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Shell middens and other anthropogenic soils as global stratigraphic signatures of the Anthropocene

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ABSTRACT

Evidence for aquatic foraging, fishing, and scavenging by hominins dates back at least two million years, but aquatic resource use intensified with the appearance of *Homo sapiens*. The development of new fishing and seafaring technologies contributed to population growth and the spread of humans around the world. By the late Pleistocene and early Holocene, fishing peoples lived along coastlines, rivers, and lakes in Africa, Eurasia, Australia, and the Americas, creating shell midden soils marked by accumulations of mollusk shells, animal bones, artifacts, and other cultural debris. After global sea level rise slowed ~8000 years ago, a proliferation of shell middens formed an increasingly prominent stratigraphic signature for identifying and defining an Anthropocene Epoch. The formation of these distinctive cultural soils, often marked by unique soil chemistry and biotic communities, is essentially contemporaneous with the development of agricultural economies and the widespread soil and landscape changes associated with them. Defined by these global and highly visible anthropogenic soil signatures, I propose that the Anthropocene began about 10,000 years ago and should replace or be merged with the Holocene.

Anthropogenic soils in general and anthropogenic soil horizons in particular are recalcitrant repositories of artefacts and properties that testify to the dominance of human activities. Hence, such soils are considered appropriate to play the role of golden spikes for the Anthropocene (Certini and Scalenghe, 2011:1273).

1. Introduction

As the International Commission on Stratigraphy and International Union of Geological Sciences consider a formal proposal to designate the Anthropocene as a new geological epoch defined on the basis of human domination of earth's systems, they must also consider such thorny issues as when such an epoch began and on what basis it will be defined. Most scholarly discussions about the onset of the Anthropocene have focused on very recent changes in the earth's atmosphere and markers such as the rise in atmospheric carbon levels associated with the industrial revolution or radionucleotides related to nuclear testing (e.g., Crutzen, 2002; Crutzen and Stoermer, 2000; Zalasiewicz et al., 2010, 2011a,b). Even Ruddiman (2003, 2013), who argues for an early inception of the Anthropocene, relies primarily on rising atmospheric carbon levels to define it. Such changes are most readily identified in long and continuous records of climatic and atmospheric change preserved in cores taken from glacial ice sheets in Greenland and other polar regions. If current global warming trends continue such ice records could disappear, however, a possibility that led Certini and Scalenghe (2011) to argue that stratigraphic records preserved in soils are more permanent and appropriate markers for defining the Anthropocene. Geologically, roughly synchronous and worldwide changes in soils—and the detailed floral, faunal, climatic, and geochemical signals they contain—could provide an ideal global standard stratotype-section and point (GSSP) or 'golden spike' used to document a widespread human domination of the earth.

Some scholars have argued that humans have long had local or regional effects on earth's ecosystems, but that such effects did not take on global proportions until the past century or so (e.g., Crutzen and Stoermer, 2000; Ellis, 2011; Steffen et al., 2007, 2011; Zalasiewicz et al., 2011a,b). Others, including many contributors to this volume, would push back the inception of the Anthropocene to between 500 and 11,000 years ago (i.e., Braje and Erlandson, 2013a, 2013b; Certini and Scalenghe, 2011; Ruddiman, 2003, 2013; Smith and Zeder, 2013). Stressing that human action should be central to any definition of the Holocene, Erlandson and Braje (2013) summarized ten archeological data sets that could be viewed individually or collectively as defining an Anthropocene that began well before the industrial revolution or nuclear testing. By the end of the Pleistocene (~11,500 cal BP), for instance, humans had colonized all but the most remote reaches of earth and

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were engaged in intensive hunting, fishing, and foraging, widespread genetic manipulation (domestication) of plants and animals, vegetation burning, and other landscape modifications. In many parts of the world, the presence of human skeletal remains, domesticated plant or animal remains, agricultural soils, and other markers of widespread human niche construction can be seen as logical markers for the inception of the Anthropocene.

In this paper, I explore a widespread stratigraphic marker of human presence and ecological change that has been largely neglected in discussions of the Anthropocene: anthropogenic shell midden soils found along coastlines, rivers, and lake shores around the world. Shell middens have a deep history that goes back at least 165,000 years, but the spread of *Homo sapiens* around the world during the Late Pleistocene and Holocene, along with a stabilization of global sea levels in the Early Holocene, led to a worldwide proliferation of shell middens. Anthropologists have long considered this global appearance of shell middens to be part of a 'broad spectrum revolution' that led to the development of widespread agricultural societies (Bailey, 1978; Binford, 1968; Cohen, 1977).

In the sections that follow, I: (1) discuss the effects of sea level fluctuations on the visibility of coastal shell middens; (2) briefly review the evidence for hominid fishing, seafaring, and coastal colonization, especially after the appearance of anatomically modern humans (AMH); (3) summarize the evidence for human impacts on coastal ecosystems, including a case study from California's San Miguel Island; and (4) discuss how shell middens and other anthropogenic soils worldwide might be used to define an Anthropocene epoch.

2. Sea levels, shorelines, and shell middens

We live in an interglacial period (the Holocene) that has seen average global sea levels rise as much as 100–120 m since the end of the Last Glacial Maximum about 20,000 years ago (Fig. 1). Geoscientists have long warned that rising postglacial seas have submerged ancient coastlines and vast areas of the world's continental shelves, potentially obscuring archeological evidence for early coastal occupations (Emery and Edwards, 1966; Shepard, 1964; van Andel, 1989). Bailey et al. (2007) estimated that sea levels were at least 50 m below present during 90% of the Pleistocene. During the height of the Last Interglacial (~125,000 years ago), however, global sea levels were roughly 4–8 m above present, causing coastal erosion that probably destroyed most earlier evidence for coastal occupation by humans and our ancestors. The effects of such wide swings in global sea levels leave just the tip of a proverbial iceberg with which to understand the deeper history of hominin coastal occupations.

As a result, many 20th century anthropologists hypothesized that hominins did not engage in intensive fishing, aquatic foraging, or seafaring until the last 10,000 years or so (Cohen, 1977; Greenhill, 1976; Isaac, 1971; Osborn, 1977; Washburn and Lancaster, 1968; Yesner, 1987)—the last one percent (or less) of human history (Erlandson, 2001). In this scenario, intensive fishing and maritime adaptations were linked to a 'broad spectrum revolution' and the origins of agriculture and animal domestication (see McBrearty and Brooks, 2000). The occupational debris left behind by such coastal foragers and fishers, commonly referred to as shell mounds or middens (Fig. 2), were viewed as emblematic indicators of postglacial times and human economies (Bailey, 1978; Binford, 1968; Waselkov, 1987).

Regardless of the accuracy of such assessments, it is true that the late Pleistocene and Holocene are marked by a global explosion of anthropogenic shell midden soils that are highly visible stratigraphic markers in coastal, riverine, and lacustrine settings around the world. In some areas, this terrestrial signature is accompanied by submerged records associated with ancient shorelines. The most dramatic and best documented of these submerged landscapes is the Mesolithic shell middens of Denmark, where nearly 2000 'drowned' terrestrial sites have been recorded (Fischer, 1995). Such submerged archeological sites, along with sub-aerial sites found around Pleistocene freshwater lakes, marshes, and rivers, suggest that the global post-glacial proliferation of coastal shell middens has been exaggerated by the complex history of sea level fluctuations during the Pleistocene. How long

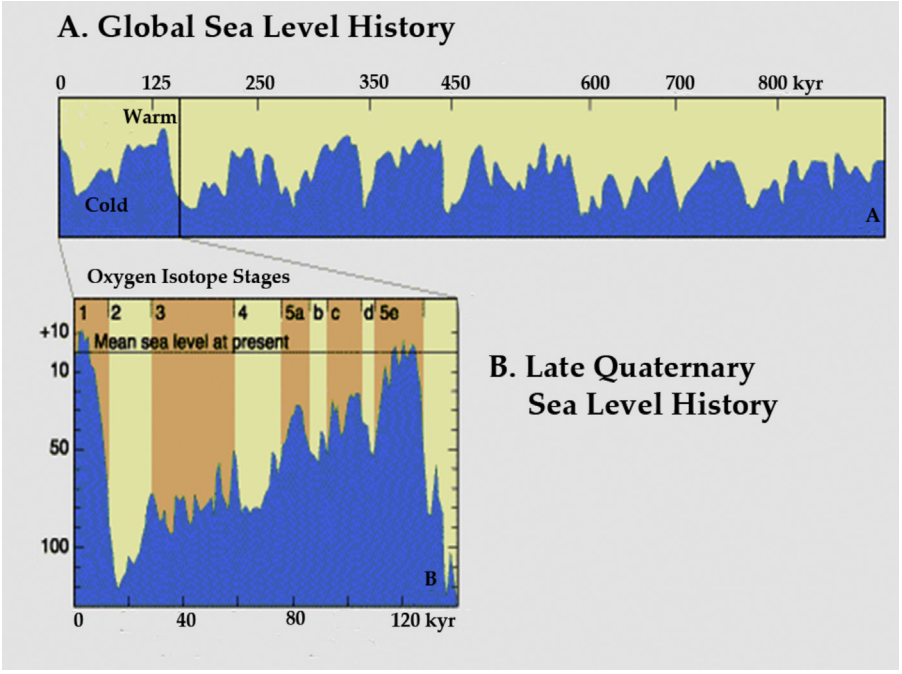

Fig. 1. (A) Fluctuations in global sea levels over the last 900,000 years; and (B) a more detailed view of changes over the past 140,000 years. Although sea level curves vary regionally and locally, such changes dramatically affected the position of marine shorelines around the world, as well as the visibility of coastal archeological records. Source: adapted from http://www.ngdc.noaa.gov/paleo/ctl/clisci100k.html#sea.