



The legacy of past manuring on the arable land of a remote Scottish Island as determined by micromorphological and microprobe analysis

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The St. Kilda archipelago is 160 km northwest of the Scottish mainland and the largest component island, Hirta, is the only one to have had extended periods of occupation. The total arable cultivated area of St. Kilda was 40-80 ha and this supported a population of up to around 200 people. Gradually the traditional economy became unsustainable so that by 1930 the island was evacuated. Of critical importance to the diet of St Kildean's were seabirds, primarily puffins (*Fratercula arctica*), fulmars (*Fulmarus glacialis*) and gannets (*Morus bassanus*) including their eggs. Cropping of bere, oats and potatoes was limited to improved land mainly in the immediate vicinity of the settlement at the Village where this land was essentially managed as a garden with much manure being added. The ingredients of this manure were ashes derived from burning of turf along with other waste materials – straw, urine and excrement, and bones, wings, and entrails of sea birds. The application of this material to the cultivated rigs gradually led to the considerable deepening of the soils, by as much as 1.5 m.

Samples were collected from different contexts on Hirta and these included (1) the deepened soils in close proximity to the Village, (2) soil buried under a consumption dyke dating to 1830 (a wall derived from stone clearance); (3) rigs in and around enclosures in an area near the settlement known as An Lag where cultivation is known to have ceased since AD 1695 and (4) rigs in a valley on the north of the islands (Gleann Mór) where cultivation ceased before 1695. Results from a geochemical survey indicated an enhancement in loadings of Pb and Zn in the rigs associated with the Village, a pattern also reflected in the results from An Lag. Cu is the only other element for which there may be some evidence for concentration. The question then is to identify

the processes which led to these elemental concentrations. Micromorphology (standard description and point counting) was used to identify inputs from manuring and then microprobe analysis to determine if elemental concentrations were associated with particular components.

Analysis of the thin sections indicated that the Village bay soils were stony and organo-mineral with granite/granophyre as the predominant lithology, with a high abundance of charcoal, partially carbonised material and bone fragments, the latter usually located more in the upper part of the soils, highly bioturbated reflected in the presence of excremental features (mainly from earthworms and enchytraeid worms). The soils from under the consumption dyke were very similar to the other Village soils, though stonier and with a higher abundance of carbonised material, charcoal and bone fragments. The soils from An Lag were more stony, but otherwise similar to that found in the old arable soils near village and with less organic matter. In summary, the slides from the old arable land at the Village showed extensive evidence of anthropogenic activity through the presence of charcoal, carbonised material, bone fragments and excrement..

Results from microprobe analysis showed that the highest levels of Zn were found in small fragments of carbonised and humified material and bone fragments compared to the surrounding material. It was interesting to note that none of the larger organic fragments (carbonised or otherwise) had significantly more Zn than the surrounding soil material. Pb tended to be low in concentration and homogeneously distributed. The highest levels of Ca were, unsurprisingly, in bone material. Some of the small mineral fragments were also elevated in Ca almost to the same extent as the bone material. Cu levels tended to be highest in those black carbonised fragments which were also elevated in Zn. The microprobe images showed that the occurrence of Cu and As was primarily associated with rock fragments.

The most remarkable feature of the old arable soils below the Village on Hirta is their depth – up to 1.2m of highly bioturbated, organo-mineral material. Such a depth is indicative of considerable additions of manures and waste materials over the centuries. It is interesting to note that the only other equivalent deepened soils in Scotland are also in very remote localities – on the island of Papa Stour off the west coast of Shetland and on Unst, the most northerly island on Shetland. Perhaps it was this remoteness factor which encouraged people in the past to practice intensive soil management and improvement in order to ensure human survival. According to the US Soil Taxonomy, a plaggen epipedon is a man-made surface horizon more than 50cm deep and formed by long-term manuring and mixing, attributes highly applicable to the old arable land on Hirta. From analysis of bulk samples it was found that the arable soils were elevated in lead and zinc with proposed sources from peat and turf ash; bird carcasses are

likely sources for elevated lead. No specific concentrations for lead were found from the microprobe results, a possible reflection of the relative mobility of lead in an acid soil. In contrast, localised concentrations of lead were found to coincide with bone fragments and black carbonised particles. The wider significance of black carbon in soils as derived from biomass combustion is beginning to be recognised and the nature and properties of such carbon particles require further investigation since they seem to play key roles in storing nutrients and contaminants in old cultivated soils.

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