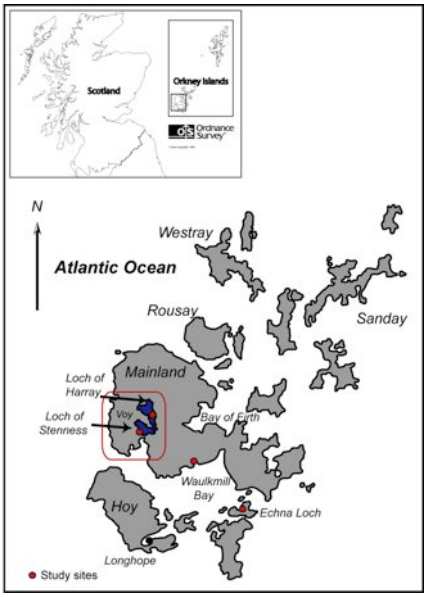
The Rising Tide: an examination of Holocene relative sea-level changes and the impact on the prehistoric human population of Orkney



The archipelago of Orkney lies off the north coast of Scotland. Areas of fieldwork to date have been highlighted in red.

Introduction

The Rising Tide was set up in 2004 to research the early settlement, changing landscape and rising sea-levels of Orkney.

People first came to Orkney some 10,000 years ago, but there is little evidence of this for two reasons:

- Orkney 10,000 years ago was a very different place. The islands comprised a single landmass and many of the lands settled by Orkney's early inhabitants now lie underwater.
- these first settlers were nomads and little of their material culture has survived the millennia.

Orkney – a unique blend of land and sea

The project involves a multi-disciplinary approach using archaeological and palaeo-geographical techniques to re-construct past sea-level change and its effects on the early inhabitants of Orkney.

Co-directors of the Project

Sue Dawson graduated from Coventry University and completed her doctorate on relative sea-level changes in Caithness and Sutherland. Her research expertise lies in Holocene sea-level change, coastal and climate change, tsunami sedimentation and diatom biostratigraphy. Her present research activities include Holocene relative sea level changes in the Maldive archipelago, Scotland and Greenland.
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Caroline Wickham-Jones studied at Edinburgh University and has worked on the early settlement of Scotland for over 30 years. Her research interests include the origins and lifestyle of the first settlers as well as the changing environment and landscape of Scotland since the last Ice Age.
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Professor Alastair Dawson has worked on relative sea level changes, climate and coastal changes for over 30 years. He has a particular interest in the Storegga Tsunami, which hit Scotland in 6500BC, and has undertaken fieldwork to examine Storegga deposits around the coast of Scotland, particularly in Shetland and along the northern and eastern coasts.
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Orkney

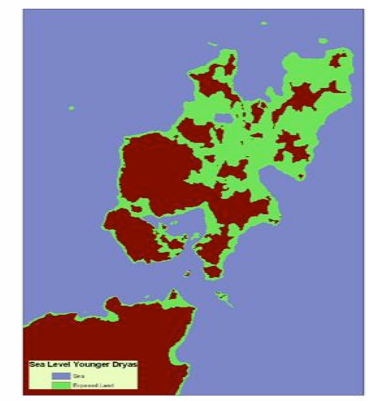
Orkney lies 20 miles off the north coast of Scotland, across the Pentland Firth. The islands are famous for their archaeology which comprises well preserved sites from prehistory to recent times. The best known sites are designated as World Heritage Sites and known as *The Heart of Neolithic Orkney*. These sites were built by Neolithic farmers about 5000 years ago, and they include homes, ceremonial centres and burial sites.

The Watch Stone by the side of the Loch of Stenness: one of the standing stones at the heart of the Heart of Neolithic Orkney World Heritage Site.

There is another, poorly studied, side to Orkney archaeology however: the landscape of 10,000 years ago, at the end of the last Ice Age. At this time relative sea-levels around the islands were up to 45 metres lower than today. This is the period when Mesolithic hunters first arrived in Orkney, but much of the landscape that they would have known has been submerged so that few of their sites survive on land.

The Mesolithic settlers of Orkney were nomads who lived by hunting, fishing and gathering. We know from remains elsewhere in Scotland that the rich resources of sea and shore were particularly important to them, and Mesolithic settlement tended to cluster along the coast.

Mesolithic Orkney spans a period of some 3000 years and provided an important foundation for the sophisticated Neolithic cultures that followed, yet little is known about it. Most of the evidence now lies underwater and though submerged archaeological sites do survive in many parts of the world there has been no work to test this in Orkney until the start of this project.



GIS reconstruction of the extent of land that may have been submerged around Orkney since the end of the last Ice Age

Changing Sea-levels

The relative lower sea-levels were caused by a combination of change in the levels of both sea and land at the end of the last Ice Age. This is a complex process which continues today, albeit much slower. At first a rapid rise took place as water, released from ice, flooded back into the oceans. In some parts of Scotland, where the ice was thickest, depression of the earth's crust meant that higher relative sea-levels produced raised beaches. In Orkney, where the crust was less depressed, many former coastal lands are now submerged.

How we work

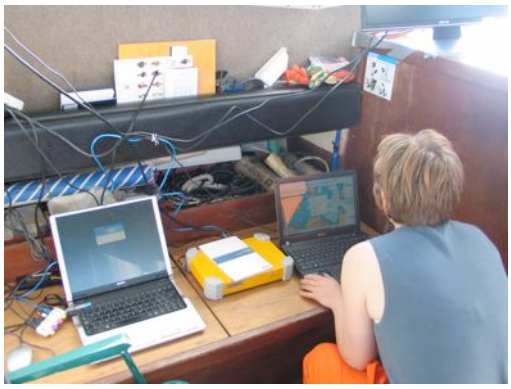
The project combines archaeological techniques with geomorphology and palaeo-environmental research.

The first stage of work is to reconstruct former sea-level positions by taking sediment cores from coastal locations, including small bays, saltmarsh, and lagoons. Microfossils within the sediments can be characterized according to type and whether they require fresh or salt water. As sea-level rises fresh water lagoons became inundated with a change from fresh to brackish microfossils; in contrast salt water inlets could become closed off by gravel barrier formation. It is possible to isolate the fossils and date the changes in salinity using radiocarbon analyses. In this way a curve can be constructed to show how sea level has risen through time.



Taking cores in the Loch of Stenness, it is not always easy to access the water!

Data relating to the seabed can then be added in order to get an idea of the shape of the land before it was submerged. A wide variety of scanning and remote sensing techniques exist to examine the seabed and its sediments. The next stage is to gather data on the locations favoured for Mesolithic settlement in similar environments elsewhere. This data can then be used to predict likely areas for Mesolithic settlement on the submerged lands around Orkney.




Setting up the equipment for sea-bed survey

The survival of sites as they are inundated is complex, but it is possible to highlight likely hotspots and null zones for remains which can be tested by survey and diving. The result is a map that both provides a greater understanding of the past, and assists the management of fragile archaeological remains underwater. This is important because the seabed is under increasing threat from many development processes such as the construction of harbours and marinas, off-shore energy, and aggregate extraction.

The Past Environment of Orkney

Lower relative sea-levels were not the only difference for the first inhabitants of Orkney. The first millennia after the end of the Ice Age were a time of dynamic environmental changes.

Even the land was unstable. The removal of the weight of ice from the Scottish land mass resulted in minor earthquakes and landslips as the earth's crust readjusted. Temperatures were slightly higher than today, and the climate a little drier. Vegetation cover also differed: recent analysis suggests that much of the islands was covered by woodland comprising low scrub of birch and hazel with some stands of taller trees including pine. There is little evidence for animals, but Orkney's restricted animal population today suggests that predators such as foxes were not present. There is, however, evidence for wild boar and red deer.

Taking cores in saltmarsh and lagoon areas can help provide an idea of past changes in relative sea-level as well as past vegetation.

Results So Far

Echna Loch

Echna Loch is a small loch enclosed by an ayre on the eastern coastline of Burray. It is up to 3m deep with up to 2m of sediment. Organic freshwater lake sediments are located at the top of the cores, underlain by grey silty sands characterised by brackish marine shells and diatoms. Radiocarbon assay has dated the transition from marine to freshwater sediments here to 2340-2570 cal BC (3950±40 BP, Beta 2242126). This provides information as to the last connection of the basin to the sea before the emplacement of the ayre (a storm beach) which now cuts off the lochan.

Loch of Stenness
The sediments from the Loch of Stenness indicate a change from brackish and freshwater species in the lower organic sediments to brackish and marine conditions in the upper sands and silts. Samples were taken from the interface in order to date this transition which represents the initial inundation of the basin by more brackish and marine conditions. The resultant date of 1440 – 1270 cal BC (3090±40BP, Beta 242127) is surprisingly recent, and probably reflects the survival of freshwater conditions in the sheltered far end of the loch.

To the western side of the Loch of Stenness lies a large embayment, at Seatter, in which greater thicknesses of sediment are present. The onset of marine conditions is represented here, and further samples have been sent for dating.


The core location at Voy on the Loch of Stenness

The core from Seatter

Stoneyhill, Loch of Harray
A sediment sequence of over 3 metres was recovered in the sheltered embayment to the east of the loch at Stoneyhill. This comprised silty sands overlying a sequence of more organic sediments (gyttja). Below these lay peats suggestive of a more terrestrial locality. Underlying the peats lay a smooth light grey clay.

The lochs of Stenness and Harray, the landscape here would have looked very different when the stone circles of Neolithic Orkney were first built some 5000 years ago.

Radiocarbon dating
Archaeologically the dates are important because they indicate just how much the landscape of Orkney has changed since the World Heritage sites were built c. 5000 years ago. Sea-levels were still relatively lower when the village of Skara Brae was first in use and while the Ring of Brodgar was taking shape. The farmers of Neolithic Orkney experienced some dramatic changes to their landscape including the inundation of coastlands by the sea.

Sea-Bed Archaeology

One exciting implication of the changes in sea-level is the potential existence of archaeological sites on the seabed. In 2008 a sidescan sonar survey was undertaken of the Bay of Firth in order to look for anomalies on the sea floor. Several features of interest were recorded and work in 2009 will examine these.

The Bay of Firth

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Stowing equipment on the Charles Ann at the end of a day of survey

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