VII

Excavation of a Late Medieval Lime Kiln on Beadnell Point, Northumberland

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SUMMARY

A burnt circular stone structure situated to the east of St. Ebba's Chapel on Beadnell Point (NU 2401 2874) was exposed by winter storms in the late 1980s. It was identified within Northumberland County Council's Strategy for Coastal Archaeology as at high risk from coastal erosion and was consequently excavated in autumn 1994. The structure, which was associated with other more enigmatic features, proved to be a substantial stone-lined lime kiln, the last firing of which has been dated by archaeomagnetic analysis to the late 15th or early 16th century; as such it provides an interesting contrast with later and larger kilns along the Northumberland coast.

INTRODUCTION (FIG. 1)

To the east of the conspicuous late 18th and early 19th century lime kilns on Beadnell Harbour is the exposed promontory of Beadnell Point or Ebb's Nook on which lies the scheduled ancient monument of St. Ebba's Chapel. This chapel is thought to be an important religious foundation possibly originating in pre-conquest times and, as the name implies, associated with Princess Ebba, sister of Oswald, King of Northumbria in the seventh century.[1]

Whatever the origin of the foundation, the chapel, which is thought to be a 13th century structure,[2] forms only one part of a wider complex of banks and walls which enclose areas of the promontory.[3] Some 50 m to the east of the chapel, on the northern edge of the promontory adjacent to the sea cliff, a burnt circular stone structure was exposed by winter storms during the late 1980s. The function of the structure was uncertain; more certain was the fact that being exposed it was increasingly vulnerable to erosion by the sea, which at high tide and with a strong wind, washed over it.

In 1994 Northumberland County Council published *A Strategy for Coastal Archaeology in Northumberland* which noted that much archaeology on the north east coast has been eroded, even over the last century, and that it was a principal objective to conserve and interpret remains wherever possible or, if conservation was not possible, to preserve by record. Beadnell Point was noted in this document as an area with high archaeological potential and an attendant high level risk from coastal erosion. It was considered that St. Ebba's Chapel was of sufficient importance to merit conservation action and therefore recommendations were put forward within the strategy document for the chapel and its associated complex. As a result, recent sand build-up has been removed from within the chapel to more clearly define its shape and a new information panel has been placed on the western side of the promontory to interpret the chapel and associated complex. However, it was felt that the circular stone structure could not be preserved *in situ* due to its exposed position which, by that time, had led to the scouring away of the sandy clay subsoil immediately to the east of the feature. Consequently, in the early autumn of 1994 the structure was excavated in order to preserve it by record, if not physically. It was hoped that excavation of the structure would both ascertain its function and date.

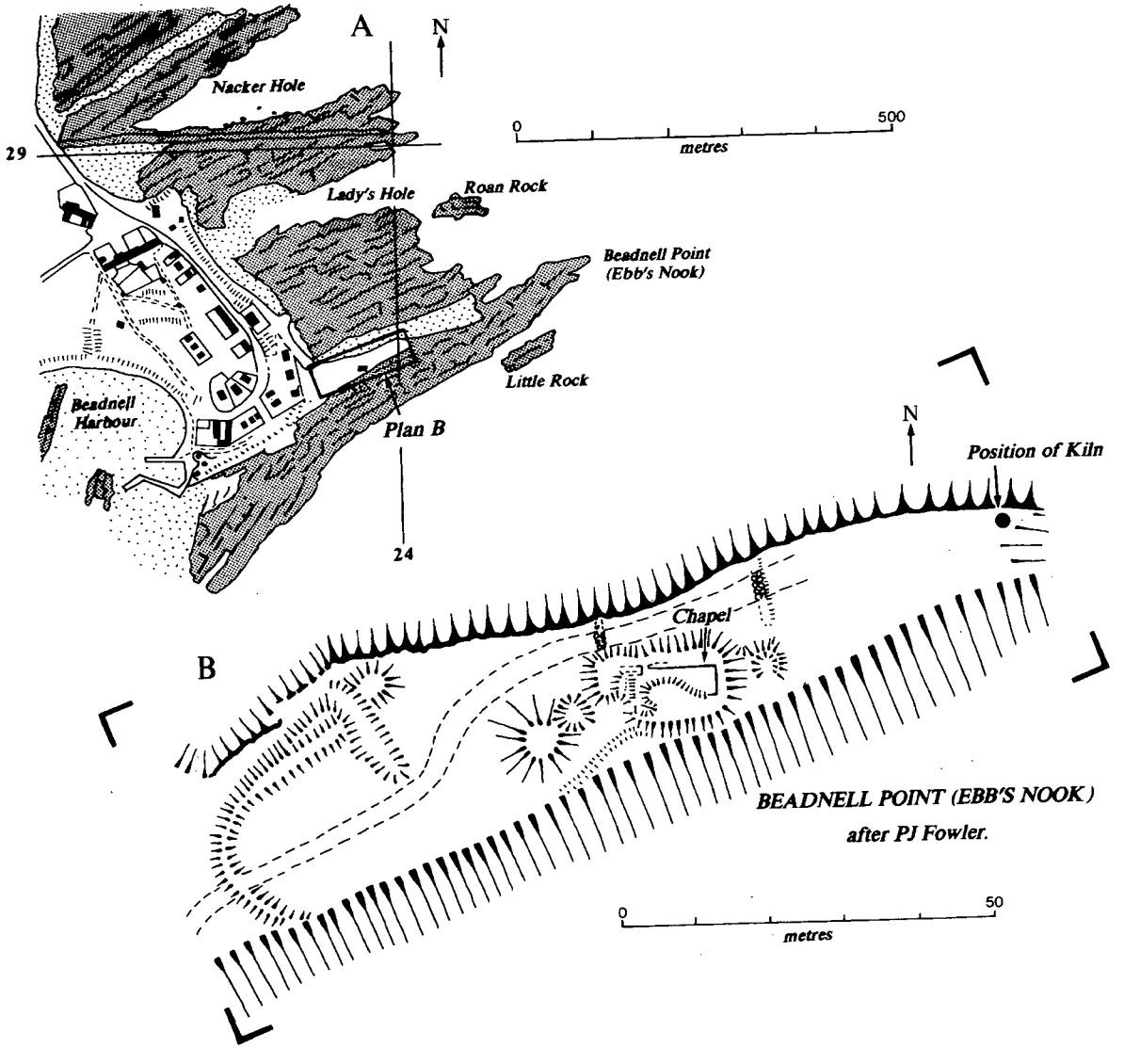

Fig. 1 Beadnell Point and Beadnell Harbour, Northumberland

EXCAVATION OF THE LIME KILN (FIGS 2, 3 AND 4)

A preliminary sampling of the feature had been carried out in August 1994 by Caroline Hardie and Sara Rushton of Northumberland County Council Archaeology Section which established that it was a coherent stone structure of some depth with stratified deposits built up within it. Subsequent excavation of the structure was carried out in September 1994 by the writers.

Turf cover was removed in the immediate vicinity of the circular feature [1] and the area

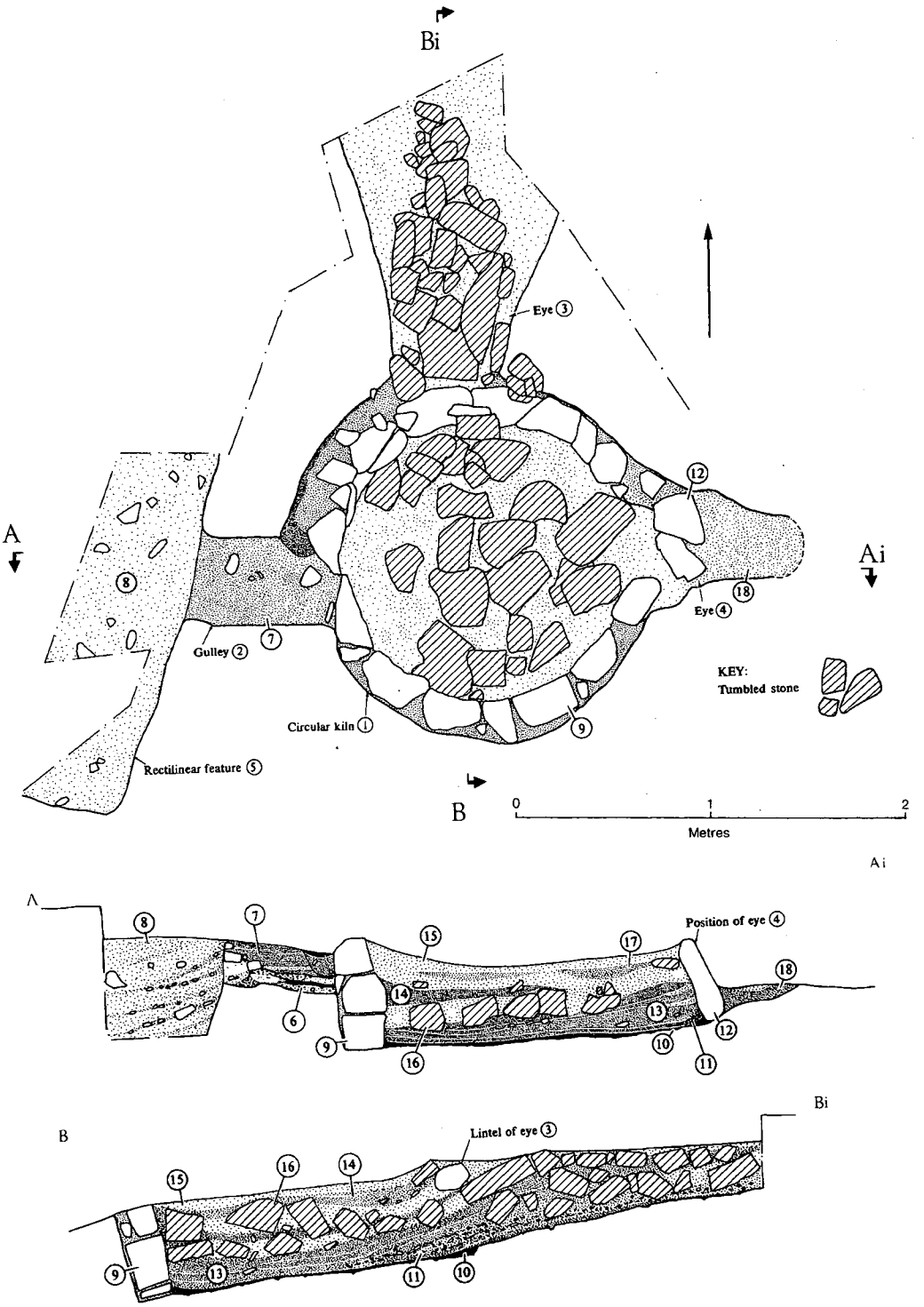

Fig. 2 Plan and sections of features [1], [2], [3], [4] and [5].

trowelled. This revealed, in addition to [1], a rectilinear feature [5] to the west and what appeared to be three eyes [2], [3] and [4] projecting radially from [1] (fig. 2). Whilst [3] and [4] did indeed prove to be eyes and functionally integral to [1], [2] proved to be earlier than either circular feature [1] or rectilinear feature [5].

Gulley [2]

This ran for 0·6 m between [1] and [5] which cut it away to east and west. It was *c.* 0·2 m deep with a shallow rounded profile. Although considerably interleaved, its fill was essentially composed of a primary deposit [6] of ash, charcoal and burnt lime, the latter two in small fragments and none of which had been burnt *in situ*. The secondary deposit [7] was composed of lenses of probably windblown brown and yellow sand. The presence of lime in the primary deposit [6] of this early feature is of some interest.

Rectilinear feature [5]

The relationship between [1] and [5] remains uncertain although [5] would appear to have cut away [2]. The full extent of [5] was not seen as it was not felt appropriate to further de-stabilize the turf cover west of the circular feature and it was consequently only partially excavated to 0·5 m; its full depth was not established. It was filled throughout this exposure with grey sand interleaved with lenses of re-deposited subsoil and small stones [8], almost certainly a secondary fill which had the character of backfill rather than natural deposition.

Circular feature [1] and eyes [3] and [4]

These had been cut through the sandy clay subsoil down to the limestone bedrock which had been utilized for their bases. The northern eye [3], was 0·45 m deep at the outer edge of the oven with steep sides which funnelled out northwards. It ran for a distance of 1·7 m before it was truncated at the cliff edge, which was clearly sheared away over the years so its original extent is uncertain. The eastern eye [4] was less substantial than [3], only 0·7 m long by 0·5 m wide, although its original extent had almost certainly been reduced through the scouring away of subsoil by the sea which had occurred markedly at this point.

Circular feature [1] was *c.* 1·9 m in diameter and survived to a maximum height of 0·7 m. The cut had been lined with stone [9], which was composed of irregular and generally quite substantial pieces of local limestone and sandstone, lightly bedded in a sandy clay. The stones were all highly burnt. The positioning of limestone and sandstone blocks within the lining did not suggest either type was favoured functionally. A maximum of four courses of stone survived which, adjacent to the northern eye [3], reached a maximum height of 0·7 m (fig. 3). The lintel stones over the northern eye [3] survived giving it a height of 0·35 m, although the two jamb stones of the eastern eye [4] indicated it had been of a similar height at *c.* 0·4 m (fig. 4).

The surviving portion of the oven, all below current ground level, formed a gently tapering cone widening to the top. It would seem unlikely that the ground surface, except to the east where considerable erosion had occurred, would have been appreciably higher when the kiln was constructed. The original height and form of the above ground structure of the kiln remains unknown.

Evidence for the use of the kiln

The natural limestone base of the oven was discoloured with two overlapping areas of burning (fig. 3). Each area graduated concentrically from an inner patch of white through black to red and would seem to reflect the varying intensities of heat within the oven during firing. Whether the overlapping indicates successive firings of the kiln or the effect of each eye during the last firing is uncertain. No burning was noted on the base of either eye, although the mouth of [3] was very reddened, the mouth of [4] less so.

A thin charcoal layer [10], overlying the base of and found exclusively within the oven of the kiln, represents the residue of fuel from

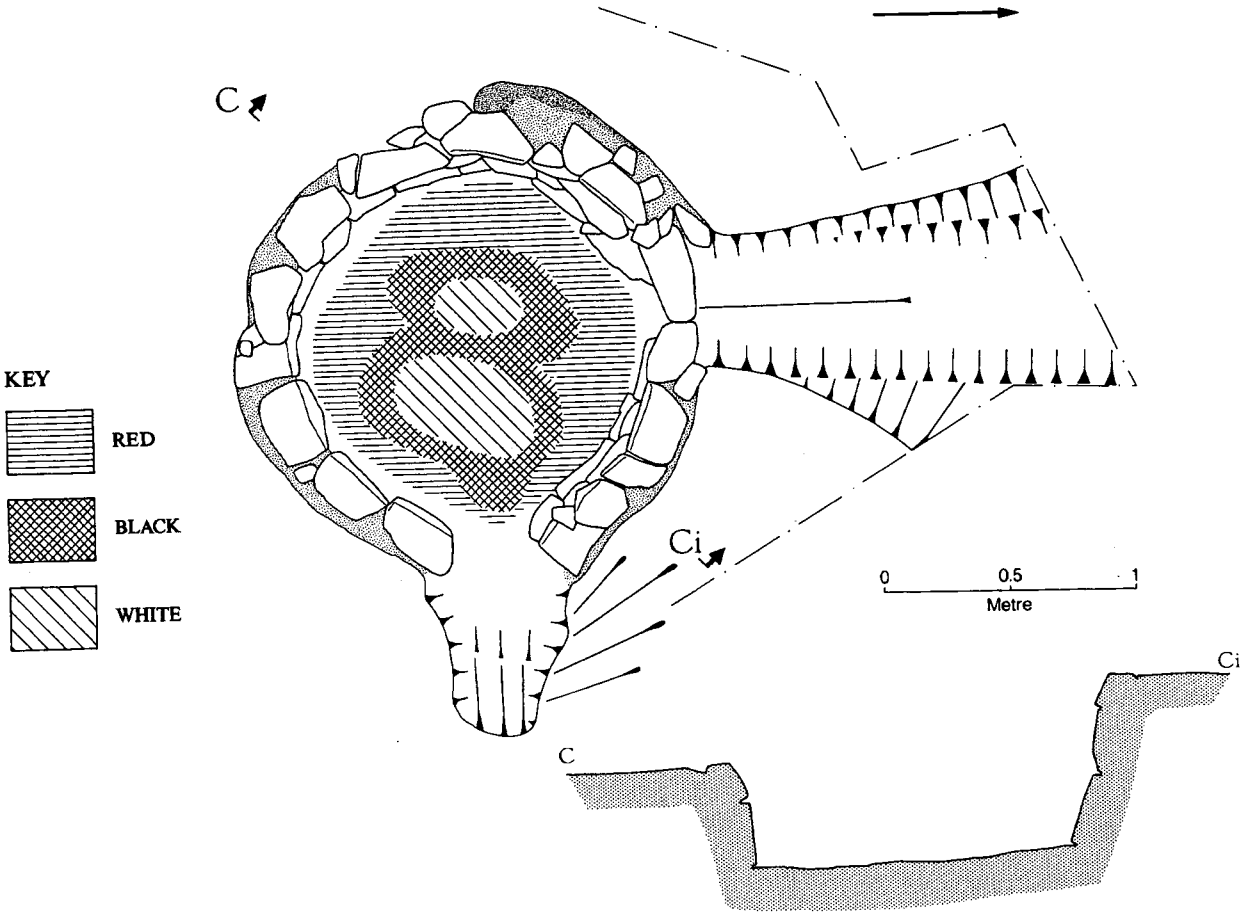

Fig. 3 Plan of features [1], [3] and [4] with fills removed and showing pattern of burning on the base of [1]. Profile C-Ci runs through the highest surviving portion of the oven.

the last firing. The origin of this material could not be specified macroscopically. Two stones [12] had been set against the outer face of eye [4] and overlay charcoal layer [10] undoubtedly to restrict the flow of air into the kiln sometime during this last firing. A layer of compact reddish brown clayey sand [11], which contained some charcoal and many fragments of lime (the largest pieces of lime lay in awkward angles such as the openings for the eyes), had built up over the charcoal layer [10] within the oven and against the baffle stones [12] and also overlaid the base of eye [3]. This layer would seem to be the remnants of the last load of a lime burning kiln which had not been entirely removed from the oven after firing. That it ran up [3] suggests that at least some of the load had been removed via this opening.

... And for its disuse

The remaining fill of the kiln consisted almost exclusively of bands of variegated sands [13], [14] and [15] with interleaving angular limestone and sandstone blocks [16]. This must represent the gradual infilling of the structure

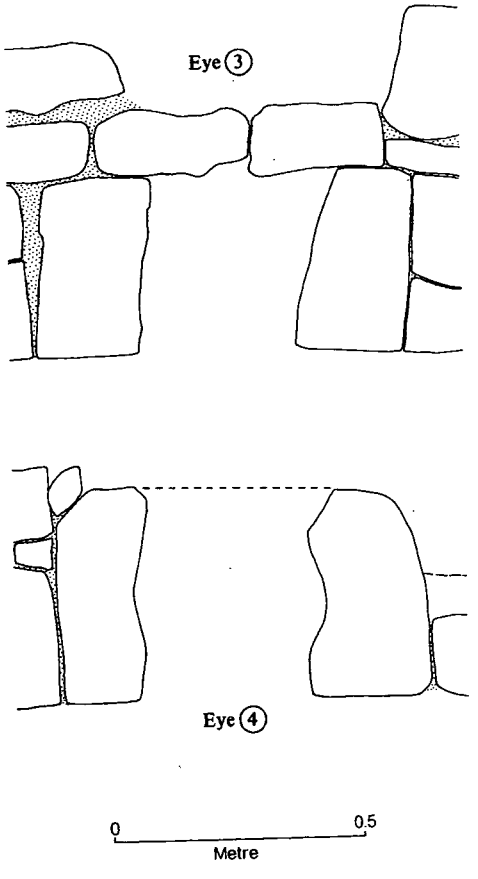

Fig. 4 Internal elevations of the mouths of eyes [3] and [4].

with windblown material and the intermittent tumbling of its upperworks into the oven and northern eye. The eastern eye was filled exclusively with windblown sand [18]. The only evidence for further use of the vanishing feature was the lighting of a small fire within the area of the oven, represented by an area of burnt sand [17], in what had become a shallow sheltered cavity on the promontory.

Dating of the lime kiln

No artefactual evidence was found during the excavation to suggest a chronological context for the kiln or any of the associated features. However, the heating of the kiln structure allowed the use of archaeomagnetic analysis to date the last firing of the kiln. This was carried out by GeoQuest Associates in October 1994 after the completion of excavations.[4] Samples from the stone lining and base of the oven were found to contain a strong and stable remanent magnetic field which defined a mean direction consistent with firing in the late medieval period, providing a date range between 1480–1510 for the last firing of the kiln.

DISCUSSION

Features [2] and [5] remain enigmatic. The circular kiln [1] certainly post dates feature [2] and they cannot have been functionally associated in any way. The presence of lime, ash and charcoal in the primary fill of [2] is of interest in suggesting that lime burning had been taking place somewhere in the vicinity prior to kiln [1] being constructed. Equally, there is nothing other than proximity to suggest any association between [1] and [5]; the stratigraphy is inconclusive. It is just feasible that [5] may represent a *puteus* or sunken lime pit and be the source of the lime in the fill of [2] although there is no burning around the edges of [5] to suggest this was the case.

What remains, apart from features [2] and [5], is a well constructed stone-lined circular lime kiln with eyes to north and east almost certainly constructed in one phase. Only the below ground portion of the kiln survives and the form of its upper works must remain conjectural. Burning was limited to the floor and lining of the oven which shows evidence of at least one firing, possibly more. The structure would certainly have been substantial enough for successive firings although it was noted during the excavation that the lining had become friable through heating.

How the kiln functioned can only be surmised, although a description of the firing of a lime kiln by George Owen, albeit 100 years later than the use of Beadnell Point kiln and referring to Pembrokeshire rather than

Fig. 5 The Beadnell Point lime kiln, looking north-east with fill removed from the oven.

Northumberland, is instructive:

> "... limestone being digged in the quarry in great stones is hewn lesser to the biggness of a mans fist and less, to the end they might sooner burn through, and being hewed small the same is put into a kill made of a wall six foot high four or five feet broad at the brim but growing narrower to the bottom having two 'lope' holes in the bottom which they call the kill eyes, in this kill first is made a fire of coals which is laid in the bottom of the kill, and some few sticks of wood to kindle the fire, then is the kill filled with these small hewn pieces of limestones and then fire being given the same burns for the space of ... and makes the limestones to become mere red fiery coals which being done and the fire quenched the lime so burned is suffered to cool in the kiln and then is drawn forth through these kiln eyes."[5]

The scale of the kiln which Owen describes is remarkably similar to that on Beadnell Point as is its form—slightly conical and with two eyes or 'lopes' as he refers to them—although whether the kiln in his description was cut down into the ground is not specified. The firing process as described by Owen involved the laying of coal and wood in the bottom of the kiln, the remainder of which was then filled with small lumps of limestone, the gaps between which would have allowed the inflow of oxygen and the outflow of carbon dioxide, necessary for calcination. The combustible material was set alight which then heated the whole load and converted the limestone to quicklime.[6] This would seem to be exactly what is represented by layers [10] and [11] within the Beadnell Point kiln: [10] representing the burnt fuel and [11] the residue of the loaded oven.

Owen's comments unfortunately do not include the length of firing, but the Beadnell Point kiln would not have held enough fuel to last any length of time; perhaps around a day. Owen also mentions the quenching of the fire, which is probably represented in the Beadnell Point kiln by the two baffle stones placed against the outer face of the eastern eye. This would have prevented the inflow of oxygen at the base of the kiln (some restriction of the flow of oxygen into the kiln may have been necessary throughout the firing to control the burn, especially on such a windy spot as Beadnell Point). The resultant burnt lime would then either have been removed via the northern eye, or from the top of the oven.

Use of the lime

The Beadnell Point lime kiln is dwarfed by the post-medieval lime kilns on the harbour and others along the Northumberland coast (e.g. Holy Island, Scremerston and Seahouses). The Beadnell Point kiln is typical of medieval lime kilns in which fuel and load would be packed in the oven and then burnt through. Once cooled the load would be removed and, if so desired, the process repeated. This would have been ideal for the production of a finite amount of lime for limited constructional purposes. The later coastal lime kilns were generally continuous, i.e. limestone and fuel was fed through and burnt in them over a lengthy period and lime removed whilst this firing process was continuing. Such kilns were used primarily for the bulk production of agricultural lime and were only located on the coast to facilitate the movement of limestone and coal to the kilns and lime from the kilns by ship.

The lime produced by the Beadnell Point kiln, as suggested above, would probably not have been used for agricultural purposes as with the later kilns. There is no evidence for the agricultural use of lime in the county before the 17th century and the small quantities of lime produced would hardly have been worthwhile exporting by ship. There is certainly no evidence of facilities for docking boats on the Point.[7] It seems more likely that the lime would have been used in the maintenance of stone structures in the chapel complex only 40 m to the west. The isolated position of the kiln is probably only a reflection of the wish to remove a noxious process downwind from the precinct.

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NOTES

[1] The promontory site has been associated with St. Ebba for over a century although there is no proof of this association. St. Ebba was a devoted Christian who is known to have founded other monasteries in Northumberland. It is also known that Beadnell was tenurially linked to the Anglian royal seat at Bamburgh. (Scheduled Monument 25055, Description, 14/4/1995).

[2] Tate visited the site in 1857 and saw part of the head of the north door of the chapel which he considered part of a pointed arch and 13th century in date (Bateson 1893, 322, fn. 1).

[3] Fowler 1992.

[4] The principles and methods used to determine this chronology are detailed in a report held with the site archive. The process is based upon the assumption that the natural remanent magnetism within the fired lining and base of the kiln, can be compared with a calibrated reference curve to give an absolute dating for the last firing of the kiln.

[5] Owen's description of lime burning in Pembrokeshire is quoted in Toft (1988).

[6] To become lime, calcium carbonate must go through a number of processes, the first of which is heating, usually carried out in a kiln. When calcium carbonate ($CaCO_3$) is heated with sufficient intensity (around 900 °C) and for a long enough time, a figure dependent on the stone used, it will calcine, that is, its constituents will dissociate to form carbon dioxide gas (CO_2) and calcium oxide (CaO). At this stage the carbon dioxide must be removed from the calcium oxide or they will recombine, this is effected by a greater quantity of air being introduced to the burning process than would be necessary for combustion alone which draws off the carbon dioxide. The resultant calcium oxide or quicklime is a reactive, volatile material. If water is added it will fall to a dry powder, hissing and steaming in the process. The resultant hydrated or slaked lime ($Ca[OH]_2$) is suitable for agricultural use as it will readily pass into the structure of the soil. For construction purposes, however, more water is generally added and the mixture, when stirred, will become creamy and quite glutinous, forming a lime putty. Mixed with sand, this will make a hard setting mortar or with other minor additions, plaster and stucco. (Ellison et al. 1993, 220–1)

[7] Beadnell Point has clearly posed a hazard to shipping as demonstrated by the wrecks of The Mistley and The Yewglen which lie in close proximity. Where lime was to be exported by sea harbour facilities were provided, as at Beadnell, and with the wooden jetties built on Holy Island and at Scremerston.