brooke, The Application of High Resolution Photographic Remote Sensing and Digital Image Processing in the Archaeological Examination of Historic Buildings, in D.N.M. Donoghue & Y. Zong (eds.) *RSS 96: Remote Sensing Science and Industry. Proceedings of the 22nd Annual Conference of the Remote Sensing Society.* Nottingham: The Remote Sensing Society, 1996, pp 667-675.

[9] J.H. Chandler & J.G. Fryer Recording Aboriginal rock art using cheap digital cameras and digital photogrammetry, *Rock Art Research* 22 (2). (2005), pp 119-130.

[20] J. Coles A measure of conviction: recording emphasis in Scandinavian rock carvings, *Antiquity* 77 (2003) 576-571.

[11] M. Díaz-Andreu, R. Hobbs, N. Rosser, K. Sharpe & I. Trinks Long Meg: Rock Art Recording Using 3D Laser Scanning, *Past* 50 (2005) 2-6.

[12] M. Díaz-Andreu, M. Rainsbury & N. Rosser (in preparation) Result of the laser scanning of Castlerigg stone circle.

[13] E. Donnan 'Recording British Rock Art', *Tracce 11*. (1999) http://www.rupestre.net/tracce/donnfra.html.

[14] E. Evans & T.A. Dowson Rock art, identity and death in the early Bronze Age of Ireland

and Britain, in V. Cummings & C. Fowler (eds.) *The Neolithic of the Irish Sea.* Oxford: Oxbow, 2004.

[15] P. Frodsham, P. Spirals in Time: Morwick Mill and the Spiral Motif in the British Neolithic. In Paul Frodsham (ed.) Neolithic Studies in No-Man's Land. *Northern Archaeology* 13/14, 1996, pp. 101-138.

[16] T.M. Lillesand & R.W. Kiefer, *Remote Sensing and Image Interpretation.* New York: Wiley. 4th edn, 1999.

[17] L. Loendorf, Rock Art Recording, in D.S. Whitley (ed.) *Handbook of Rock Art Research.* Walnut Creek, London, New Delhi: AltaMira Press, 2001, pp. 55-79.

[18] J. Scott, The stone circles at Temple Wood, Kilmartin, *Glasgow Archaeological Journal* 15 (1989) 53-124.

[19] E. Shee Twohig, *The Megalithic Art of Western Europe.* Oxford: Clarendon Press, 1982.

[20] I. Trinks, M. Díaz-Andreu, R. Hobbs & K. Sharpe, Recording rock art using 3D laser scanner data, *Rock Art Research* 22(2), (2005), pp. 131-9.

[21] M. van Hoek, The spiral in British and Irish rock art, *Glasgow Archaeological Journal* 18 (1993) 11-32.

[22] J. Waterhouse, *The stone circles of Cumbria.* Chichester: Phillimore, 1985.

[23] A. Watson. & R. Bradley, In the Image of Ireland? Monuments and Landscape in Neolithic Cumbria, *Archaeology north* 22 (2004)11-13.