

THE DUNCRAGGAN STONE

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A sundial stone inscribed with the date 1666 was found some twenty years ago at a place called Duncraggan on the southern edge of the Scottish Highlands, lying in a pile of rubble. Its owners were intrigued by its history, if it was genuine, and whether it could be restored. They approached the BSS, and subsequently Macmillan Hunter, on these points. This article completes the story, with grateful acknowledgement at the end to the several contributors.



Fig 1. The Duncraggan stone, showing sundial hour lines and numerals with date 1666.

INVESTIGATION OF THE STONE

Visual Examination

The stone is marked out as a sundial with hour lines, half hour marks, and numerals and it carries the date 1666 (Fig. 1). The gnomon slot was found empty except for remnants of lead packing. The stone is a piece of carved sandstone about 25 cm square and 4 cm deep with a rebate round the underside. The hour lines run clockwise showing that it is a horizontal rather than a vertical sundial.

An immediate question is whether the sundial is genuinely as old as 1666, or is it more recent, or even a modern piece. The form of the numerals with '6's having a tail wrapped to the right is not unlike styles of writing in the 17th century. And the numerals face inwards rather than outwards, unlike today's sundials. The lettering appears irregular in places, primitive even, and suggests amateur work. The '8's have rather a weak form like two 'O's one above the other. Some

letters appear to have been re-cut; the '2' completing the '12' seems squashed into place, the '4's might be modern. Recent scratch marks seem to have been used to pick out parts of the detail.

The top surface of the stone is pitted and worn away in shallow hollows, the surface falls off towards the edges, and all corners and edges are worn or damaged (Fig. 2). The surface wear looks like weathering by wind, rain and the four seasons over long periods; quite reasonably this could have been over three and a half centuries. Although the stone was found in a heap of rubble, all of the carved, worn and damaged surfaces are weathered; none is fresh or very recent.



Fig 2. Indications of wear on the stone.

Original Location

Duncraggan is an unlikely place to find a sundial. At least, it would be very unlikely to find an ancient sundial of the grand Scottish style in such a place because the surrounding land is extremely poor and wet, not the location for a substantial landowner in the seventeenth century building a large mansion house with pleasure gardens. Duncraggan is a croft, at that time offering an eked-out subsistence living from the land supplemented with fishing in the river and lochs. Situated 10 km west of Callander in Stirlingshire, it is quite close to the Trossachs, which did not become famous until two hundred years later when Queen Victoria opened Glasgow's new water supply at Loch Katrine in 1859. The 1666 date of the sundial, however, is not unreasonable when compared with the 1630 date of the earliest and grandest of Scottish sundials at Drummond Castle, 30 km to the east.

The stone is characteristic Scottish sandstone very likely to be from Kingoodie quarry, Invergowrie, next to Dundee, 80 km to the east of Duncraggan. The colour and flakiness of the stone are distinctive from that quarry. Similar sandstone from Alloa, near Stirling, has more pink in its colouring. This does not explain why a small stone sundial came to be found where it was, but it does suggest that at some time in its history it was taken from one place to the other. One clue might come from the hour lines; for example were they made for the latitude of Dundee?

Analysis of Hour Lines

A pencil tracing of the hour lines showed up well enough to be transferred to computer and overlaid with precise lines drawn in at calibrated angles using computer graphics (Fig. 3). In case this method relied too much on judgement by eye, the study was repeated using a photo of the sundial instead of the tracing (Fig. 4). A further cross-check might have been to analyse the half hour marks, but this was not done. The two sets of hour line angles were then compared with calculated hour line angles for several latitudes. If the hour lines matched a particular latitude it would provide additional information on the design location of the sundial.

The latitude of Edinburgh, 56° N, was used as a reference. If the hour lines matched a latitude north of Edinburgh, the

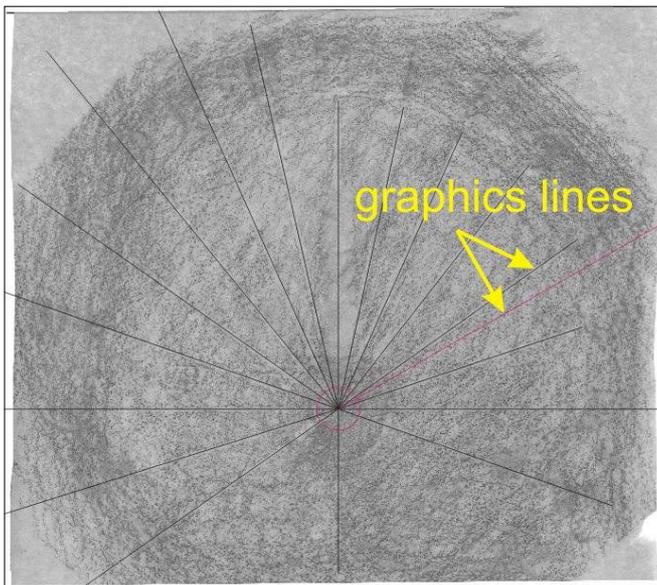


Fig 3. Pencil tracing of the dial surface after transferring to computer graphics and overlaying precise hour lines at known angles.

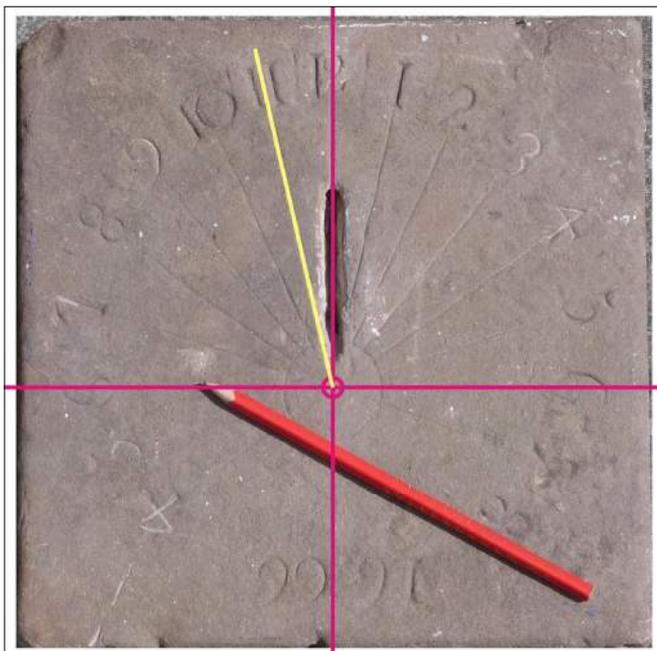


Fig 4. Photo of the dial surface after transferring to computer graphics showing reference hour lines (red) and 11am hour line (yellow).

sundial might be said to be in its home territory, but if they matched a more southerly latitude it might be far from home. To cover the whole of Britain equally, the other latitudes were 51°, 53.5°, and 58.5°, shown in Fig 5. In this graph, the hour line angles obtained from the tracing and from the photo are consistent with each other and, surprisingly, they match latitudes in the broad range 51° to 53.5°. They do not match 56° and they do not indicate that the design was for any latitude higher than 56°. The design appears to be for somewhere from Yorkshire southwards.

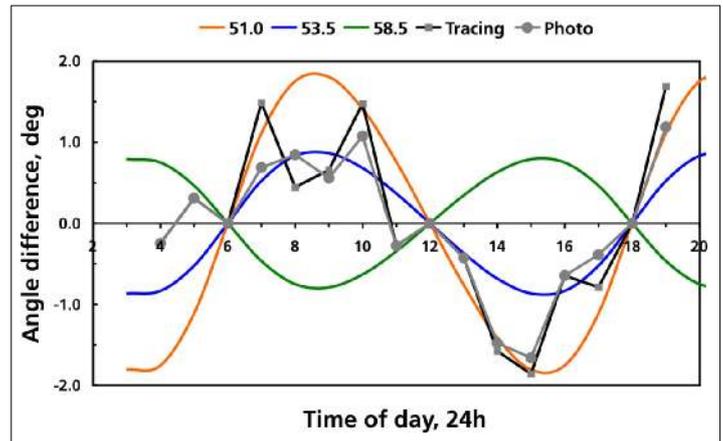


Fig 5. Analysis of hour line angles as a difference from computed angles for latitude 56°—angles derived from tracing and photo of the stone compared with angles for latitudes 51°, 53.5° & 58.5°.

Laboratory Analysis

Another aspect of the sundial that might indicate its history would be the material the gnomon was made from. If it was iron and any fragments remained they could be analysed and might be characteristic of a particular era. But, as mentioned above, the gnomon slot was empty. The residual lead packing at the bottom of the slot did show the imprint of a gnomon plate but did not contain any metal fragments. The gnomon, or the last gnomon fitted, must have disappeared, perhaps broken or knocked out or fallen out.

In order to prepare the stone for fitting a new gnomon, all the residue needed to be cleaned out of the slot, and this was carefully kept. Apart from the pieces of lead, the rest appeared to be dust but this was actually a mixture of iron with sand from the sandstone, which could be separated using a magnet (Fig 6). These fine particles were sub-millimetre in size, as revealed by electron microscope (Fig. 7). The presence of iron was confirmed by its definitive X-ray signature (Fig. 8). The residue material is still available for further examination, if it is of interest.

RESTORATION OF THE SUNDIAL

Design of New Gnomon

Because of the plain design of the sundial stone, a plain design of gnomon seemed suitable. A simple triangular flag was chosen (Fig 9). This needed to fit accurately into the existing slot in the stone and to provide for secure fixing. The design drawn up for manufacture had an oversize



Fig 6. Entire residue recovered from the gnomon slot, separated as iron, sand, and lead particles—the iron was separated by magnet.

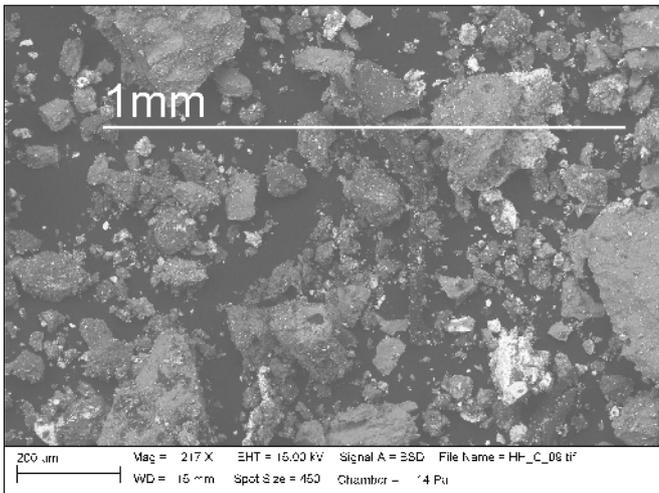


Fig 7. Sample of mixed fine particles of mainly iron and sand displayed as back scattered electron (BSE) image, shown against 1mm size scale.

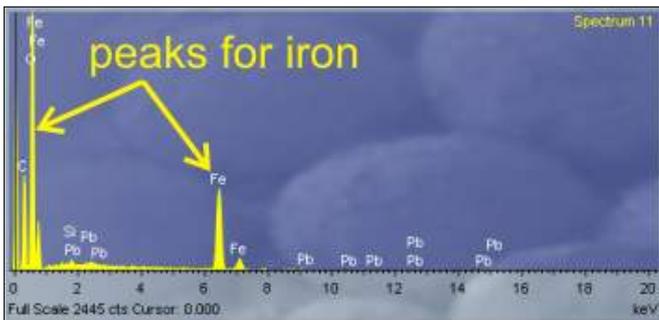


Fig 8. Energy dispersive X-ray (EDX) analysis of a single particle showing a definitive signature for iron.

flange, for final fitting after it was machined. The gnomon angle (style height) was made 53° , consistent with the hour line analysis explained above.

Stainless steel and brass were offered as choices for the gnomon material, in either case to be sandblasted leaving a dull finish rather than a polished one. The material chosen was brass. The gnomon was cut out by CNC machining.

Fitting the Gnomon

The gnomon flange was fitted by hand to go exactly into the slot, which had an irregular shape. Because the sundial

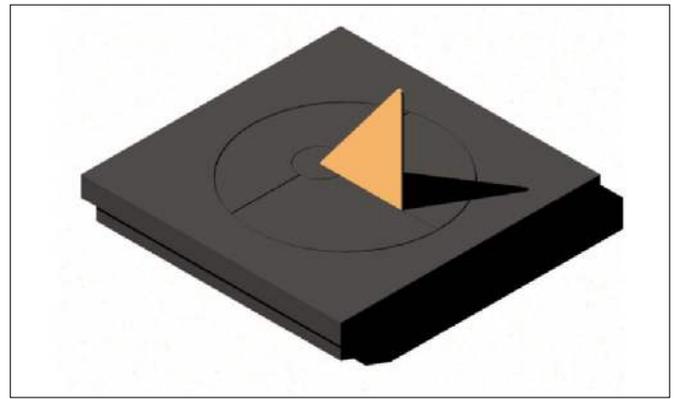


Fig 9. Chosen design of new gnomon for the stone.

stone was not strong, at only 4 cm thick, and because of its flaky sandstone layers, the slot itself could not be cut to fit in case the stone broke or split apart. For the same reason, a proprietary lime mortar type of mix was selected for fixing the gnomon, in a colour to match the stone. Packing with lead would risk splitting the stone (even though it had been done before), and a modern resin bond would be strong enough to split the stone if the gnomon was hit or forced by accident at a later date. Instructions for setting the gnomon correctly were provided (Fig 10).

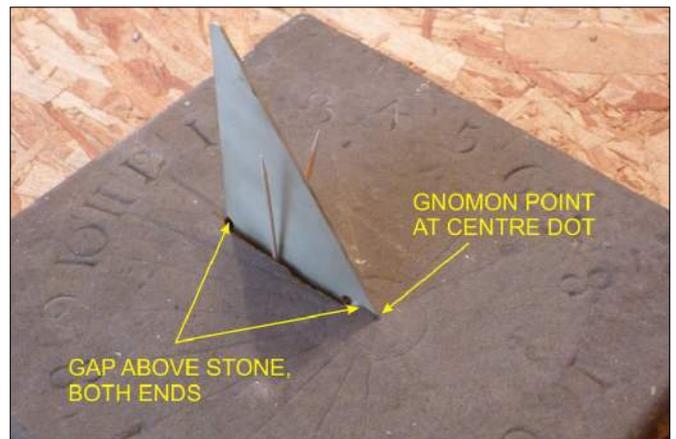


Fig 10. The new gnomon machined in brass and sandblasted, with instructions for setting it into the stone.

The finished sundial has a pleasing look (Fig. 11) and the gnomon proves to have been correctly set (Fig. 12).

Discussion

The restored sundial now provides a very satisfactory working timepiece with historical associations for its owner to enjoy in their garden. The inscribed 1666 date, the seventeenth century epoch of developing the art of stone sundials in Scotland, the curled but basic style of carved lettering, and the worn and weathered stone coming from a Scottish quarry, all point to a genuine item of three hundred and fifty years old. Over its long lifetime some of the sundial lettering may well have been re-cut where it had become worn away. It is not exceptional for the Museums of Scotland to receive requests for advice on small sundial stones. In fact, sundials do appear as a subject in school textbooks of the period, so amateurs did make sundials for themselves

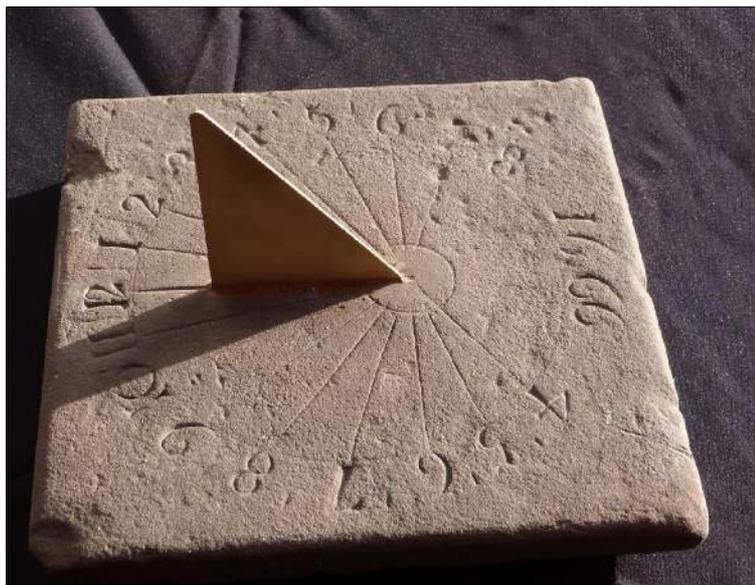
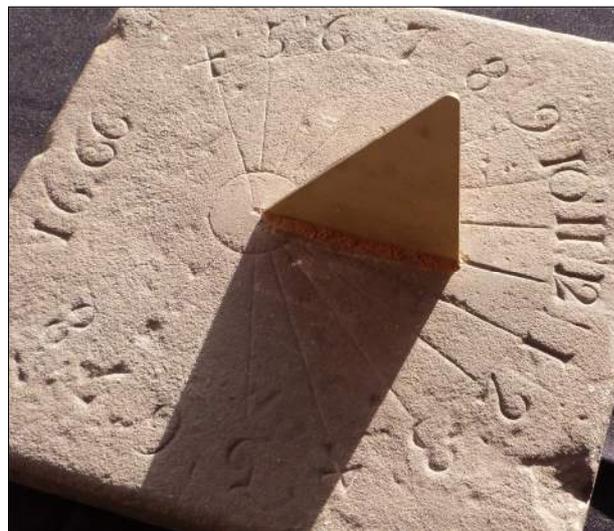


Fig. 11. Restored sundial reading 10am.

Fig. 12 (above right). Gnomon position at the sundial origin verified by shadow along 6pm hour line.



as well as skilled masons who made them for their employers. The apparent inconsistency between the south latitude of the design and the Scottish location for the stone may simply be that the hour lines were copied from another example or from a book. The location at Duncraggan could be where the sundial's owner from some more recent time had moved to live. The decision to use brass for the gnomon is appropriate today, although long ago the choice would have been iron.

Conclusions

The small sundial stone inscribed with the date 1666 found at Duncraggan in the Scottish Highlands appears to be a quite genuine example of work from that period. Characteristics of the lettering, the quarry stone, and the weathering, all support the reckoning that it is three hundred and fifty years old. It is probably amateur work, which was not uncommon at the time. Its design may have been copied from another example or from details in a book. The sundial is now restored with a new brass gnomon and the owner intends to install it in their garden.

ACKNOWLEDGEMENTS

Responding to the original enquiry, our Chairman Frank King in consultation with fellow BSS members, advised on the 1666 date for the stone. Alison Morrison-Low, Principal Curator of Science at the National Museums of Scotland, Edinburgh, advised on the characteristics of stone sundials in 17th century Scotland and on education about sundials at that time. Staff at the Mineralogy Department, Natural History Museum, London, carried out laboratory analysis. Nick Sweeney, stonemason with wide experience of restoring historic stonework in Scotland, advised on sundial restoration.

Alastair Hunter is a retired engineer from Edinburgh. His interest in sundials was triggered five or six years ago when he thought he would like to have one in his own garden. He looked at what was available but didn't see any he liked, so he decided to design his own. His idea was to take the ancient technology of the sundial and use it to create something with a cutting-edge contemporary design. His Macmillan Hunter range of sundials went on display in 2012 for the first time, at both The Chelsea Flower Show and Gardening Scotland. He is currently working on a number of bespoke designs for home and overseas, doing restorations, and giving talks to local societies. He can be contacted at sundials@macmillanhunter.co.uk.



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Frank King wins the Sawyer Dialing Prize

The Sawyer Dialing Prize is awarded annually by the North American Sundial Society for services to sundialling. The 2012 Award was to our own Chairman, Frank King, and the citation states that it was "in recognition of his innovative mathematical and astronomical solutions to problems encountered in the modern design of notable sundials".

The prize, a glass Spectra sundial delineated for Cambridge, with details of the award and with the motto ΖΗΘΙ (which is the Greek for *Life!* and is also the numbering on some Greek sundials) was presented at the NASS Conference in August 2012. For his acceptance talk, Frank gave a version of the paper *See Naples and Dial – An Italian Job* which he gave at the BSS Conference earlier in the year.

One of the nice features of this international prize is how it has been won for so many different aspects of dialling—making dials, mathematics and computing, teaching, historical research and so on.



Roger Bailey

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