

# Arable agriculture in prehistory: new evidence from soils in the Northern Isles

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## ABSTRACT

*A Neolithic agricultural soil, a late Bronze Age to early Iron Age soil and a range of midden deposits were analysed from the multi-period settlement sites of Tofts Ness, Sanday, Orkney and Old Scatness, Shetland. The analysis was undertaken in order to compare the midden material which had accumulated within the settlement to the cultural material in the arable fields. The comparison was undertaken in order to determine whether manuring was practised in the Neolithic and, if so, to identify which materials were selected as fertilizers. Thin section micromorphology, phosphate analysis, particle size distribution and loss on ignition were used to identify and characterize the materials which were added to the soil. The results indicate that in the Neolithic period at Tofts Ness the middens themselves were cultivated, although midden material was also added as fertilizer to the fields around the site. The cultivation of midden heaps in the Neolithic may have been a common practice and is evidence for intensive arable agriculture on a small scale. The cultivation of a Late Bronze Age to Early Iron Age midden at Old Scatness, Shetland suggests continuity of the practice. Parallels are drawn with other Neolithic, Bronze Age and Iron Age sites.*

## INTRODUCTION

There has been a great deal of debate about the nature of early agriculture and settlement in Britain. Arable agriculture in the Neolithic was once thought to have taken place in small fields in temporary clearings, based on the ‘swidden’ or slash and burn system which was recorded in 17th-century Scandinavia and which was practised until the 20th century (Iversen 1941). Subsequent models suggested a more sedentary population, especially after investigations began to take place on a landscape scale. Studies in a number of regions found that funerary monuments appeared to mark out territorial

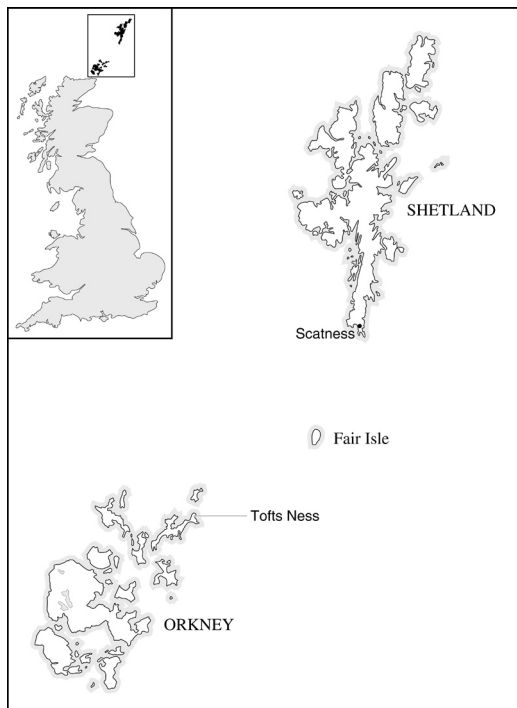
boundaries between Neolithic communities with distinct material cultures (Barker 1985). Recently, there has been a reaction against the sedentary Neolithic model, mainly because of the lack of evidence for Neolithic structures in the English lowlands (Thomas 1991; Whittle 1996a; 1996b). In Scotland, by contrast, the Neolithic continues to be regarded by many as a period of settled farmers, largely because of the occurrence of stone structures and extensive field boundaries (Barclay 1997; Dockrill, forthcoming).

Intensive landuse can take place in areas that are not delineated by field boundaries, but without the field boundaries they are more

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ILLUS 1 Location of Tofts Ness and Scatness

difficult to identify. Arable production can be intensified either by the expansion of cultivated areas or by the addition of fertilizers, which may be derived from a number of different sources and which leave differing traces in the soil. One indicator for intensive arable land use is the occurrence of artificially deepened topsoils which have been created by the addition of manuring materials. These soils are widespread in north-western Europe (Pape 1970) and have also been recorded in the Northern Isles of Scotland, where they have been dated to the late Norse period, that is, the 12th–13th centuries (Simpson 1993; 1997).

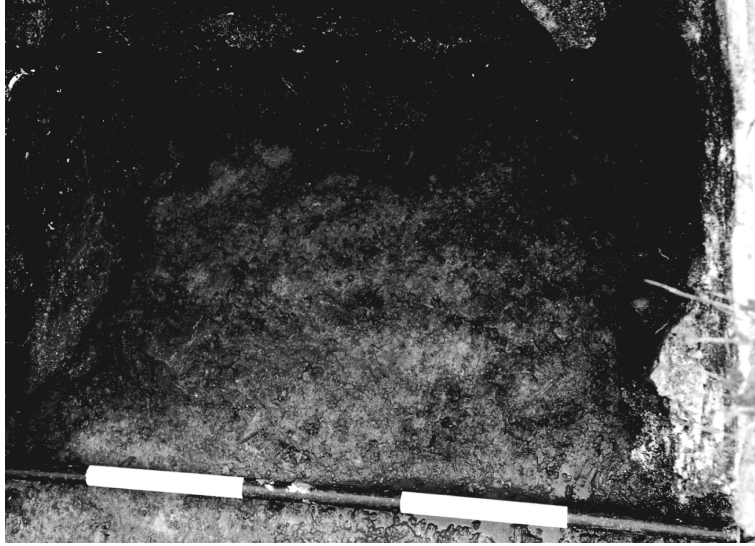
Where soils have not been artificially deepened, the key indicators for manuring include the presence of cultural material in the soil (Rhodes 1950) and traces of the manuring materials themselves, which may survive on a microscopic or even a molecular scale (Davidson & Carter 1998; Simpson et al

1998a). The addition of manures to enhance soil fertility is known to have taken place as early as the Neolithic in Switzerland, where animal manures were applied (Nielsen et al 2000), and the Netherlands, where domestic waste was used (Bakels 1997). At Machrie Moor on the Isle of Arran (off the west coast of Scotland), a Neolithic soil was found to contain algal spores, which suggests that it may have been manured with seaweed (Haggarty 1991), a practice used extensively in coastal areas in the pre-industrial period (Fenton 1978; Bell 1981).

This paper considers recently discovered manured prehistoric soils in the Northern Isles of Scotland, at Tofts Ness, Sanday, Orkney and Old Scatness, Shetland (illus 1). Laboratory investigations are used to determine the unusual way in which these soils were enriched: instead of spreading midden material onto the arable plots, the arable plots were placed on top of the midden heaps, transforming them into small areas (as small as around 10sq m) of rich agricultural land (Guttmann 2001). The paper goes on to consider the evidence for these land management practices elsewhere during the Neolithic, Bronze Age and Iron Age, and concludes that they may have been widespread.

## METHODS

This section micromorphology is used to identify processes that take place in the soil, and also to identify materials that have been added. Undisturbed soil samples from the study areas were collected in Kubiena tins and soil water was replaced with acetone. The samples were impregnated with resin under reduced pressure, cured and manufactured to 30µm for observation under a petrological microscope (Davidson & Simpson 2001). The method is increasingly used together with complementary geochemical and geophysical techniques, which can contribute greater detail to the thin section interpretation. For this research, thin section analysis was used to identify materials added to the soil, and the complementary methods provided some idea of the quantities involved. Reference slides of modern peat, peat ash and sheep and cattle dung were created to aid in the identification of the archaeological



ILLUS 2 Ard marks beneath the Neolithic soil at Tofts Ness (*Alan Duffy*)

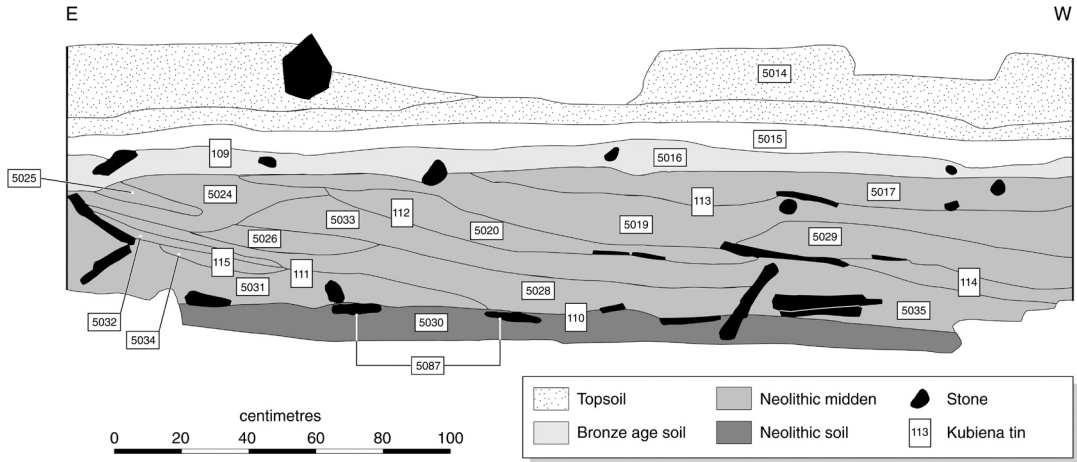
materials, together with the standard reference books (Bullock et al 1985; Courty et al 1989; FitzPatrick 1993). The reference slides were observed at magnifications of  $\times 20$  to  $\times 400$  under different light sources (plane polarized, cross polarized and oblique

incident), all of which help to identify distinguishing characteristics.

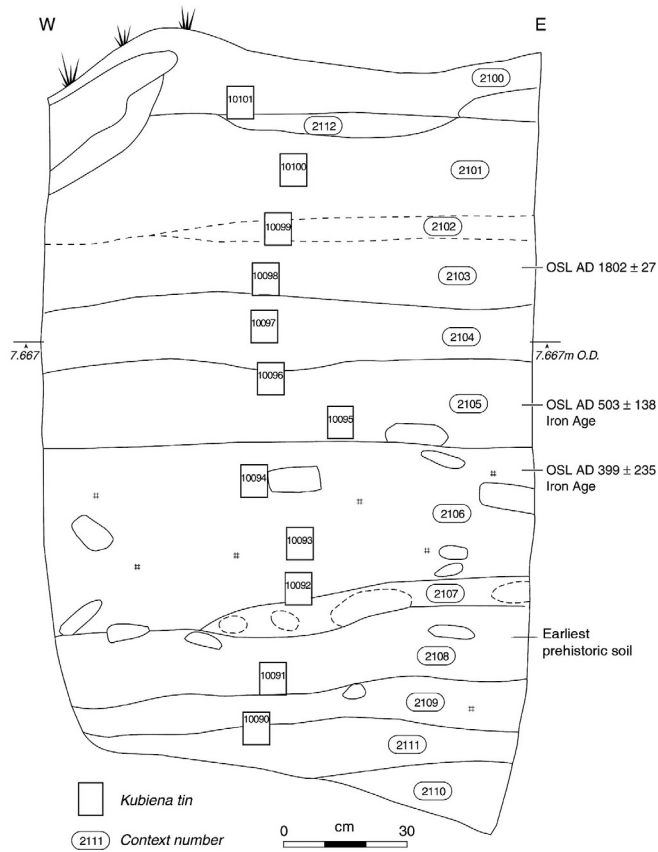
The peat had a distinctive red, fibrous quality, and the bright red and yellow colours of the reference peat ash in oblique incident light were particularly



ILLUS 3 Ard marks beneath the Late Bronze Age/early Iron Age soil at Old Scatness (*Val Turner*)



ILLUS 4 Tofts Ness, Area A, showing the Neolithic soil (5030) and middens



ILLUS 5 Section showing the Late Bronze Age/early Iron Age soil, Old Scatness (contexts 2108 & 2109)



striking, usually having a Munsell value/chroma of 7/8 and above. By recording the Munsell colour of the archaeological samples in reflected light, a semi-quantitative assessment of the peat ash content in the archaeological samples was achieved. The sheep dung was characterized by common parenchymatic tissues (plant tissues), many of which contained well preserved, articulated phytoliths. Calcitic spherulites were apparent in cross polarized light; these are known as a key indicator for herbivore dung (Canti 1997). The cattle dung was obtained from a muckheap, and it therefore contained large amounts of straw mixed in with the dung. The cattle dung fragments appeared similar to the sheep dung, however, and spherulites were also apparent in the sample. The peat and the sheep dung were collected from the Corrigall Farm Museum in Orkney, and the cattle dung was taken from a farm near Scatness, in Shetland. The peat ash was from peat taken from a range of different geologies on Orkney and Shetland. The samples were heated in a furnace to 400°C (the temperature of an open fire) and 800°C (the temperature reached in metal-working fires).

The phosphate levels in the soils and middens were analysed in order to assess the amount of waste material in these deposits. The level of phosphate enhancement was ascertained by comparison of the soils and middens with control samples which were taken from the modern pasture topsoil near each of the sites. Phosphorus in the soil is derived from rocks, plants and animals, and is especially concentrated in human and animal excrement. High levels of phosphates are found around settlements, where they are mostly derived from excrement (which is 15.8% phosphorus), bone (23.5% phosphorus) and food waste (Eidt 1984). The phosphates were processed by acid extraction using 10ml 12N sulphuric acid, and colorimetry was carried out using an ammonium molybdate reagent.

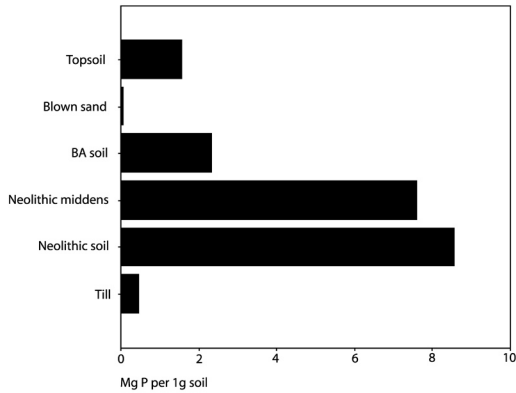
Indication of the organic material in the soils and middens was assessed using loss on ignition. This is a simple process in which an air dried soil sample is weighed before incineration in a furnace at 425°C. The weight after incineration is then subtracted from the weight before, the difference between the two indicating the percentage of organic material. The particle size distribution was analysed to further characterize the soils and sediments. Particle size (clay, silt and coarse, medium and fine sand) gives some indication of the origin of the sample, enabling links to be made between sediments in different parts of the site and its surroundings. The samples

were sieved at 500µm and subjected to loss on ignition before dispersion and sampling in a Coulter Counter. The particle size curves were plotted and overlain using the Coulter Counter software, which also provided the statistics for each sample so that comparisons could be made between samples.

## TOFTS NESS AND OLD SCATNESS

Two buried prehistoric agricultural soils were analysed from the multi-period settlement sites of Tofts Ness, Sanday, Orkney and Old Scatness, Shetland (illus 1). The soils on both sites were deeply buried beneath wind blown sands, and on both sites there were ard marks cutting into the drift geology underlying the soils (illus 2 & 3). The soil at Tofts Ness was found around a small settlement; two Neolithic structures were recorded but much of the settlement mound remains unexcavated. The Neolithic soil at Tofts Ness (5030) was sealed beneath midden deposits (illus 4), and a cattle bone from the midden produced a radiocarbon date of 3140 ± 220 cal BC (95% probability), providing a terminus ante quem for the soil below (GU-2210, 4480 ± 70 BP). At Old Scatness the excavation has not yet reached the Neolithic levels, but there was an area of ard marks in the field system west of the broch village (Dockrill et al 1995) and an adjacent test pit exposed a deep sequence of soils outside the main concentration of Iron Age structures (illus 5). The earliest soil contained prehistoric pottery, and quartz grains within the soil were OSL dated to 2449 ± 791 BC (Burbidge et al 2001). This date range is the time when the quartz grains were last exposed to sunlight. This same stratigraphic deposit elsewhere on the site was clearly sealed by the broch and has returned a later radiocarbon AMS date of 820–510 BC at 95% confidence (2555 ± 45 BP AA-48325/GU-9862). A further AMS date of 400–160 BC at 95% confidence (2220 ± 55 BP AA-48337/GU-9874) was obtained from charred barley taken from the same ard-cultivated soil south of the settlement. This evidence indicates that cultivation took place prior to the construction of the broch, and may have continued over a long period of time.

The thin section analysis demonstrated that both the soil and middens at Tofts Ness contained 2–5% charred peat/turf fragments (Table 1); the soil contained 4.26% organic matter as assessed through loss on ignition, and the middens contained 3.77–6.19%. The bright yellow colour of the soil in oblique incident light was identical to that of the midden deposits, which suggests a common



ILLUS 6 Tofts Ness phosphate levels

source; these samples were distinct from the darker brown of the later soils. These results indicate that the Neolithic soil beneath the midden at Tofts Ness contained nearly as much peat ash as the midden deposits above.

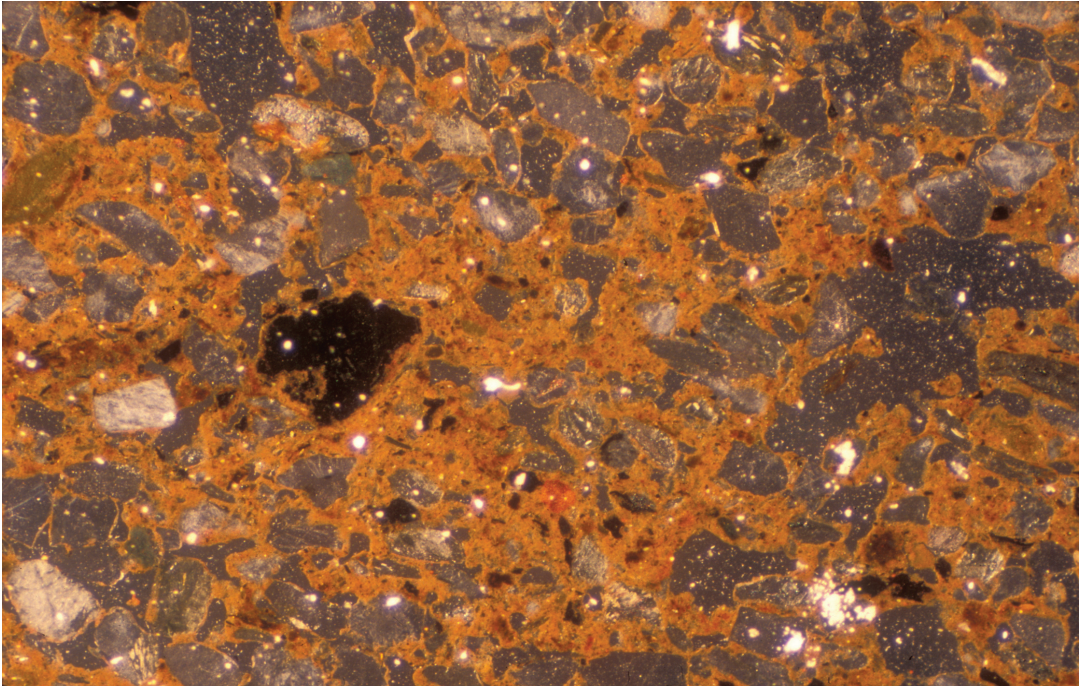
The Neolithic soil was strongly enhanced in phosphates, with a level 5.5 times that of the modern pasture topsoils (illus 6). The phosphates in the later, Bronze Age soils were much lower, although they were slightly enhanced compared to the modern topsoil. The Neolithic soil contained 2–5% phytoliths, indicating that plant material had been added; the average background level of phytoliths in the other soils was much lower, at <0.5% of each thin section

slide. The fine grain size of the Neolithic soil beneath the midden was almost identical to the average grain size of the middens, in contrast to the coarser particle size in the surrounding Neolithic soils and in the later soils (Table 2). The phosphate analysis, thin section analysis and particle size distribution analysis all demonstrate the similarity between the Neolithic soil in Area A and the overlying middens.

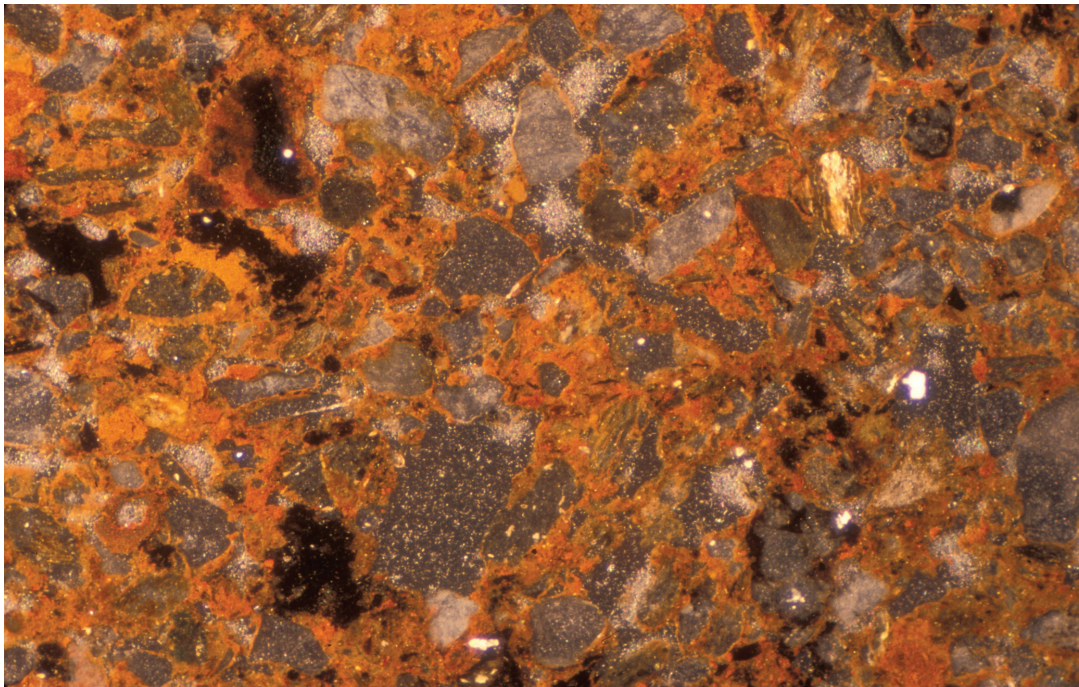
The earliest soil at Old Scatness (2108 and 2109) was a very distinctive red colour in the field (5YR 3/3 and 4/3), and the same red soil filled the arid marks cut into the sand (2111) below the soil (illus 7). The red colour was particularly striking in thin section under oblique incident light, and in this light the soil was identical to Iron Age ash middens found elsewhere on the site (illus 8). The particle size distribution analysis confirmed that this soil was distinctly different from the subsequent soils; all of the later soils and sediments in the sequence and the underlying sand had predominantly medium sand size textures (200–500 $\mu$ m), whereas the earliest soil was very similar to the middens, with a finer silt and fine sand size texture and very little coarser material (Table 2). The earliest soil had a total phosphate range of 691–1516mg P/100g soil as compared with 25–52mg P/100g soil in the control samples taken from nearby pastures (Table 3); this demonstrates a significant phosphate enhancement in the early soil. There were no Neolithic or Bronze Age middens with which to compare the phosphate levels in the soil, but the Iron Age middens had a lower average phosphate level than the primary prehistoric soil.

TABLE 2  
Particle size distribution ( $\mu$ m)

Site and area	Range of means	Average of means	Median range	Median average
Tofts Ness: EIA middens	58–123	94	25–74	49
Tofts Ness: LBA–EIA soils	235–246	245	229–257	243
Tofts Ness: Bronze Age soils	53–301	190	23–294	160
Tofts Ness: Neolithic middens	44–132	79	12–75	37
Tofts Ness: Neolithic soil, Area A (below middens)	77	77	38	38
Tofts Ness: Neolithic soils (other)	102–227	171	68–215	140
Scatness: 18th–20th-century soils	198–234	221	193–249	229
Scatness: LIA middens	114–80	97	32–27	29
Scatness: MIA middens	58–175	107	20–122	51
Scatness: Iron Age soil (Simpson et al 1998)	258–296	280		
Scatness: Primary soil	104–166	135	113–60	87



ILLUS 7 Primary prehistoric soil, Old Scatness. Oblique incident light (magnification  $\times 25$ )



ILLUS 8 Iron Age midden deposit, Old Scatness. Oblique incident light (magnification  $\times 25$ )



TABLE 3  
Phosphate and loss-on-ignition ranges, Old Scatness (mg total P per 100g soil)

<i>Description</i>	<i>mg P per 100g soil</i>	<i>Average total P</i>	<i>LOI range</i>
Neolithic soils	691–1516	1151	0.9–3.8
Middle Iron Age middens	279–402	329	2.9–7.9
Late Iron Age midden	863–1072	968	4.1–4.5
Controls	25–52	39	5.1–10.4

## DISCUSSION

At Tofts Ness the cultivated Neolithic soils and at Old Scatness the primary soils were nearly identical to the midden deposits found in the settlements. The evidence suggests that the arable plots were placed on top of the midden heaps, that is, the midden heaps were transformed into cultivated plots. The cultivated midden formed a small plot at Tofts Ness; the extent is unknown but the midden soil was not found in the surrounding test pits, which suggests that the plot was no more than c10 or 20sq m. The material which infilled the ard marks was clearly the same as that which overlay them, which demonstrates that the arable soils were not stripped away and replaced by dumped midden deposits. The thin section analysis, phosphate analysis and particle size distribution demonstrated that the arable soils were composed of the same material as the midden heaps and were not simply soils with added midden material, such as occurred in later phases. At Tofts Ness the cultivated area also extended beyond the midden, and midden material was added to these soils. The ash and phosphatic material occurred in much lower concentrations in these areas than in the cultivated middens, although they were significantly higher than in the modern pasture soil (Guttmann 2001). At Old Scatness it appears that ash rich midden was applied to a sand surface and then cultivated over a long period of time; there may have been soils beyond the midden but this can only be established by further excavation and analysis.

A review of the archaeological literature suggests that the cultivation of midden heaps in

the Neolithic may have taken place on a number of other sites in the Northern Isles and on at least one site in England. At Pool, Sanday, Orkney there were ard marks beneath the Neolithic midden, and the excavator suggested that the agricultural soil was removed prior to the midden dumping (Hunter et al, forthcoming), which was clearly not the case at Tofts Ness or Old Scatness, and in light of this research may not have been the case at Pool either. At Knap of Howar, Papa Westray, Orkney there were two phases of Neolithic activity dating from 3500–3100 BC (Ritchie 1983). In the first phase a midden up to 40cm thick was deposited. In the second phase structures were built on top of the midden and cutting into it, also using midden material as building material or insulation within the walls. An upper midden deposit associated with the structures was then accumulated. Both the upper and lower midden deposits had level surfaces, and the excavator suggested that they might have been cultivated; the midden material covered an area of c500sq m (ibid). The evidence from Tofts Ness suggests by analogy that her interpretation could well be correct. Links of Noltland, Westray is another site with an extensive area of possibly cultivated Neolithic midden, measuring at least 210 by 70m (Clarke et al 1978). Cultivation of a midden in the Neolithic was also suggested by Macphail (1990) at Hazleton North, Gloucestershire, where small, shifting arable plots were recorded beneath a long cairn, and one of the plots was placed on top of a midden heap.

The cultivation of middens seems to have taken place at Old Scatness in the Bronze Age and Early Iron Age. Further evidence of midden cultivation might be suggested on a number of

sites in the Western Isles, where large amounts of midden material have been identified interleaved between the machair sands on several sites. Gilbertson et al (1999) established that Bronze Age and Iron Age buried soils in the machair at Cill Donain, South Uist contained large amounts of midden material and represent anthropogenic activity rather than periods of natural dune stabilization. It is possible that some of these deposits were cultivated middens rather than natural soils with added midden material. Midden material was also deposited over large areas at Baleshare, North Uist and Hornish Point, South Uist (Barber 2003). Midden material was dumped onto the soil to create arable plots at Baleshare, but at Hornish Point the author suggests that the Iron Age midden deposits were probably cultivated in situ (ibid).

The fact that middens were cultivated from the Neolithic to the Iron Age suggests that the occupants recognized the fertility of their own domestic waste, although the waste material was not used as efficiently in prehistoric agriculture as it was in later periods. Peat ash on its own is not a particularly effective fertilizer, but nevertheless it provides some nutrients and would have improved the soil to some degree (Romans 1986). It is much more effective when combined with other domestic waste such as animal bone (which is present in the soils at both Tofts Ness and Old Scatness) and food residues. Animal manures were probably not widely used as fertilizers in Britain until the Iron Age, when domestic livestock were kept more intensively and dung would have been easier to collect (Simpson et al 1998b; Guttman et al 2003).

Early prehistoric houses in the Northern Isles were typically excavated into midden heaps, and midden material was also used on some sites in the house walls, possibly as insulation. Domestic waste therefore had several functions, and was used both in the settlements (for structural purposes) and in the fields (as fertilizer). In midden heaps with a sufficient proportion of organic matter and a carbon/nitrogen ratio of

between 26 and 35, the decay of the organics would have created a certain amount of warmth (Poincelot 1972), which may be another reason why structures were placed within the middens. Compost heaps will reach temperatures of 70°C within a few days, even if they are uncovered, and will continue to produce heat for up to five months or more (ibid). If organic material continued to be added, the mound would have continued to give off heat.

The discovery of enriched arable soils around the Tofts Ness and Old Scatness settlements indicates that the absence of field boundaries does not mean that there was an absence of intensive cultivation. The cultivation of midden heaps on both sites and the addition of midden material to the arable soils at Tofts Ness are indicative of a small-scale but intensive and sustainable land management system. The discovery of a cultivated midden in Gloucestershire (Macphail 1990) suggests that this practice was not confined to the Northern Isles, but may have been more widespread. These enriched soils would have been an important resource, which suggests long term occupation or repeated re-occupation of the sites.

#### ACKNOWLEDGEMENTS

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