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Anthropogenic Sediments and Soils: Geoarchaeology

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Introduction

Archaeology has gradually but consistently increased its interest in the study of soils and sediments over the last decades. As a result of this emphasis, the discipline has not only sought to characterize the terrigenous matrix within which the great majority of archaeological materials are found but, increasingly, to also understand soils and sediments in their double dimension: as archives of archaeological and environmental data and as *sui generis* artifacts (Butzer 1982; Waters 1992; French 2003; Holliday 2004; Goldberg & Macphail 2006; Walkington 2010). This salience notwithstanding, a tendency to conflate the meaning of sediments and soils continues to exist within the discipline. In some cases, this owes much to the nature of archaeological findings and their context; artifacts are found in sediment deposits that have stratigraphy and which, generally speaking, are sufficiently close to the surface to be affected by soil-forming processes. Be that as it may, it is useful to draw a contrast between "anthropogenic sediments" and "anthropogenic soils" (and indeed between sediments and soils) because the distinction highlights different earthly processes that can affect the formation of this type of archaeological evidence. Put another way, both anthropogenic sediments and anthropogenic soils imply terrigenous material with distinctive characteristics resulting from the strong and enduring influence of past human activity. However, each concept emphasizes a different aspect of the life history of the landscape, that demands the separate attention of archaeological research, especially the subdiscipline of geoarchaeology.

Definition

Sediment is non-lithified material made up, most of the time, of mineral particles of different composition, shape, and size. Sediment is subject to alteration through weathering and can be transported by different agents, which can select different particle sizes as a function of overall energy. Sediment is generally studied by archaeology in deposits that have stratigraphy: the composition of particles, their distribution in terms of size classes, and the sedimentary structures at various scales of observation both inform about the history of a deposit and provide crucial information about preservation factors (Goldberg & Berna 2010). Anthropogenic sediments are those sediments whose distinctive characteristics are a result of the strong and enduring influence of past human activity. Their geoarchaeological study focuses on their composition, history of deposition, and post-deposition alteration, taking into account the significant material effects of human agency. A more intuitive starting point is that most human activity takes place on land surfaces and that land surfaces are subjected to different actions that modify their characteristics over time. Modifications resulting from the activity of people produce a specific range of changes and inputs that lead to detectable differences when preserved: even fairly simple human activities can produce a variety of debris, e.g., charcoal, ash, bones, pottery, plaster, lithics, phytoliths, and slag; one might also consider here other human activities such as excavating, heaping, and winnowing of sediments for different purposes. The archaeological correlates of these inputs and activities are detected through specific material signatures that endure over time and alter the measurable properties of sediments. It is important to underscore that anthropogenic sediments do not only include sediments enriched by anthropic debris or depleted by associated chemical alteration. Unaltered sediments that have been relocated by humans (for instance, those used in platforms, agricultural raised fields, as well as sand or clay mined from quarries and transported to other locales), and sediments that have been modified by humans as raw materials for the manufacture of objects (e.g., clay deposits for making pottery, adobe, and mudbrick), among others, also deserve to be considered as anthropogenic sediments. Human impact on the stability of sedimentary deposits (for instance, through vegetation clearance and burning) are also known to contribute to higher mobility of sediments (e.g., via erosion), but the concept of anthropogenic sediments is probably best reserved for those sediments so mobilized that show the enduring and telltale material signatures of human activity, e.g., re-deposited anthropogenic sediments and soils.

A measure of the importance of distinguishing between anthropogenic sediments and anthropogenic soils is gained by examining what the notion of soil embodies and, consequently, how we can understand the notion of anthropogenic soils. Soil constitutes a complex and open system, a material continuum that drapes the entire planet. It is an assortment of organic and mineral material resulting from the interaction between geomorphological and biotic processes as they affect, and modify the properties of, surface sediments. Collectively, these processes are known as soil-forming or pedogenetic processes and lead to the formation of distinctively patterned layers known as soil horizons (Phillips & Lorz 2008). While key characteristics of soil horizons are determined by the parent material of soil, in other words by the actual composition of the sediments upon which soils have formed, the differences that can be observed between horizons are often the result of the decay, mixing, and depositional action of soil, the mobilization of non-consolidated or dissolved mineral and organic material through the existing pore structure (much of which results from the action of soil biota), and other forms of chemical modification. Horizontal variation in soil characteristics along a land form – a soil catena – subsumes contrasts in parent material as well as variation in slope, drainage, vegetation cover, etc. Anthropogenic soils, in turn, are those whose formation and characteristics have been enduringly influenced by the material effects of human action. Their geoarchaeological study emphasizes an interpretation of the properties of soil horizons as a partial outcome of past human modification. Examples are as varied as they are intriguing: they include soils which were deliberately enhanced through the addition of materials in the past (often to increase fertility, including here compost heaps, home gardens, and agricultural fields) inasmuch as the mineral and even organic components are resistant to degradation; they also include soil horizons formed on human-transported or human-manufactured anthropogenic sediments (e.g., landforms created or altered by humans, including raised fields, soils formed on disturbed materials associated with mining); soils formed in situ on abandoned habitation areas; and soils whose surface horizon has been modified by topsoil disturbance and/or irrigation associated with different types of agriculture (e.g., slash and burn soils, paddy soils), among others (Limbrey 1975; Woods 2003; Dudal 2005).

Anthropogenic sediments and soils exist at variable spatial and temporal scales, from sand piles, pit fills, and compost heaps ephemerally accumulated in the vicinity of houses to entire landscapes blanketed by sediments dislodged by clearance and modified through millennia of continued agriculture. The foci of geoarchaeological studies of anthropogenic sediments involves, among others, establishing which sediments have been transported by humans deliberately (and wherefrom), which in situ sediments have been modified due to human activity (and how), and which sediments have been chosen to craft particular materials (wherefrom and how). The study of anthropogenic soils, on the other hand, includes how soil horizons' properties record the enduring influences of past populations (and to what extent the soil archive can be used to examine past land use), how these material signatures can be used to infer past human activity, and whether soils formed on old occupation deposits have been subsequently employed for cultivation, among others.

Historical Background and Current Debates

Archaeological research focused on anthropogenic inputs on soils and sediments trace their lineage back to Arrhenius' studies of phosphate enrichment in Sweden (Arrehenius 1929) and include geochemical prospection in a wide array of different contexts. The interpretation of modified properties as evidence of anthropogenic enrichment rests on the conceptual premise that humans concentrate metals and nonmetals, and develop other signatures in the sediment record (for instance, enhanced magnetism as a result of burning, changes in pH, etc.). Ethnographic and actualistic situations, in turn, document enrichment with phosphorus, carbon, calcium, potassium, magnesium, manganese, zinc, copper, and other elements associated with different settlement practices or activity areas (Woods 2003). These studies constitute a powerful tool to infer patterns in the use of space, especially when chemical properties are interpreted with the aid of micromorphological observations (Milek 2012). In this connection, compared to some pioneering research of the 1970s and 1980s (Eidt 1984, 1985), the application of micromorphological observations (Courty et al. 1989) has both greatly expanded the overall scope of this research and illustrated the remarkable heterogeneity that characterizes occupation deposits as archives of past human activity (Brochier 2002; Goldberg & Macphail 2006).

Approaches to the study of anthropogenic soils as archaeological entities owe much to studies of *plaggen* soils, the latter being deliberately enhanced farming soils resulting from applications of manured animal bedding made of heather, grasses, and peat by medieval farmers of the sandy lowlands of North-West Europe (Blume & Leinweber 2004). Examples are studies documenting the impact of *plaggen* cultivation on the landscape and research focused on determining new recipes for *plaggen* production (Simpson et al. 2005). Other examples of anthropogenic soils modified for agricultural purposes include soils modified by liming (Conry 1971) and *terra mulata* soils of the Amazon basin, modified by intensive in-field burning (Arroyo-Kalin 2012). In parallel, studies emphasizing the deliberate "making" of anthropogenic sediments include the construction of ash mounds of South India (Paddayya 2002), the making of Tell mudbrick (Rosen 1985) and New World adobe bricks (Goodman-Elgar 2008). Also important are studies devoted to the construction of mounds from more incidental materials, including earth and shells (Roosevelt 1991; Gaspar 1998; Villagran et al. 2011; Rostain 2012).

Worthy of note are examples of anthropogenic soils developed on abandoned archaeological sites, such as Amazonian Dark Earths (Arroyo-Kalin et al. 2009) and European Urban Dark Earth (Macphail 1983; Cammas 2004). Some of the more sophisticated geoarchaeological studies of these deposits focus on ascertaining the properties, mode of formation, spatial extent, and variability of anthropogenic soils, with a particular emphasis on how pedogenetic processes have been affected by past human action (Cremasci & Nicosia 2010). Further areas of research include the actual timing of anthropogenic soil formation (Arroyo-Kalin 2012) and the extent to which these soils, enriched with human occupation debris, can be said to have been used for cultivation (Devos et al. 2009). The latter is an important avenue for research in light of ethnoarchaeological and actualistic studies documenting within-settlement soil improvement (Schmidt 2013, in press), as well as sophisticated, experimentally-based, studies of the material signatures of past cultivation (Lewis 2012). A related line of enquiry focuses on the use of refuse and/or manure in broad areas around settlements, which has prompted important discussion in the archaeology of North-West Europe, the Mediterranean region, and Middle East (Wilkinson 1989; Bintliff et al. 1990; Guttmann 2005).

Techniques employed in the study of anthropogenic sediments and soils are, for the most part, those deployed in other environmental archaeology investigations (Rapp & Hill 1998; O'Connor & Evans 1999; Goldberg & Macphail 2006): a combination between quantifying inclusions and fossil remains, measuring physical and chemical properties of terrigenous material, and studying undisturbed samples microscopically – all within an understanding of processes of landscape evolution. A key methodological issue, however, is the need to establish adequate baselines to assess anthropogenic modification. While human activity can be linked to higher phosphorous, calcium carbonate, carbon, as well as changing particle size classes and enhanced magnetism, it is not straightforward to successfully establish the extent of enrichment or depletion of soils and sediments in absolute terms. One approach is to use maps to compare relative abundance of selected parameters. Another is to employ a "background" for comparison. The extent to which this "background" is equivalent to "natural" conditions depends on the particular features of different regions: in some areas of the world agricultural modification of large expanses makes it next to impossible to detect parts of the landscape that are comparable to archaeological situations and which have not seen major impact by humans (Sanders in Turner & Sanders 1992). In other parts of the world, "backgrounds" can and should be sought because their study permits understanding local processes and situating anthropogenic modification in the specific context of local sediment dynamics and soil forming processes (Arroyo-Kalin et al. 2009). In this connection, some crucial considerations are to study "background profiles" rather than simply "background topsoil samples" (in order to compare to the profiles, rather than surface samples, of archaeological interest); ideally, to locate study profiles on the same landform as archaeological exemplars; and, importantly, to take into consideration the position in the soil catena or palaeocatena (French 2003).

Future Directions

The fundamental common ground between the study of anthropogenic sediments and soils is that both bear distinctive characteristics which can be traced back to human action. These characteristics are enduring, such that, on the one hand, they can be studied as material signatures of past human activity and landscape transformation and, on the other, they can affect the properties of anthropogenic sediments or anthropogenic soils, rendering substrates that have become enriched, depleted, polluted, or otherwise transformed as a result of human agency. Given the ubiquity of human modification of the landscape throughout the Holocene – in many cases an integral consequence of the widespread adoption of agricultural livelihoods over millennia – geoarchaeological studies of anthropogenic soils and sediments constitute a developing and ever more important research program. It is increasingly realized that questions such as "What was the human impact on past environment?" can in many contexts oversimplify the issues at stake, namely, that the legacy effects of past human inhabitation constitute an important source of landscape variability which subsequent inhabitants had to both confront and creatively engage with (Stahl 1996). Put another way, in many cases, and via the enduring effects of manipulating environmental affordances, human populations have played the role of a keystone-species (Balée 2006), both in the flux of ecological interactions and as part of long-term processes of change that have modified the actual properties of the landscape.

Cross-References

- ► Agrarian Landscapes: Environmental Archaeological Studies
- ► Aksum: Environmental Archaeology
- ► Amazonian Dark Earths: Geoarchaeology
- ► Anthropogenic Environments, Archaeology of
- ► Archaeological Soil Micromorphology
- ► Chemical Survey of Archaeological Sites
- ► Environmental Archaeological Evidence: Preservation
- ► Geoarchaeology
- ► Historical Ecology and Environmental Archaeology
- ► Landscape Domestication and Archaeology
- ► Magnetic Susceptibility of Soils and Sediments in Environmental Archaeology
- ► Paddy Soils: Environmental Analyses
- ► People as Agents of Environmental Change
- ► Urban Dark Earth

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Antioch, Apamea, and the Tetrapolis, Archaeology of

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Introduction/Definition

Seleukos Nikator is traditionally referred to as the founder of a constellation of colonies in the Syrian region and in particular of the *Tetrapolis*, a consortium of four sister cities that occupied first millennium BCE settlements: two inland foci (Antioch and Apamea) and two seaports (Laodikeia and Seleukeia in Pieria). Altogether, these foundations were essential in stamping Seleucid hegemony over Syria in light of the overall peaceful settlement with Ptolemy Soter, who in turn seized most of Phoenicia after the fall of Antigonos Monophthalmos. By this rationale, the *Tetrapoleis* created a web of urban foci that firmly secured the Orontes Valley and the coastline in Seleucid hands, thereby curbing expansion ambitions of the Ptolemies. We can safely infer that this ambitious plan of geopolitics was brought to completion in fairly rapid terms during the last years of the fourth century BCE, following the foundation of the new capital at Seleukeia on the Tigris, Seleukos' assumption of kingship,