Micromorphological evidence for the use of urban waste as a soil fertiliser in and near to historic Scottish towns

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Abstract
This paper presents micromorphological evidence for the addition of urban waste to soils in and near to three historic Scottish towns; Lauder, Pittenweem and Wigtown. Waste deposited within historic town cores included human and animal excreta, kitchen refuse, building materials, industrial wastes and fuel residues. Similar types of waste are also evident in nearby agricultural land. Mechanisms of waste disposal are likely to have included direct application and midden spreading within town cores and dunghill redistribution to the hinterland. It is proposed that urban waste was deliberately used as a fertiliser to enhance soil quality within and near to historic Scottish towns, thus increasing agricultural sustainability.

Key Words
Waste disposal, urban refuse, soil micromorphology, Anthrosols, soil modification, fertiliser.

Introduction

Prior to sedentarisation, the settlement of nomadic people in a permanent place of habitation, waste disposal was not a problem given the transient nature of hunter-gatherer subsistence (Rathje and Murphy 2001). However, residents in the first permanently settled communities until today have been faced with the problem of what, where and how to dispose of their waste. In contrast to modern perceptions, waste in the past was seen as a resource rather than a burden, and was routinely used in soil enhancement strategies. As far back as 2300 years ago people were applying household rubbish to cultivated terraces on Pseira Island, Crete (Bull *et al.* 2001). Similarly, the formation of Amazonian Dark Earth is testament to long-standing pre-Colombian practises of soil enhancement through application of domestic refuse (Sombroek *et al.* 2002, Woods and McCann 1999).

Waste disposal in historic Scottish burghs (towns)

The use of rubbish as a fertiliser is not confined to ancient cultures; recent studies indicate this practice was a feature of many historic Scottish burghs. Davidson *et al.* (2006) attribute an area of deepened topsoil at the edge of Nairn, Nairnshire to sustained application of urban waste for the purpose of soil enhancement. Examination of a deepened phase revealed a maximum concentration of phosphorus in the Ap3 horizon supporting the theory of using urban waste as a fertiliser. In addition, both Davidson and Dercon *et al.* (2005) identify a significant quantity of finer material in the upper A horizon within the deepened sequence at Nairn, the presence of which is associated with mineral components of applied rubbish such as sand and ashes, used in byres to absorb fluid and stabilise dung, and turves used in building construction and repair. Deepened topsoil deposits have also been identified within the burgh core (urban centre) of many historic towns including St. Andrews, where the occurrence of 'garden-soil' deposits reflects a deliberate and sustained attempt at soil improvement for the purpose of urban cultivation (Cachart 2000; Carter 2001). As yet there have been no systematic attempts to characterise and compare soils modified through deposition of urban waste materials. This paper presents micromorphological evidence for the use of urban waste as a soil fertiliser in and near to three historic Scottish burghs, and discusses the wider implications of soil improvement within past urban environments.

Methods

Three historic Scottish burghs (historic towns) were chosen for investigation based upon differences in geography and past function; namely Lauder, Pittenweem and Wigtown. Functional zones were delineated within each burgh through spatial analysis of selected soil properties including topsoil depth (Golding and Davidson 2005) and elemental concentrations, in addition to historical research. Comparable areas are evident within all burghs including the 'High Street' (historic burgh core) and 'Hinterland Near' zones (Figure 1). The location and number of soil pits within each burgh was determined by patterns in soil variability. At least one soil pit was dug within each delineated zone, and additional soil pits were located in areas of high heterogeneity such as the burgh core.

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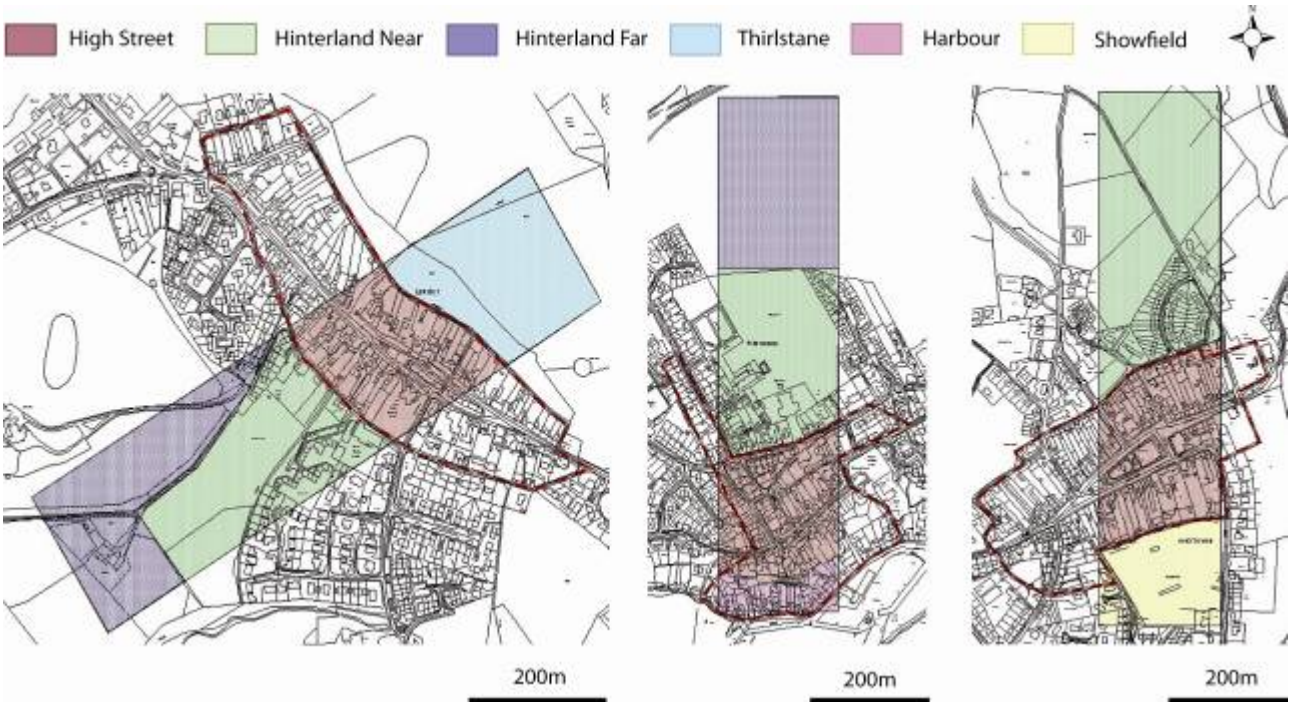

Figure 1. Delineation of zones at Lauder, Pittenweem and Wigtown (left to right). Red boundary delimits mid-late AD 19th century urban extent. Certain zones are specific to individual burghs, for example only Pittenweem has a Harbour zone.

In total 42 Kubiena tin samples were taken from exposed topsoils for micromorphological analysis. Thin sections were prepared from undisturbed soil samples at the Thin Section and Micromorphology Laboratory, University of Stirling (impregnation and processing procedures are outlined at http://www.thin.stir.ac.uk). Thin sections were examined using an Olympus BX 51 petrological microscope and described according to procedures outlined in Bullock *et al.* (1985) and Stoops (2003). A range of magnifications (x10-x400) and light sources (plane polarised, cross polarised and oblique incident light) were used. Semi-quantitative determinations of coarse mineral and organic features were made using a randomised grid system to enable statistical comparison of key anthropogenic inclusions (Figure 2). Precise details of the methodology used to semi-quantify coarse anthropogenic features are described in Golding (2008, 92-99).

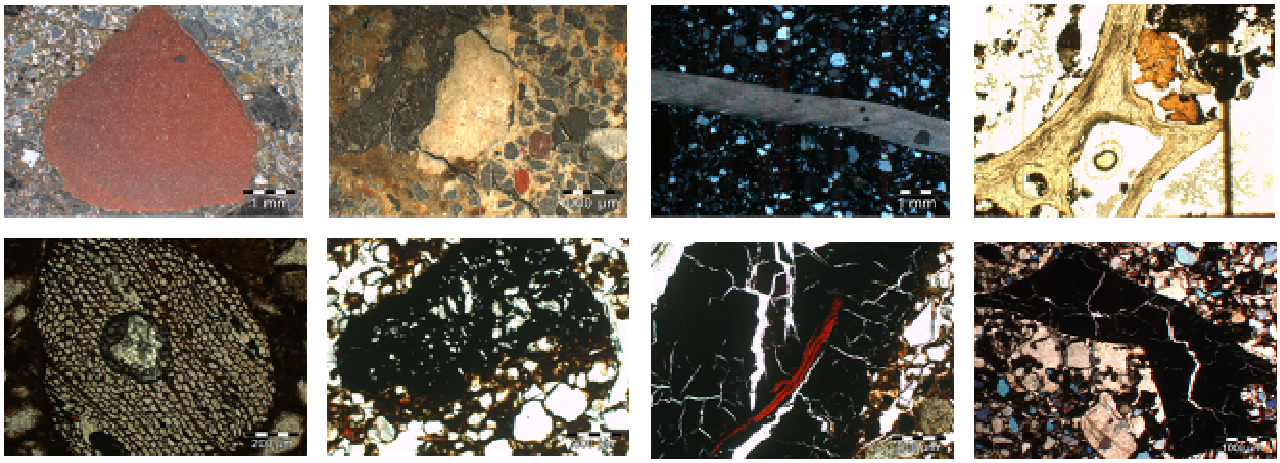

Figure 2. Example images of selected coarse mineral and organic features in thin section from Lauder, Pittenweem and Wigtown. First row: pottery, mortar, shell and bone. Second row: charcoal, fuel residue type 4, fuel residue type 3 and fuel residue type 1.

Results

A summary of key results emerging from micromorphological analyses is presented in table 1.

Table 1. Summary of trends in micromorphological characteristics of topsoils within three historic Scottish towns; Lauder, Pittenweem and Wigtown.

Soil Feature	Summary of Key Trends
Profile characteristics	Soils within all three burgh cores are characterised by hortic topsoil horizons. Soils within the immediate hinterland of Lauder exhibit hortic properties.
Coarse mineral material	Anthropogenic mineral material is most abundant and diverse in burgh cores. Anthropogenic mineral material is present within the wider hinterland at Lauder and Pittenweem. Shell inclusions are limited to Pittenweem and Wigtown. Abundances of shell, mortar and pottery differ between the High Street and Harbour areas within the burgh core at Pittenweem.
Fine mineral material	Soils within all three burgh cores are characterised by brown/dark brown, dotted fine mineral material.
Coarse organic material	Anthropogenic organic material is most abundant and diverse in burgh cores. Anthropogenic organic material is present within the wider hinterland at all three burghs. Differences in principal fuel residue types are apparent between towns. Abundances of certain fuel residues differ between the High Street and Harbour areas within the burgh core at Pittenweem.
Fine organic material	Amorphous red and yellow organic material is present within all three towns.
Pedofeatures	The nature and distribution of pedofeatures is site specific.
Structure	Soils within all three burgh cores are characterised by channel and chamber microstructures with vughy elements. There is no significant difference in coarse material arrangement, groundmass, Coarse:Fine (C:F) distribution or C:F ratio between towns.

Discussion

Waste disposal within burgh cores

Waste deposited within the burgh core at all three towns includes building materials, human and animal excreta, kitchen refuse, industrial wastes and fuel residues. Evidence for shell waste is limited to Pittenweem and Wigtown, reflecting their historic involvement in marine resource exploitation. In addition, differences in the abundance of key fuel residue types were identified between burgh cores, signifying variation in fuel resource utilisation and/or industrial processes between towns. Whilst there is strong evidence for sustained waste deposition within burgh cores, methods associated with waste disposal are less clear. It is suggested that domestic refuse associated with individual households and mixtures of straw, sand and dung from byres were applied to the backlands as a convenient source of fertiliser. Considering the diversity of materials in burgh core topsoils, it is also likely that middens comprising domestic and/or industrial wastes were periodically spread across back gardens.

Waste disposal within the burgh acres

Urban derived waste was deposited within the hinterland of Lauder, Pittenweem and Wigtown in areas corresponding to the burgh acres, agricultural land historically owned by the towns' burgesses. Despite similarities in the nature of waste deposited within burgh cores and burgh acres, anthropogenic inclusions are less diverse and fewer in number within burgh acres. Waste disposal processes are likely to have involved the transportation of dunghills, temporary stores of urban waste, from burgh cores to the burgh acres by means of horse and cart, and in some cases individual labour. In addition to soil improvement, application of urban waste to the burgh acres alleviated problems associated with dunghill accumulation such as the obstruction of thoroughfares in burgh cores. In agreement with Davidson *et al.* (2006) it seems that an early form of urban composting was practised within these towns, with dunghills acting as waste stores prior to redistribution on local soils.

Conclusions

This study has used micromorphological evidence to investigate the legacy of waste disposal on soils in and near to three historic Scottish towns. It is evident that urban refuse was applied to soils within burgh cores and burgh acres at Lauder, Pittenweem and Wigtown. Mechanisms involved in processes of waste disposal are likely to have included direct application, midden spreading and dunghill redistribution. It is proposed that urban waste was deliberately used as a fertiliser to enhance soil quality within both burgh cores and

burgh acres, thus increasing agricultural sustainability. Improvement in the quality and yield of crops was central to meeting the consumption needs of an expanding urban population, yet not all residents had access to the burgh acres. Urban horticulture was an important strategy in enhancing the food security of poorer/lower-status residents, who were able to produce foodstuffs for their own consumption and fodder for livestock within back-gardens. Given current challenges associated with finding environmentally sustainable solutions to waste management and the growing importance of urban horticulture, particularly in developing countries, the significance of urban waste as a past soil improvement resource should not be overlooked.

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