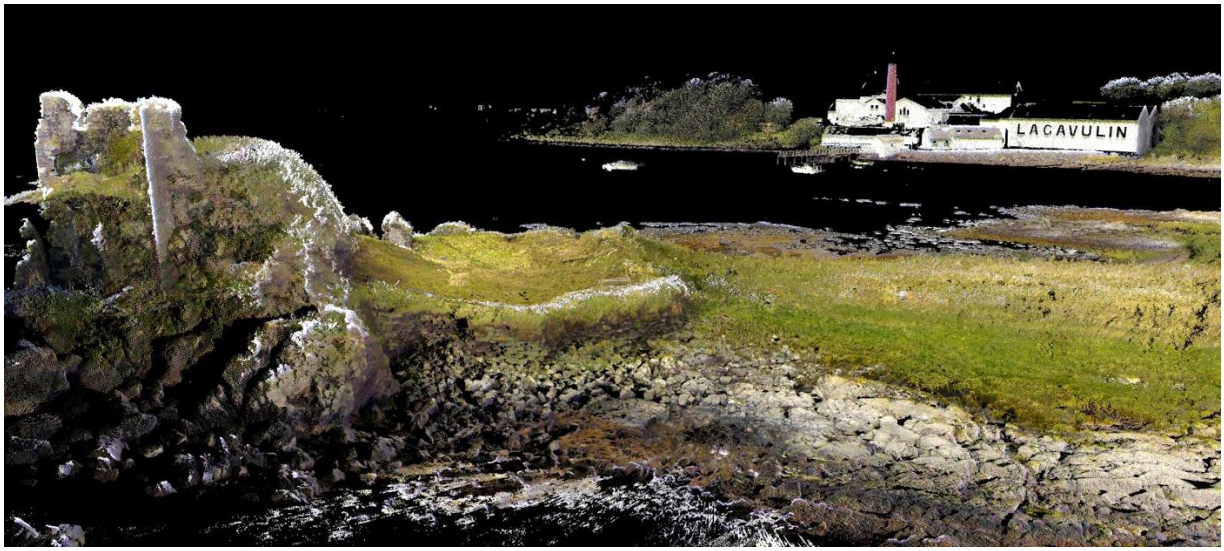
ISLAY HERITAGE
DUALCHAS ÌLE

DUNYVAIG CASTLE

Results of the electrical resistance and the terrestrial 3D laser scan surveys

August 2017



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Introduction

Islay Heritage is working with a range of academic partners to devise a multi-year archaeological project centred on Dunyvaig Castle starting with an archaeological assessment of the castle and its environs in summer 2018. The project will address a range of research questions concerning the origins and the history of the castle, its place and the role in the landscape, its maritime importance and so on. The project will provide a field school for students and Islay volunteers and it will pave the way towards the conservation of the monument and its better presentation to the visitors. The starting point in this process is the modern digital survey of the castle, which has only been professionally surveyed once before in the 1970s by the Royal Commission for Ancient and Historical Monuments in Scotland (RCAHMS 1984).

In August 2017 Islay Heritage commissioned a terrestrial 3D laser scan survey of the castle and the initial geophysical survey of the castle courtyard and the immediate approach to the northeast.

Electrical Resistance Survey

Electrical resistance survey is a geophysical technique which maps differences in the resistance to the electrical current in the ground. It is particularly sensitive to the presence or absence of moisture in the ground, which decreases or increases the resistance and conductivity, respectively. As such, this technique is particularly well suited to tracing stone built features, e.g. walls, which contain very little moisture in contrast to the surrounding soft deposits. However, one has to be cautious in interpreting the electrical resistance data, as the ground conditions can vary, especially in relation to the weather conditions, i.e. ground saturation, vegetation and the presence of bedrock near the surface. On one hand, too much water in the soil can mask subtle differences between the features which would otherwise retain moisture for longer than the surrounding ground, such as filled in ditches, pits, post-holes, etc., and they will go undetected as a result. On the other hand, if the bedrock is too near the surface it will show as a high resistance area and could mask archaeological features or could even be mistaken for artificially built walls, platforms or demolition rubble spreads. Both of these factors are an obvious danger in the Hebridean landscape, especially on a coastal promontory such as Dunyvaig.

Electrical resistance survey was carried out by a team from the University of Reading led by Dr Robert Fry. The survey was carried out using RM-15 electrical resistance meter with twin probe configuration, 0.5m probe spacing, 0.5m traverse spacing and 0.5m interval spacing. In other words, the resolution of the data collected is 0.5m in any direction. The survey is conducted in 20m grid squares, one at a time, which are then ‘stitched up’ during the computer processing of the results, thus giving us a continuous plot of the survey area (Figure 2). The extent of this initial survey, which will be extended in 2018, can be seen in Figure 1. It shows the aerial view of the promontory with the plan of the castle on the left and the geophysical results on the right. The hall building or the tower, as it is sometimes also known as, was inaccessible to this type of survey and, in fact, there would be a very little point to it considering it is situated on the rock stack and covered in rubble. Thus the survey focused on the courtyard area and the ground beyond the castle walls, which is probably the most interesting, as its archaeological potential is largely unknown. The results are presented as greyscale images in which dark areas are the areas of high resistance and the light areas the areas of low resistance.

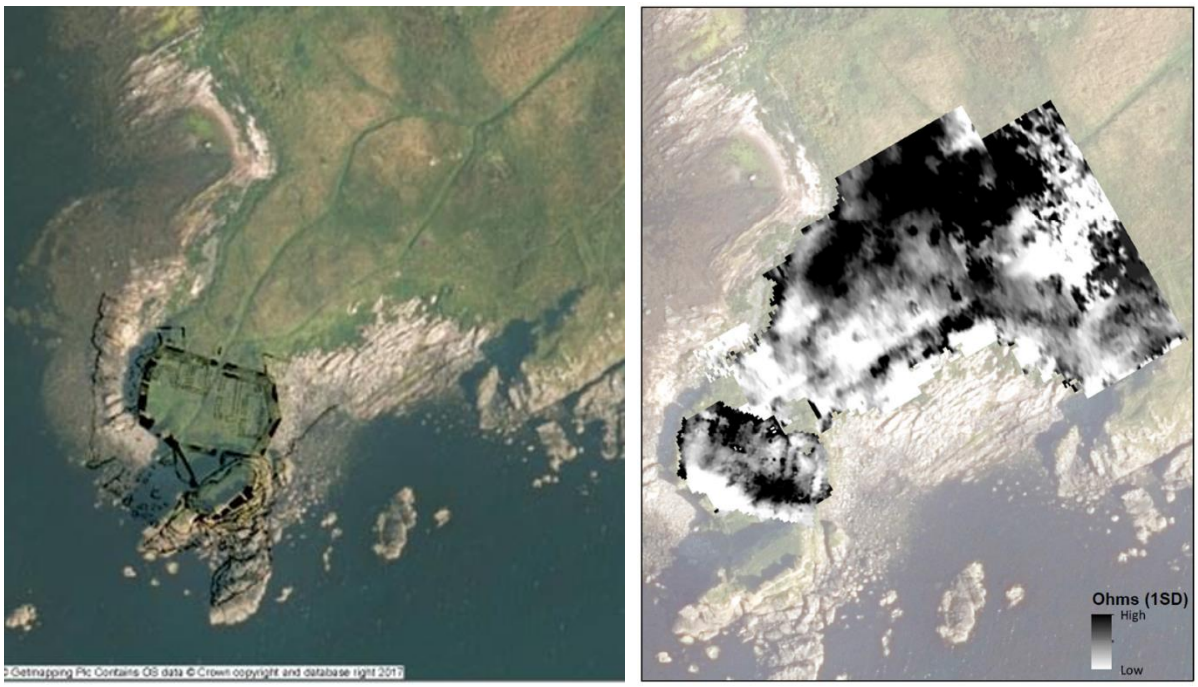

Figure 1 Aerial view of Dunyvaig and its environs with superimposed RCAHMS plan (left) and electrical resistance survey data (right).

Figure 2 Electrical resistance survey at Dunyvaig castle. The surveyor holds the frame with the resistance meter mounted on the top and the electrodes making contact with the ground below.

The courtyard

As expected, the electrical resistance was successful in detecting the outlines of the stone-built structures in the courtyard. The geophysical data very closely matched the RCAHMS survey plan from the 1970s (Figure 3). It also shows an amorphous high resistance anomaly at the southern end of buildings A and B, which might represent a pile of rubble from the collapse of the adjacent inner courtyard wall. Some fainter anomalies can be seen in the central and western parts of the interior, which were thought to be devoid of buildings, and it remains unclear whether these anomalies represent structural remains. The area adjacent to the sea gate in the southwest part of the courtyard is characterised by low resistance and might represent accumulation of soft organic deposits, such as midden. The interior of the buildings is low in resistance relative to the surrounding walls, which might indicate that any infilling rubble deposits might not be too substantial. The response of the outer wall west of the entrance is of much higher resistance than to the east of the entrance and this might be due to the east segment being partly hollow, which could validate the presence of a passage containing stairs or similar, which has filled up with soil.

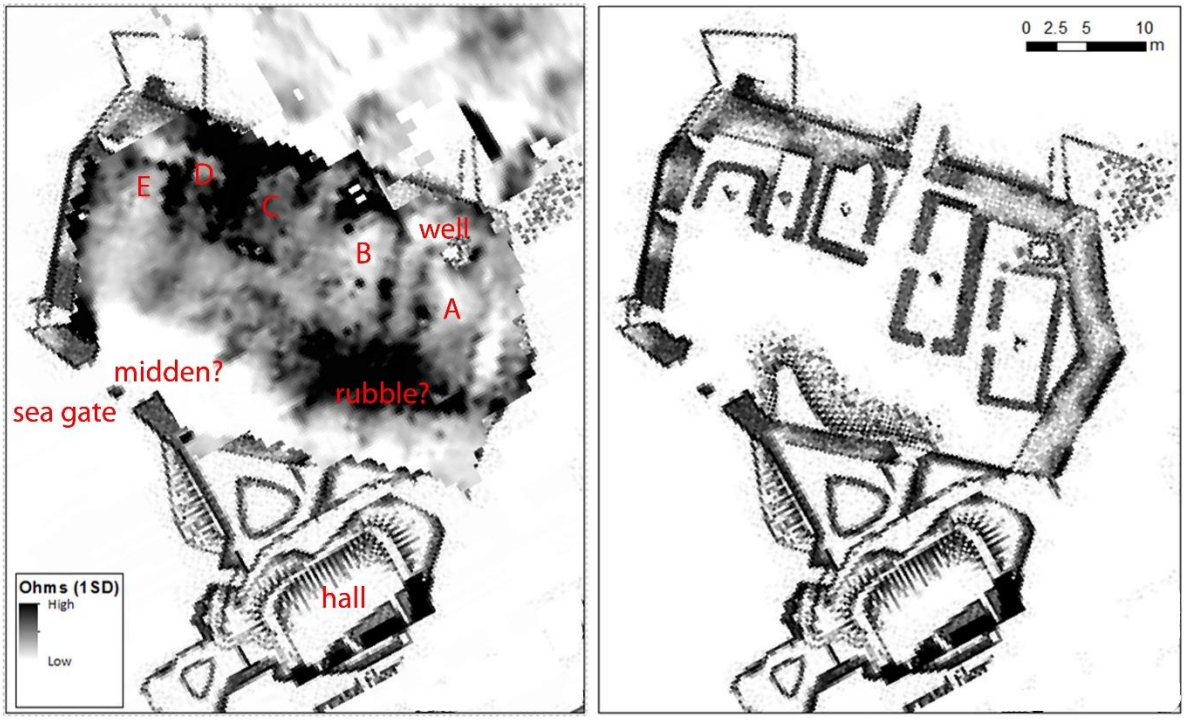

Figure 3 Electrical resistance data plot of the castle courtyard compared with the RCAHMS plan.

The approach

In the absence of detailed topographic and archaeological survey of the area to the northeast of the castle, i.e. the approach, it is much more difficult to corroborate the results of the survey. The results are dominated by large high resistance anomalies in the north part of the survey extent. Three separate high resistance linear anomalies diverge from the castle courtyard towards northeast. These linear high resistance anomalies could easily be mistaken for walls, however, they correspond to the footpaths, as can be seen when the data is compared to the aerial photograph (Figure 4).

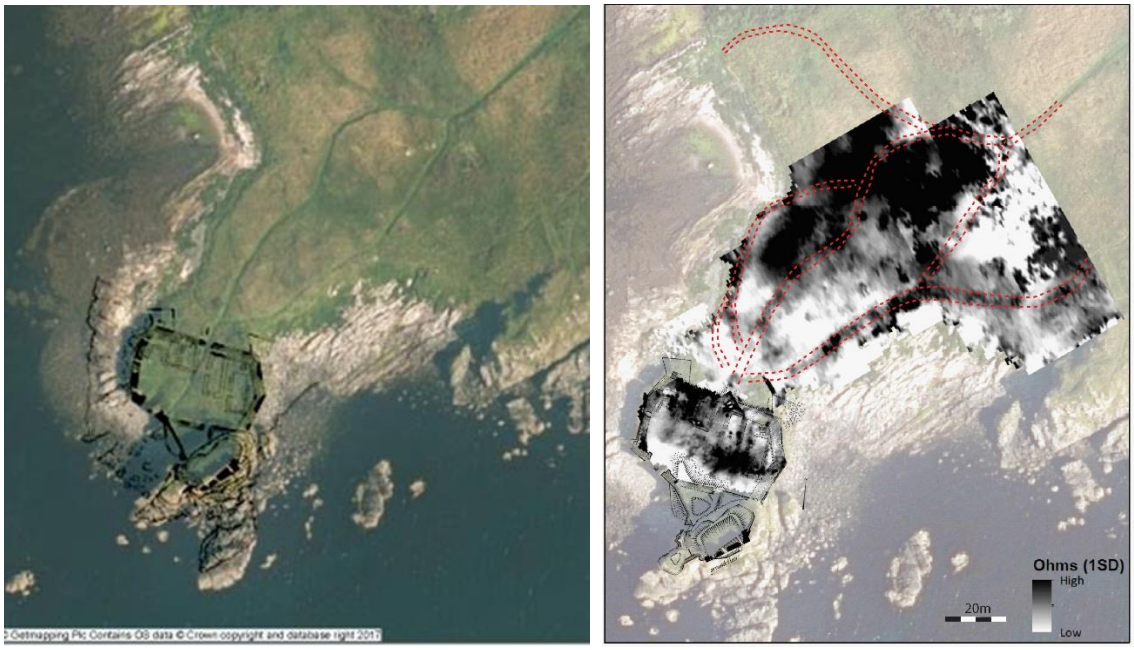

Figure 4 Aerial view of Dunyvaig and its environs with superimposed RCAHMS plan (left) and electrical resistance survey data with marked layout of the footpaths (right).

It appears that the foot traffic has compressed the vegetation and the ground surface along the footpaths to the level that they show up as high surface resistance in contrast to the surrounding ground where taller vegetation has retained excess moisture. The source of other high resistance anomalies is unclear. They are very extensive and it is possible that some of them could be the response to the bedrock near the surface or, equally, further distinction between the short and long vegetation. On the other hand, at least some of them could be area of rubble, where structures or enclosures have stood in the past. Without ground truth trenching to investigate the source of some of these anomalies it is currently impossible to have a meaningful interpretation of the results in the area outside the castle walls. However, once corroborated by trenching, the results could prove incredibly valuable. In August 2018, Islay Heritage will be conducting further assessment of the environs area, which will include continuation of the electrical resistance survey, but also other geophysical techniques that might be less susceptible to the ground conditions, such as magnetic gradiometry and ground penetrating radar. In addition we are planning archaeological evaluation of the castle and its environs by trenching, providing we are successful in obtaining the Scheduled Monument Consent from Historic Environment Scotland.

Terrestrial 3D laser scan survey

The terrestrial Laser Scanner (Figure 5) collects coordinate data of its surroundings. It emits a rotating laser beam that can capture 120,000 points a second. It colours this data from panoramic photographs or alternatively provides colourless topographic 3D model. Each scan takes approximately 15 minutes. Once a scan is complete, the equipment is moved and set up again ready to scan. Each scan is then ‘registered’ together using common GPS locations and overlap in point data from matching geometry (40-60%). This creates a very accurate virtual model of the site. The 3D laser survey at Dunyvaig was conducted by Aiji Castle from Topcon.

Figure 5 Terrestrial laser scanner survey of Dunyvaig castle.

The 1970's RCAHMS measured survey provides the foundation for all subsequent survey and research at the castle (RCAHMS 1984). At the time, the survey was conducted manually with the help of tapes, plane tables and dumpy levels and, crucially, it includes surveyor's interpretation of the architecture and other features. With the help of digital instruments, such as 3D laser scanner and digital cameras and photogrammetry software, today we can carry out much more detailed and accurate surveys in a fraction of the time and present the results as a 3D model or similar. Nevertheless, the interpretation principles of the survey remain the same. Another important thing to remember is that the monuments in the landscape do not remain static, as the time passes they are subject to the weather and the actions of people, which affect the level of preservation and their environment. For example, our survey shows that the site is much more overgrown than in the 1980s, perhaps as a result of a change in grazing regimes (Figure 6). The increased vegetation has an effect on the laser scan, and although the measurements might not be as accurate as on bare walls, the survey does correspond to the true state of the monument at this period of time.

Figure 6 View of the buildings in the courtyard photographed from the hall in 1983 (left, Canmore image 1578061) and 2017 (right).

Figure 7 View of the inner face of the southern wall of the hall building in 1983 (top) and a still image from the 3d laser scan survey in 2017 (bottom).

The passage of time can also be seen in the preservation of the upstanding walls, which have deteriorated in the last 20 years or so (Figure 7). Comparison between the photographs held by the Historic Environment Scotland and the 2017 survey shows that certain parts of the wall face have crumbled away and the walls are more affected by the vegetation and the roots which crumble away the mortar and loosed the stones.

The 3D laser scan data can also provide a detailed topography of the surface, as best visible in the courtyard (Figure 9). The area beyond the castle walls was not in the brief for this particular scan, and although the topography of the surrounding area appears very detailed it is only a by-product of the castle scan and, hence, not very reliable. Nevertheless, several interesting features can be discerned in the data. In summer 2018 we will be conducting much more detailed survey of the environs of the

castle and a photogrammetric survey of the castle itself to compliment 3D laser scan data. Together they will give us ability to construct very detailed 3D models of the monument.

Figure 8 Laser scan survey model of the courtyard with photographic cover as seen from the northwest

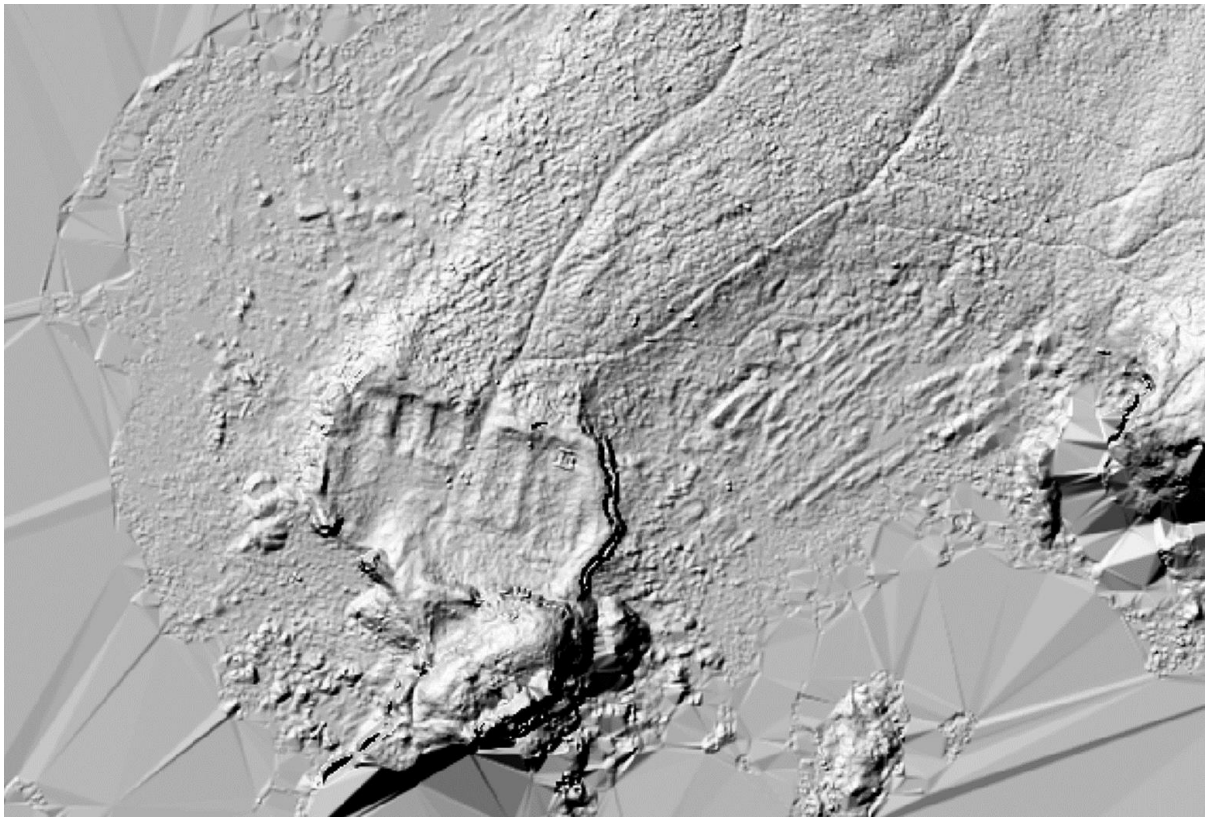

Figure 9 Laser scan survey model shown as topographic data

Conclusions

Dunyvaig castle and its surrounding are being investigated and surveyed for the first time since the 1970s. This survey will continue in 2018 and beyond, introducing new techniques and thus gathering more information about the monument and its state of preservation and thus facilitating further research and informing its conservation and management.