

Phosphate analysis of soils associated with the Old Kinord field and settlement system, Muir of Dinnet, Aberdeenshire

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ABSTRACT

This paper presents the results of a soil phosphate survey of the Old Kinord field and settlement system in Aberdeenshire. The survey shows a good relationship between surviving field remains and the spatial distribution of soil phosphate concentrations and appears to differentiate between areas of settlement and those of agriculture.

INTRODUCTION

Field and settlement systems were a common feature in the landscape of prehistoric Britain (Feachem 1973; Cunliffe 1974). It has been suggested that for the county of Sutherland alone, there were perhaps 500 such systems (Fairhurst & Taylor 1971). The form of such settlements, with their characteristic hut and enclosure foundations, field walls, cairn-fields and, frequently, souterrains, attests the agricultural function which was the basis of their economy. The poverty of finds typically produced by the excavation of such monuments leaves a tantalizing gap in our knowledge concerning early land use. The methods of environmental archaeology can, however, usefully balance or augment the inferences possible from the excavation (Evans 1978; Shackley 1981).

It has been claimed that 'no single archaeological aid has so many applications' as soil phosphate analysis (Provan 1971). The method has been employed extensively overseas to detect settlement and burial evidence (Arrhenius 1935; Lutz 1951; Cook & Heizer 1965; Provan 1971; 1973; Davidson 1973) but less frequently within the British Isles (eg Johnson 1956; Sieveking *et al* 1973; McCawley & McKerrell 1972; Proudfoot 1976). The phosphates derived from activity around a settlement comprise three main sources (Cook & Heizer 1965); (i) urine and faeces of man and animals, (ii) refuse derived from bone, meat, fish, plants, together with skeletal remains in graves, (iii) animal manure applied as fertilizer. The phosphates which enter the soil accumulate very quickly, have low solubility, a strong ability to fix within the soil profile, and can remain for millennia on archaeological sites without appreciable leaching. The concentration of phosphates over an area can reveal the relative extent and intensity of occupation and allow inferences concerning say the arable or pastoral nature of agriculture. It cannot, however, easily distinguish age and different phases of settlement, or the nature of activity if the pattern of land use has varied greatly.

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This paper reports the results from a reconnaissance phosphate survey of the soils associated with a field and settlement system in Aberdeenshire.

THE STUDY AREA

The area under investigation is on the Muir of Dinnet National Nature Reserve (Marren 1979) in the Howe of Cromar, Aberdeenshire (NGR NJ 445 003), where it is located among the denuded remains of the Old Kinord field and settlement system. The undulating surface of the Howe is situated N of the River Dee and 50 km W of Aberdeen on the margin of the Grampian Highlands. The Old Kinord remains are located c 250 m SE of Loch Davan and at an altitude of 165 m OD. The area is floored with freely drained iron podzolic soils of the Corby Association which have developed from fluvio-glacial drift deposits (Glentworth & Muir 1963).

The field and settlement system at Old Kinord consists of the stone foundations of five huts or enclosures, two souterrains and extensive field walls and small stone cairns. The complex is similar to that of the adjacent New Kinord group and is one of 24 surviving systems identified in Cromar (Edwards 1975; 1978a). Their age is uncertain although they would conventionally be assigned to the Iron or Dark Ages in Scotland. It should be noted that a possible Bronze Age date for some of the systems in Cromar has been suggested (Edwards 1975; 1978a) while a clearance cairn associated with cultivation ridges in the Old Kinord group (fig 1) has been dated at c AD 1440 (Edwards 1978b). The monuments of the area have received attention over many years (Stuart 1854; Abercromby 1904; Michie 1877; 1896; 1910; Ogston 1931; Simpson 1944) and tradition links the Kinord settlements with the British Tazali tribal centre of *Devana* (cf Loch Davan) on Ptolemy's c AD 160 map of Britain (Michie 1910). Thomas (1876), however,

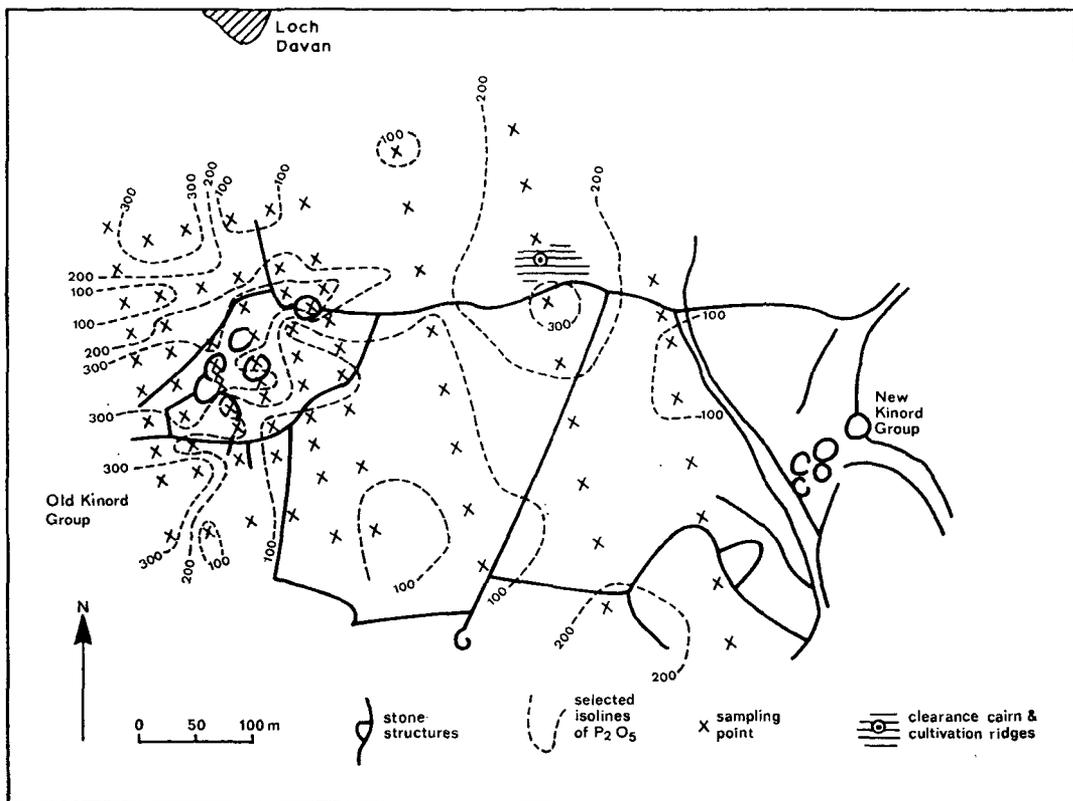


FIG 1 Spatial distribution of soil phosphates around the Old Kinord field and settlement system

prefers to equate Devana with Aberdeen (cf Gaelic, *Aber-dhemhan*) in spite of Ptolemy's location of the centre at an apparent 45 miles W of the present city.

PHOSPHATE SURVEY AND ANALYSIS

Soil samples were taken on a sampling grid based on points 25–100 m apart dependent on areas of immediate archaeological interest (figs 1 and 2). The coarse grid employed was dictated by the exploratory nature of the investigation and it would have to be tightened if the survey results were to be employed as a basis for the excavation of areas which appeared to be of particular interest. Eighty-four soil samples were taken at a constant 5 cm depth below the soil surface. Preliminary sampling had shown this depth to be the general minimum over the survey area. Trial pits indicated that soil horizon differentiation was not well developed and it would not have been feasible to consistently sample separate horizons (Provan 1971; 1973). Vegetation type and slope information were also recorded for each sampling point. In order to assess whether the vertical distribution of phosphates varied substantially through the profile (Williams & Saunders 1956; Proudfoot 1976) additional samples were taken at three locations and the results (Table 1) were considered to be sufficiently homogeneous to be disregarded for the purposes of this enquiry. The question of lateral variation in phosphate distribution is more readily ascertained by the degree of patterning visible in the final phosphate survey.

TABLE 1
Vertical distribution of soil phosphates

Location	Depth (cm)	Description of soil	mg/100 g P ₂ O ₅
Pit 1: 5 m E of northernmost hut-circle	1	Organic layer	339
	5	Brown mineral	265
	10	Brown mineral	311
	15	Yellow/brown mineral	201
	25	Yellow/brown mineral	150
	35	Yellow/brown mineral	311
	45	Yellow/brown gravelly	380
Pit 2: 14 m S of small cairn	1	Organic layer	230
	5	Brown mineral	196
	10	Brown mineral	247
Pit 3: 58 m N of small cairn	1	Organic layer	322
	5	Brown mineral	247

Soil samples were analysed to determine their total inorganic phosphate (P₂O₅) content rather than acid extractable phosphorus because of the possible more meaningful nature of results based on total recovery (Johnson 1956; Provan 1971). The analytical method (based on Hesse 1971) consisted of the nitric, perchloric and hydrochloric acid digestion of 1–2 g of dried sieved soil. Aliquots of sample solution were developed in vanadomolybdate and read at 470 nm on a Pye Unicam SP6-500 spectrophotometer.

The phosphate content of the soils is presented in histogram form in fig 3, where values are grouped in 50 mg classes. The data are also mapped in figs 1 and 2 where isolines of similar P₂O₅ concentrations have been interpolated.

DISCUSSION

Fig 3a shows that the overall distribution of phosphate concentrations is essentially skewed. Over 67% of the values lie below 250 mg/100 g of P₂O₅. On the basis of the untestable assumption that post-Kinord settlement additions of phosphate have been uniform (though see later comments), and that natural phosphate levels are distributed 'normally' up to about 250 mg/100 g, then higher concentrations of total phosphates are taken to represent increments of added phosphorus. Even if a higher P₂O₅ concentration such as 350 mg/100 g is taken as the minimum

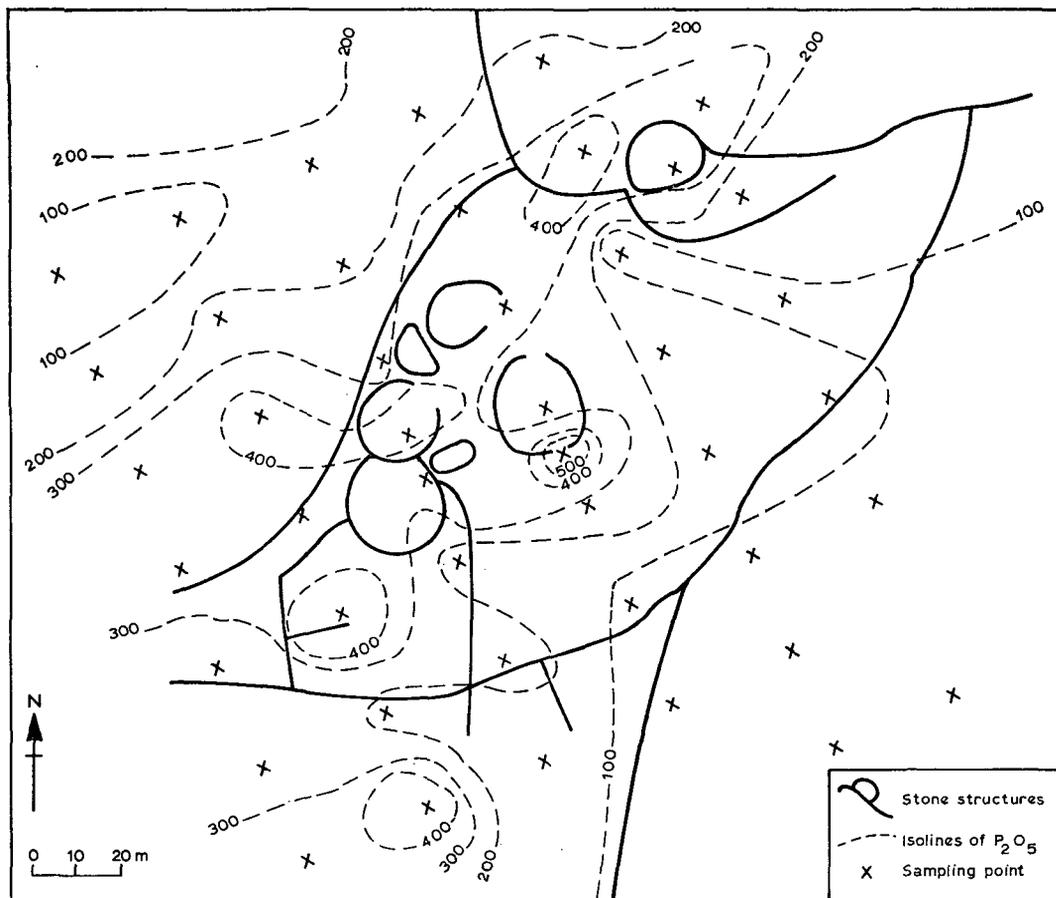


FIG 2 Spatial distribution of soil phosphates around the Old Kinord settlement

addition level, the general distribution of phosphates would retain a similar spatial pattern as can be seen from the contours in figs 1 and 2. The maps indicate an association between high phosphate values and cultural features of settlement (discussed below). In order to assess whether there could be other underlying reasons for this relationship, the phosphate data were disaggregated on the basis of overlying vegetation type and slope values at the point of sampling. The plant types within 1 m of each sample point were recorded. Although grass and heather were dominant there was a mixture of taxa at 49 points, with bracken and birch also being locally important. The phosphate values and the associated dominant plant type for particular soil samples are presented in figs 3b, c and d. The low sample sizes make it impractical to test for meaningful differences between populations using a chi-square test. Of the values greater than 250 mg/100 g of P_2O_5 , the soils under grass alone account for 8 out of 27 such concentrations and another 12 of the 27 scores occur for soils beneath a vegetation cover which includes grass together with at least one other plant type. 'Level' slopes ($<1^\circ$) have 12 of their 22 phosphate scores in the >250 mg/100 g group (fig 3f), a greater proportion than for either of the other two slope categories of $1-3^\circ$ and $>3^\circ$ (figs 3g and h). There are too few combinations of similar slope value and plant type to produce worthwhile data though an example is produced in fig 3i where

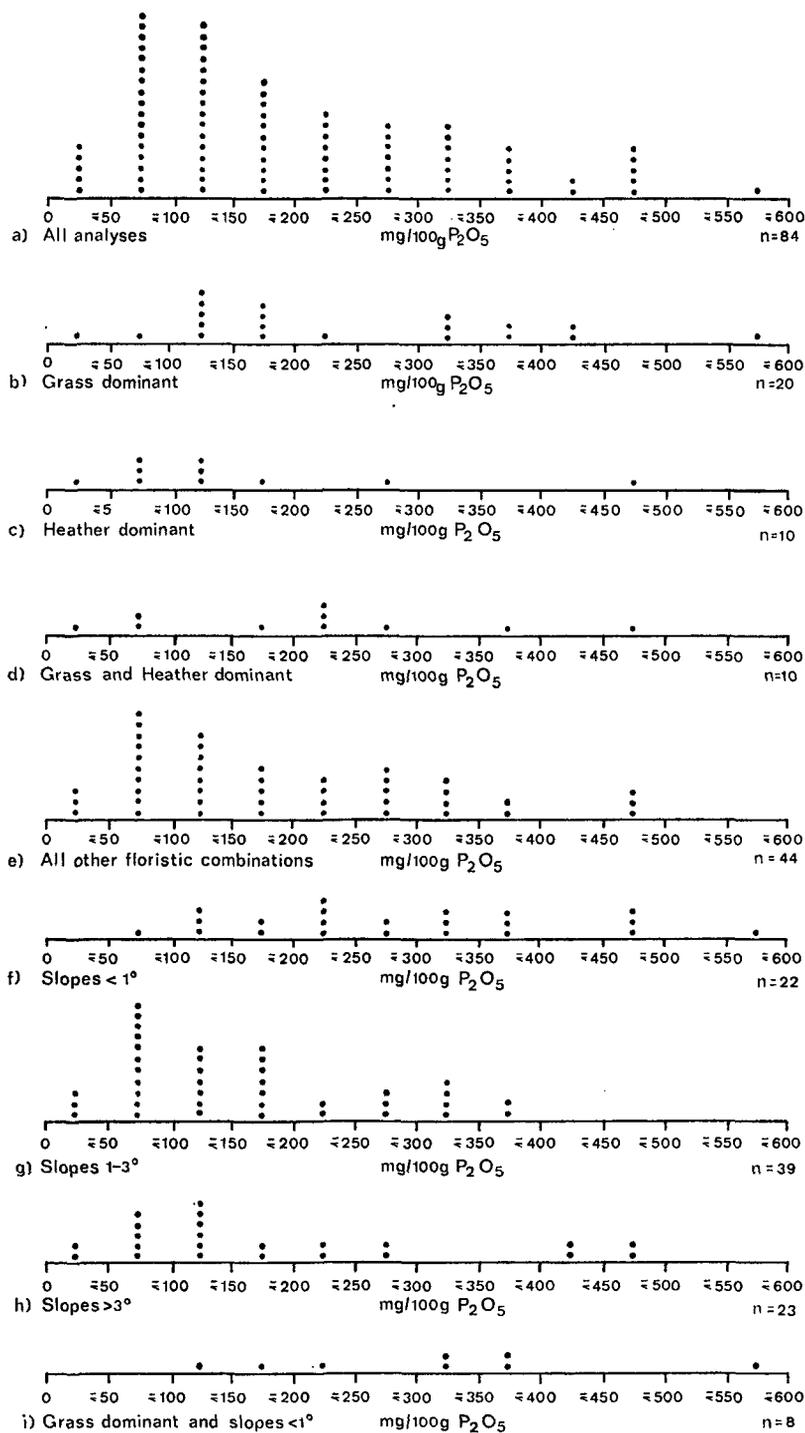


FIG 3 Phosphate content of soils from the Old Kinord system

it can be seen that 5 out of 8 > 250 mg/100 g scores are from soils with level slopes and under a grass vegetation cover.

Such representations as seen in figs 3b-i, however, could (and probably do in this case) result not from vegetational, geomorphological or pedological causes (which could be a result, in part, of human agency) but from predominantly human action. Figs 1 and 2 demonstrate a strong relationship between the Old Kinord settlement and high phosphate concentrations. If man is going to select a level or slightly sloping land surface for his settlement and agricultural activities then it would be expected that low slopes will subsequently produce signs of more intensive activity (ie high levels of phosphate accumulation). Similarly, such areas during both Iron Age and subsequent periods are likely to be favoured for grazing, if not arable cultivation, and this could also explain why a grass-dominated plant cover is also found in association with high phosphate levels. Indeed, the variations in vegetation type might themselves be partly a response to phosphate concentrations. It should not be overlooked, of course, that the vegetation cover over the Old Kinord area is likely to have changed over the last 2000 years. Even the last 10 years have seen a great increase in birch colonization, largely a result, perhaps of decreased grazing in the area.

The results obtained from the Old Kinord system and mapped in figs 1 and 2 would seem to indicate a much greater accumulation of phosphates around the settlement itself (generally over 300 mg/100 g) and lower concentration (usually less than 200 mg/100 g) within the fields. The high values around the huts and enclosures (attaining 559 mg/100 g of total phosphates outside the central hut-circle of the group) probably represent the high local additions deriving from human and animal waste and refuse. The low values within the fields may indicate their use for arable cultivation predominantly, rather than for the grazing of animals. The addition of animal excreta to the fields, perhaps intentionally applied as manure to improve soil fertility in a mixed farming system, might be expected to raise phosphate values to levels somewhat higher than recorded, unless the uptake of phosphates by crops has reduced the available supplies, or cultivation on such inherently infertile soils may not have been favourable to phosphate retention. Leaching does not appear to deplete the phosphorus reservoir to any great extent (Hendrick & Welch 1928). It could be the case that the contrasting concentrations of P_2O_5 between the fields and the settlement could be due to additions of waste from livestock sheltering within the circular structures over a long period of the post-occupation phase and such an eventuality cannot be dismissed. The lack of a time control is a basic weakness of phosphate surveys.

The relatively high concentrations of phosphates (above 200 mg/100 g) in the NE of the sampled area are perhaps explicable in terms of prolonged land use. This is an area of open land which is covered with the faint though distinguishable signs of a ridge and furrow system. These old cultivation banks are aligned approximately E-W and their shallow relief amplitude of less than about 8 cm is perhaps testimony to their age, intensity of use and thinness of the soils. This is possibly a relict portion of medieval or recent historical 'runrig' and higher levels of phosphates may be related to post-prehistoric land use in this local area (Edwards 1978b).

CONCLUSIONS

Given that past human activity is unlikely to have been randomly located, the degree of spatial structuring visible in the mapped phosphate data from Old Kinord is encouraging. At the reconnoitring level reported here, an apparent differentiation is seen between areas of settlement and those of agriculture. The low phosphate levels in the enclosed fields, and beyond them, may suggest arable use without the addition of manure as fertilizer. The surviving field and

settlement remains assist in the understanding of the phosphate values. They may also act as a key in providing confidence in the interpretation of phosphate patterns from systems where the visible remains are much less evident. The existence of residuals of high P_2O_5 levels such as around the area of medieval cultivation (fig 1), or to the S of the settlement perimeter wall (fig 2) may indicate areas which would repay special attention and perhaps excavation. The high values may result, for example, from the existence of a burial or a midden. Refinements to the above survey would include the use of a finer sampling grid as well as the determination of the organic phosphates' fraction in the soil, which may enable a distinction to be made between the agencies responsible for phosphate concentration.

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