Norse Mill at Loch Borralie, Durness, NW Scotland

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1. Abstract

Horizontal water mills, also known as Norse mills, click mills, or clack mills, represent one of the most ancient and widespread forms of water-powered technology ever devised. Found in a broad arc from the Mediterranean and the Near East to Scandinavia and the British Isles, they are particularly associated in Scotland with the northern and western regions, where they persisted as working machines into the twentieth century. Their story is one of remarkable continuity, simple, elegant technology, perfectly adapted to the small-scale grain-processing needs of scattered upland and coastal communities, sustained across more than a millennium with little fundamental change. Here we describe an ingeniously engineered horizontal mill at the northeast end of Loch Borralie near Durness, NW Sutherland. The overall structure is consisitent with Norse mills from Orkney and Lewis, which have been dated to Viking times. We believe that the site may have been associated with Norse settlements found on the Loch Borralie Headland, dating to the earlier part of the Norse period from the 9th -12th centuries or later. However, it is unlikely that the horizontal mill continued after the Balnakeil mill, shown on Pont´s 16th century map, was erected.

2. Introduction

The name 'click mill' or 'clack mill' derives from the distinctive sound produced during operation. A peg or clapper attached to the rotating upper millstone struck a wooden chute or hopper with each revolution, shaking grain steadily downward into the eye of the stone. A peg in the upper stone knocked against a chute sprinkling grain into a hole in the top of the stones, thus making a distinctive clicking sound with each revolution (Oxford Reference, 2010).

The horizontal watermill is believed to have been conceived in the Greek-speaking world, or Byzantium, between the 3rd and 1st centuries BC (Wikander, 2000). It probably evolved from earlier manual tools like the saddle quern and the rotary quern, where human or animal power was replaced by the force of water. The geographer Strabo noted a 'water-grinder' at the palace of King Mithridates of Pontus around 70 BC, which is one of the earliest documented references to such an apparatus (Wikander, 1985).

Simple in design, rugged in construction, and perfectly adapted to relatively small streams and modest-scale grain economies of Highland and Island communities, they were deployed across Scandinavia, Shetland, Orkney, Shetland, the Western Isles, Caithness, Sutherland, Outer Hebrides, Isle of Man, Ireland and the Faroes for over a thousand years (e.g. Goudie, 1886, Wilson, 1960, Batey, 1993, Macleod, 2009). The technology, probably reaching Scotland

via the Irish early Christian monastic tradition and then perpetuated and spread by Norse settlers from the ninth century AD, persisted in working use until the mid-twentieth century (Figure 1).

Figure 1. The Norse mills did not always have to be sophisticated (left photo) as long as they served their purpose (right photo). These photos are of working horizontal mills on the Isle Lewis from 1930 and 1935 respectively (Macleod, 2009).

Very few early horizontal mill sites have been found on mainland Scotland. One of the earliest sites is located at a Pictish monastery in Portmahomack (Easter Ross) dating from the 8th century (Macleod, 2009). In Orkney at Earl´s farm, a Norse Mill has been dated to the earlier part of the Norse period, about the 9th -12th centuries (Batey, 1993). Fenton (1978) notes that there were 28 mills in *c.* 1600 on Mainland Orkney. It appears that the Norse mills were introduced as a by-product of Norse culture, if not actually Norse in origin (Hunter, 1991, Batey, 1993).

The Norse mill thus occupied a distinct ecological and social niche: it served sparsely populated communities growing modest quantities of barley (especially bere, an ancient multi-row landrace) and oats, processing grain for domestic consumption rather than for commercial trade.

The horizontal mill was not highly efficient machinery by later standards. They were unsuited to large-scale commercial flour production, as they could process only small quantities at a time. However, they possessed critical advantages for the communities that used them, for example, in northern and western Scotland. The mills were an imaginative technology, making the best of a low head and volume of water, adapting well to local topography. Vertical wheel mills, which required gearing systems, larger water volumes, and more skilled construction, were poorly suited to the small stream that characterised the Highland and Island landscape.

Horizontal mills began to decline across Scotland during the eighteenth and nineteenth centuries as larger, more powerful vertical-wheel mills became accessible even to remote communities, facilitated by improvements in roads and the market economy. By the mid-nineteenth century, hundreds of horizontal mills, as on Lewis, had already fallen out of use. The Highland Clearances, which depopulated areas such as the Borralie Headland from the late eighteenth to early nineteenth centuries onwards, further hastened their abandonment.

Where communities survived, the transition from subsistence bere and oat cultivation to a more monetised economy made it uneconomic to maintain small communal mills.

One factor that hastened the loss of these small mills was the action of landowners who constructed large, more productive vertical mills. They often pressured tenant families to abandon their small individual enterprises and pay to use the landowner's central mill. Oral tradition in Lewis tells of many millstones having been smashed or taken away from the Norse mills erected by the local communities (Macleod, 2009).

3. Structure of a Norse Mill

The horizontal mill is characterised by its simplicity (Figure 2). Water was diverted from a stream or loch via a lade (channel) and brought to a mill race or chute. From there, it was directed downward at an angle onto the blades (paddles, or 'tirl') of a wheel set horizontally in a lower chamber ('under house') beneath the mill building ('upper house'). This horizontal wheel, mounted on a vertical shaft, drove the upper millstone (the runner stone) directly above it without the need for any gearing system. The lower millstone (the bed stone) remained stationary, and grain was fed through a hole in the centre of the runner stone via a wooden hopper. As the stone rotated, grain was ground and the resulting meal collected around the edge of the stones (Macleod, 2009).

Loch or stream management was an integral part to the system. Mill ponds were created by constructing small dams to raise water levels, with sluice gates controlling flow, ensuring adequate head of water even in dry seasons. The mills were perfected for subsistence economies, simple to construct from limited resources, eliminating the need for gearing, and using a minimum of iron. It was common for several mills to be built in sequence along the same stream, with each re-using the same flow of water (e.g. Shetland.org, 2020). Milling would probably have taken place in short burst of time after the mill pond had been replenished with water (e.g. Batey, 1993).

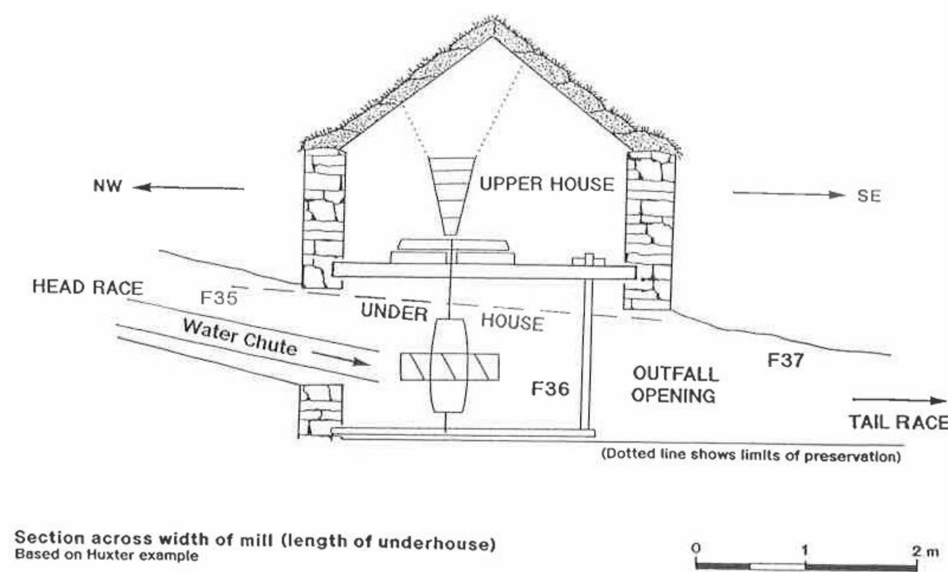

Figure 2. Diagram of a Norse mill in Orkney (from Batey, 1993).

4. The Loch Borralie Norse Mill

4.1 Site location

The Loch Borralie mill is located at the NE end of Loch Borralie (NC 38766 67463 centred). The main apparent visible remains are the lade and the vague remains of the upper house of the mill, but in addition a distinct horse-shoe shaped dich, the mill pond and two sluices, one, likely to have been used to control water flow into the pond, the other controlling water-flow into the mill (Figure 3). The mill rests against a fractured limestone ridge, with three main faults cutting the limestone formation (Figure 4). Water flowing into the mill would have run through the structure, turning the paddles and subsequently run out and through the faults in the limestone ridge, only to reappear on the other side. In fact, when water levels in Loch Borralie are high, the stream in the lade does indeed flow through the under house, disappearing at the far end of the structure into the limestone ridge and resurfacing on the other side of the ridge (Figure 4).

Figure 3. Location map of the Norse mill at Loch Borralie (GoogleEarth).

The stream can be seen on the Ordnance Survey map of 1874 (Figure 5), both where it disappears to the west and subsequently reappears to the east (red arrows). However, a mill is not indicated on the map, nor on the Extract from estate map of 1798 (RHP 1159 2/2) as cited in a paper of Lelong and MacGregor (2003).

Today, the area where the stream reappears east of the limestone ridge (Cnocbreac; Figures 4 and 5) is flat and boggy plain which has been partially drained. However, in the past, it is likely that water from the mill stream would have accumulated on the plain forming shallow wetland. This would have encouraged the growth of reeds (for thatching) and attracted wild fowl (for eating).

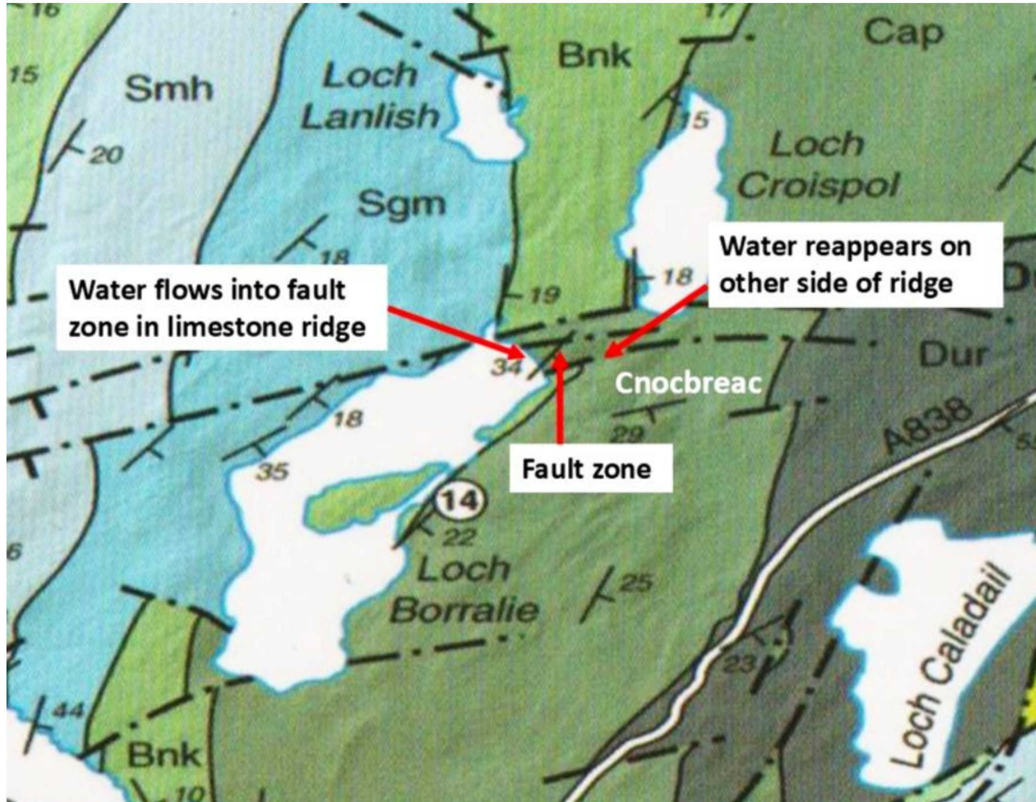

Figure 4. Faults in the Durness limestone (black dotted lines) cutting a limestone ridge behind the mill. Water flows underground from the west and reappears in the east on Cnocbreac (base map from Goodenough and Krabbendam, 2016).

Whether the location of the mill was chosen specifically so that the water would both serve the task of turning the mill paddles and to deliver water to the shallow wetland on the other side of the limestone ridge we will, of course, never know. But deliberate or accidental does not change the fact that the site location, construction and engineering was outstanding.

By 1874, when the area was mapped by the Ordnance Survey, little settlement survived in the survey area (Figure 5) which in the past had several settlements on the Headland. The ruined church is shown in its graveyard at 'Balnacille', while to the east by Balnakeil House, enclosures and a corn mill of the estate (Figure 5) are described. The current Balnakeil House mill was constructed following the acquisition of the Reay Estate by the Duke of Sutherland. While the current structure is 19th-century (*c.* 1830), it sits on a site with much older roots. Maps from the late 16th century (Timothy Pont, 1590–1600) show that two mills previously existed at this location. There are traces of a potential water mill by a small stream on the eastern grassy flanks of the Kyle of Durness (Figure 5), which is mentioned in Lelong and MacGregor (2003), but the ruins are in very poor condition. Given the dimension of the overgrown structure and the potential water volume of the stream, it must have been a horizontal mill.

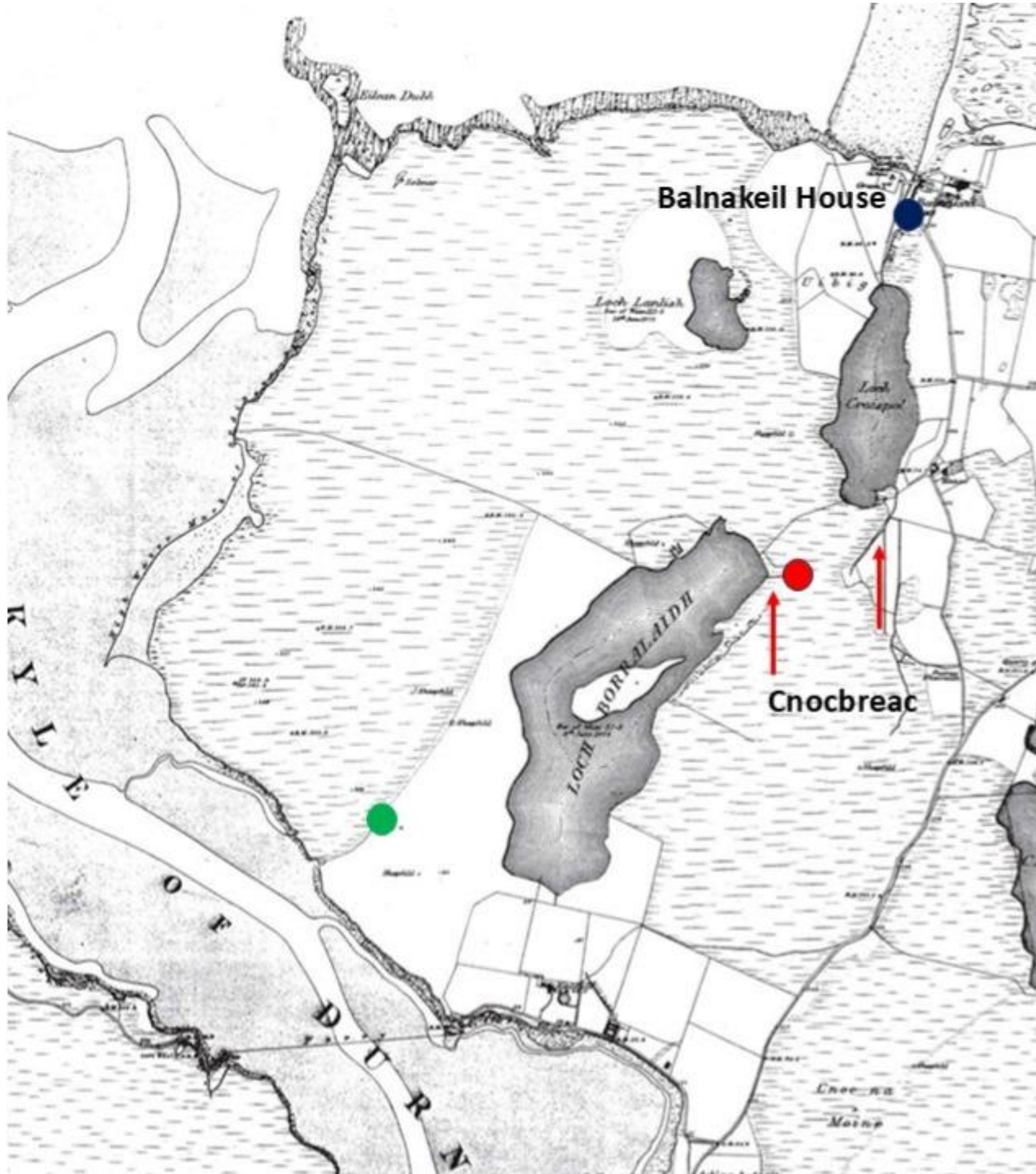

Figure 5. Ordnance Survey map (1874) showing a stream flowing from Loch Borralie (left red arrow, and on the other side of limestone ridge into Loch Croispol (right red arrow). No traces of a mill are indicated. Red circle = Norse mill; Green circle = Relics of water mill (Lelong and MacGregor, 2003); Blue circle = Balnakeil House mill.

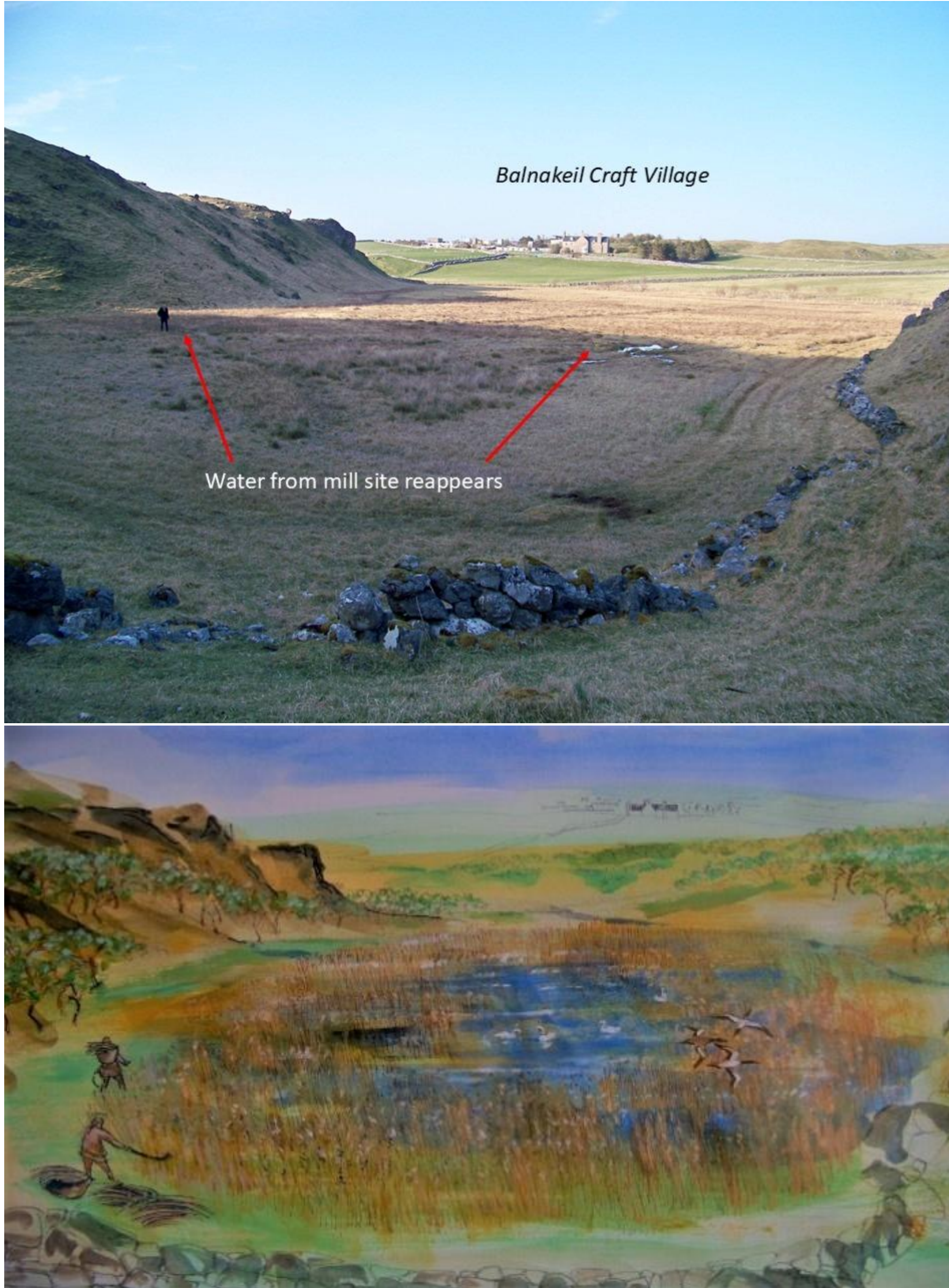

Figure 6. Cnocbreac today (upper) and reconstructed to past times (lower).

4.2 The Mill Structure

The remains of the upper house (Figure 7) are about 8 m long, 5 m wide and 2 m high from floor level to present ground level. It is mostly collapsed and almost all the wall rocks have been robbed. However, the base of the walled structure can be recognised. 'Sluice 2' on Figure 7 is located where water would have entered the under house of the mill. There is no clear evidence of where the vertical shaft and millstones would have been located as the floor of the upper house is completely obscured by rock debris and vegetation.

Figure 7. The Borralie upper house is located in front of the person.

The under house (Figure 8) can be approached from sluice 2 (Figure 7) and from the NE corner of the mill (below feet of person in figure 7). It is very well preserved. The dimensions are about 1,2 m high and 90 cm wide. The walls are perfectly constructed from Durness limestone and quartzite erratics.

Figure 8. The under house seen from sluice 2 (see Figure 7).

A substantial horizontal wooden pole is sitting on the floor of the under house about 25-30 cm in diameter (Figure 9). The length is unclear due to limited access. However, it is clear, that the dimensions of the pole are such that the mill structure would have had to be partly dismantled to put it into position. It is therefore likely it was an integral part of the structure, probably forming a saddle for the vertical shaft leading up to the upper house. The pole is in a relatively good condition, which may imply that the mill was in use until Early Modern Periods. No excavation, test units/trenching, geophysical survey or detailed mapping has been executed. No artifacts have been found at the mill site and due to limited access to the under house, we have not found the vertical shaft, or paddles, or any other smaller objects relating to the mechanism of the mill and the millstone is missing.

Figure 9. The under house showing the horizontal tree trunk.

4.3 Kiln

It was always necessary to dry grain before it could be milled and one way of doing this was in a kiln. The kiln was solidly built with large stone slabs and clay, and its purpose was to dry the grain by having smoke filter through it (Macleod, 2009). We have not found definite evidence of a kiln, but there is vague evidence of stone walls to the NW of the mill house (Figure 3), forming a credible candidate for such a structure.

4.4 Lade

The lade is about 80 m long running from Loch Borralie to sluice 2, about 2 m deep, 3,5 m wide at the top but less than 1 m at the base (Figure 10). It is overgrown, partly collapsed but dammed at the entrance to the loch. However, it is clearly walled and appears to have a pristine V-shaped structure, which is obscured by crumbling from the top edge.

Figure 10. The lade leading towards the mill from Loch Borralie. The faults in the limestone ridge into which the stream disappears are shown as broken black lines. The upper house is located at the far end, to the left of the person.

4.5 Sluices

Two sluices are found in the lade (Figure 11), sluice 1, which seems to be connected to the mill pond (Figure 12), and there appears to be a channel between the two, which one can stick an arm into. Sluice 1 would have been used to control water flow into the mill pond. The other (sluice 2) is right at the entrance to the under house of the mill, controlling the water flow turning the mill paddles. The sluices are made of flat, worked limestone, approximately 95 by 75 cm, and are set into the rocks forming the walled lade.

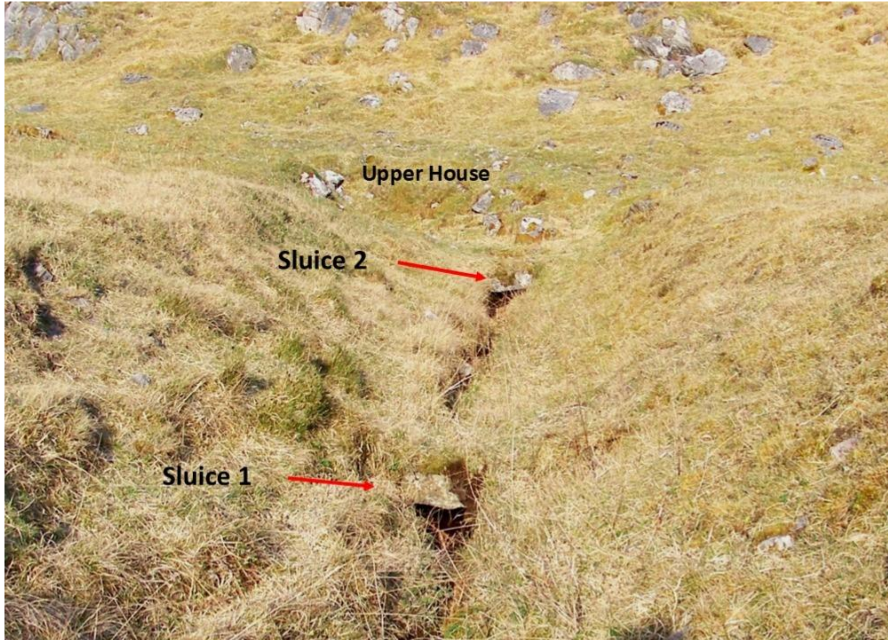

Figure 11. The sluices in the lade leading into the Borralie mill. Refer to figure 3 for relative location.

4.5 Mill Pond

During mill days, enough water had to be available to keep the millstones grinding for some time. Therefore, it would have been necessary to have sufficient water supply, more than that provided by the lade. We believe that the horse-shoe structure seen next to the lade (Figure 12), controlled by sluice 1 in figure 11, may have been used for this purpose. The pond is about 3 m wide, 13 m long and 1 m deep.

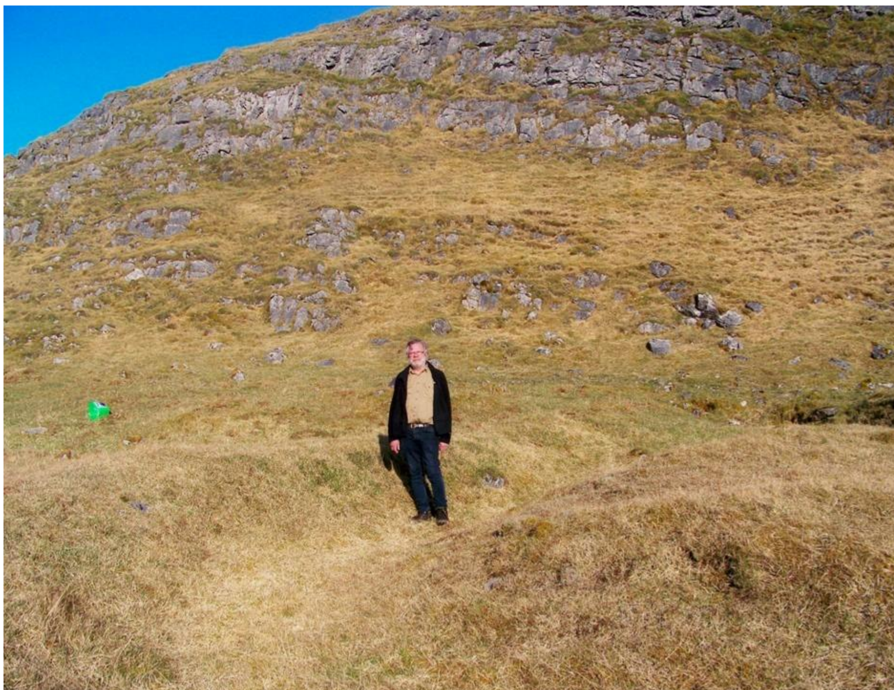

Figure 12. The mill pond of the Loch Borralie mill. The lade is to the right of the picture.

5 Discussion and Conclusions

Loch Borralie and the immediately surrounding landscape on the Borralie Headland in Northwest Sutherland represent one of the most archaeologically rich parts on the north coast of mainland Scotland. The primary driver of settlement was the Durness dolomitic limestone formation, whose fertile calcareous soils provides the most productive agricultural land in an otherwise base-poor and leached surrounding landscape of Torridonian sandstone and Lewisian gneiss. This geological advantage, combined with the sheltered loch-margin environment, access to coastal resources of Balnakeil Bay and the Kyle of Durness, and the topographic variety of the peninsula, has sustained human communities from the Neolithic to the 19th century.

From the earliest times settled communities cultivated, bere and oats as staple sources of diet. There was much work entailed in producing meal, from the sowing and reaping on arable land to the processing of the grain into flour. The labour of securing a reliable source of food would have been a yearly cycle of work. This was particularly strenuous when there was little technology to carry the burden of work.

The introduction of horizontal mills, provided some relief from the basic hand-operated rotary quern-stone. Here, we have described a horizontal mill at Loch Borralie for which we have not found any tangible documents. The only mills recorded in the immediate area are much later and related to Balnakeil House, and a potential mill lade by the Keodale farm (Lelong and MacGregor, 2003). There are also poorly preserved remains of a possible horizontal mill on the eastern slopes of the Kyle of Durness (Lelong and MacGregor, 2003).

The Loch Borralie mill is an ingeniously engineered horizontal mill. The overall structure is identical to several Norse mills from Orkney and Lewis which have been dated to the early Medieval times. The remains of the upper house appear of great age, similar to ruins assigned to Norse farmsteads on the Borralie Headland (e.g. Lelong and MacGregor, 2003). The structure of the lower house is well-preserved, being underground and undisturbed. Maps by Timothy Pont show that two vertical mills existed by Balnakeil House in the late 16th century when Huistean Du Mackay led the Mackay clan. He may not have looked favourably on a communally-run horizontal mill at Loch Borralie.

We believe that the site may have been associated with Norse settlements found on the Loch Borralie Headland, dating to the earlier part of the Norse period, sometime between the 9th and 12th centuries It may have been in use until much later as communities existed on the Headland into the Early Modern Period. However, it is unlikely that the horizontal mill continued after the Balnakeil mill, shown on Pont´s 16th century map, was erected.

6 References

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