Evaluating Process and Effect

Coastal erosion at the Knowe of Swandro, Rousay

The multi-period site at the Knowe of Swandro on the west coast of the island of Rousay, Orkney is being destroyed by the sea. Archaeological investigation began in 2010 while the team were recording another site, a more conventional cliff exposure at South Howe, just south of Mid Howe broch. At Swandro the situation is very different as there is no cliff, just a cobble beach running seamlessly into the storm beach and the low-lying land. It appeared as if the Knowe of Swandro was partially eroded, but that this was a small site with limited coastal exposure. Investigations have produced a very different story.

The Knowe of Swandro was recorded as a grass-covered mound partially eroded by the sea and thought to be possibly an Iron Age round house. The original plan was to investigate and record the limited amount of archaeology that appeared to be affected by erosion as part of the larger project to investigate eroding sites along Rousay's Westness coastline, but a number of set upright stones were found, protruding from the cobbles of the beach and suggesting there were archaeological remains surviving beneath the ever-shifting stones.

Excavation over the next few summers revealed a complex archaeological sequence that had been truncated by the sea, with areas of remarkable survival. The site is a multi-period settlement mound dating from the Iron Age to the Pictish period and probably through to the Norse period. To the north, a large monumental structure which survived under the beach and which forms the foundation of the Knowe itself was at first thought to be a broch-like structure, but further investigation revealed casement walling more indicative of a Neolithic chambered cairn. The sea had attacked the *in situ* archaeology under the boulder beach, forming a series of truncated erosion terraces creating quite literally steps in time. The survival has in part been facilitated by the presence of the monumental structure on the northern side which has acted as a shield against the worst of the weather coming in from the Atlantic. The erosion 'steps' have been formed in part by the resistance offered by structural stonework and stone flagged flooring in the archaeological layers. The erosion can be seen to increase along the beach to the south, where the protective effect of the cairn is lost.

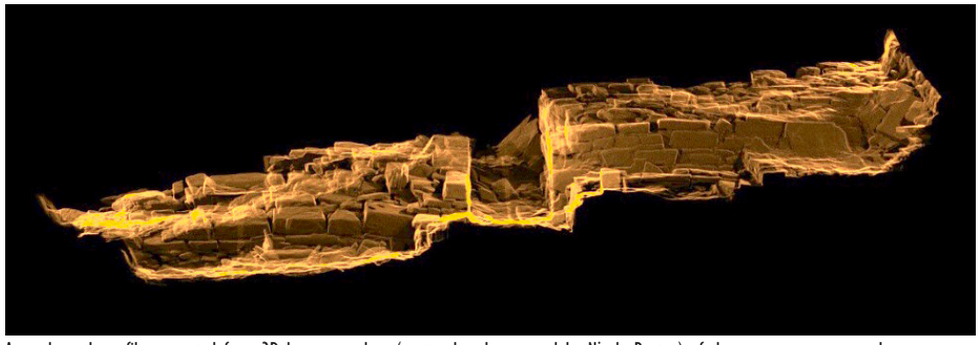
The erosion of the concentric walls of the chambered cairn as exposed in 2015 © S. Dockrill

Structure 3, the working floor of the Pictish metalworkers building. The subsidence of the walling on the seaward side of the structure can be clearly seen at the top left hand side of the image. © S. Dockrill

Investigation revealed a number of buildings; the earliest (Structure 1) survived in part on one of the lower terraces. The wall of this roundhouse was defined by a series of orthostats forming part of the circumference of the building. The surviving eastern segment of the roundhouse contained a cell formed by the circumference of the building and two radial orthostatic divisions. The floor of this cell was covered by a single large flag containing two carefully cut circles to take posts, enabling the support of a mezzanine floor around the circumference of the building. In the adjacent cell on the northern side, the remains of a stone-built oven and a large hearth survived.

Excavation of one of the more complete Late Iron Age buildings provided evidence of a Pictish smithy or workshop (Structure 3). Structure 3 was semi-subterranean, entered by a flight of steps and a corridor turning at right angles to a doorway (helping to create a light trap). The door position was indicated by a pivot stone, door jamb and two bar holes, suggesting that the wooden door could be secured both externally and internally. The location of the hearth, two stone anvils, artefact distribution and XRF together with magnetic susceptibility analysis of the floor indicated that the building had been used for copper alloy casting and blacksmithing.

Excavation of the suspected chambered cairn, with its concentric casement walling, showed that it has been affected by both storm and daily tidal effects. The western circumference is under the high tide level. The casement structure is formed by single-faced walls, packed with smaller rubble. The number of courses and depth of deposits was found to increase on the landward side. A substantial entrance passage for this structure was found to contain secondary midden sealing rubble collapse. This midden contained the remains of sheep butchered with a large metal blade, the bones of several cats (one articulated), and a coin of Eanred, a 9th-century king of Northumbria, suggestive of a Viking Age deposition.



A north-south profile generated from 3D laser scan data (captured and processed by Nicole Burton) of the entrance passage and outer casement wall. The seaward side is on the left and landward side on the right. © Bradford Visualisation

The monumental structure had been reused in the Iron Age with the construction of a large round house; this in turn seems to have a long history, with a significant re-modification in the Late Iron Age or Pictish period. The archaeological survival under the protection of the grass on the landward portion contrasted significantly to that even under the higher levels of the storm beach. In particular the survival of ash and midden material was more extensive than on the beach. The walling and the structural collapse indicate a significant depth of stratigraphy and it is hoped to investigate this further in the next two seasons.

Key to the project has been the adoption of 3D photogrammetric recording and laser scanning in order to provide an accurate spatial documentation of the archaeology. Conventional planning using a grid and planning frame proved difficult due to the shifting nature and gradient of the beach, and the nature of the archaeology. The laser scan documentation has allowed a quantitative analysis of the archaeological erosion of the casement wall between 2012 and 2015. The laser scan data provide an opportunity to view different aspects of the site from orthographic plans, angled view points, to vertical slices providing elevations and sections. This has proved to be a cost effective means of recording such sites especially in the intertidal zone where excavation and recording are limited by the tidal cycle.

The long-term nature of the investigation over nine seasons has provided a greater understanding of the process of erosion. The site is low-lying with no cliff, being formed by a beach rising from high tide level. Thus the site is being affected by storm surges and the violence associated with high energy storm effects moving substantial blocks of stone. The site is subjected to daily erosive effects associated with the tides. The high-energy storm and wave effects have contributed to the truncation and removal of archaeology. For example, the excavation of the suspected chambered cairn in 2012 and 2015 has revealed a significant amount of change over this period. The outer casement wall has been in part removed by erosion and was significantly water-worn. The core of packing material (earth and small stone) recorded between the casement walls had been compromised, with much of this material having been washed out and replaced by beach material. The use of 3D recording has enabled a high-resolution comparison of the changes in the intervening three years.

It was expected that storms and high seas were the main erosive forces, but work at Swandro has shown that daily tidal movements also have a serious impact on the archaeology. Tidal effects have impacted further up the storm beach and even in areas that might have been considered to be safe. The land based water table also runs under the beach to sea level and in winter months and wet summers this can be quite high, combining the effects of fresh water waterlogging and tidal movement. The suction created by the receding tide removes the suspended particles and the high-energy pressure of water from the advancing tide redeposits beach sand in the voids created by the removal of the soft archaeology deposits. The detailed understanding of this process has only been achieved by the multi-season approach, which has allowed long term observation.

The archaeology at Swandro demonstrates both the potential of survival under a boulder beach and the vulnerability of low lying coastal zones under the 4m OD contour. The archaeological complexity of the site, with some 2m of stratigraphy still surviving at the top of the storm beach and significant survival at the high tide zone, was unexpected and again illustrates the quality of evidence surviving in such conditions. The effects of the pressure created by the daily tidal action for archaeological sediments under the high tide zone has been seen to have an impact even on the landward side where observation of the visible upper sequence would suggest that this is unaffected, being beyond apparent tidal action. These effects are magnified by the winter storms. Work at Swandro is providing a new and more detailed understanding of erosion processes, an important consideration for the future management of such low lying sites.

The 2018 excavation area seen as an orthographic plan generated from photogrammetric 3D recording. The enhanced archaeological survival in this higher part of the beach and landward edge contrasts with the evidence recorded under the storm beach in 2015. (Photogrammetric plan captured and processed by Lindsey Kemp) © L. Kemp

The archaeological survival and the importance of the retrievable information is highlighted by the detailed understanding of the Pictish smithy. The evidence from this metal workshop has provided a unique insight into metal production and the spatial usage of the building. The quality of the evidence from the other archaeological sequences above the high tide line is providing an important sequence of settlement from the middle Iron Age to the Norse period together with its associated cultural and economic biography. Swandro, like many sites is being unavoidably destroyed by the sea, but the complex datasets from such sites can both enhance our existing knowledge of Scotland's past and further our understanding of coastal erosion and its future management.

Stephen Dockrill and Julie Bond

The research is led by Dr Julie Bond and Dr Stephen Dockrill of the School of Archaeological and Forensic Sciences, University of Bradford with the Swandro-Orkney Coastal Archaeology Trust and Julie Gibson, Professor Jane Downes and Dr Ingrid Mainland of the Archaeology Institute, University of the Highlands and Islands, Dr Ruth Maher, William Paterson University with City University New York, and Visualising Heritage, University of Bradford. The project is funded by the University of Bradford, Historic Environment Scotland, Orkney Islands Council and Swandro-Orkney Coastal ArchaeologyTrust (for more information see www.swandro.co.uk)