



## Guest Editorial

## Soil and sediment archives of ancient landscapes, paleoenvironments, and archaeological site formation processes

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**1. Introduction**

Archaeological Geologists, also known as geoarchaeologists, employ a wide variety of techniques and approaches to study human culture in context of landscapes and environmental dynamics. The premise of a geoarchaeological approach dates to the 1840s when Charles Lyell, the father of Geology, emphasized the need for stratigraphic evaluation of archaeological sites for determining cultural chronologies and resolving debates about human antiquity (Lyell, 1863). By the early 20th century, emerging stratigraphic concepts caused a methodological shift that affected the nature of archaeological excavation—this change has been cited as the first “new” archaeology (Browman and Givens, 1996). During the 1920s, archaeologists in the North American southwest were concerned with the stratigraphy and site formation processes of pre-historic sites that contained Pleistocene faunal remains (Holliday, 2000). To geoscientists such as E.H. Sellards, C. Vance Haynes, and Claude C. Albritton, “geologic research was inseparable from their approach to archaeology” (Holliday, 2000: 11). By the 1970s, the USA federal law mandated cultural research management (CRM), and consulting firms began geoarchaeological investigations to understand site formation processes and discover archaeological material. This was particularly important in the Great Plains of North America, which had been considered devoid of people during the middle-Holocene Altithermal (Mandel, 2000). By 1976, Colin Renfrew coined the term “Geoarchaeology,” and the specialization had coalesced as a hybrid of anthropology, geoscience, and Quaternary studies (Goldberg and McPhail, 2006).

Today, our discipline effloresces as a nexus science, as practitioners bridge ideas from virtually all specializations of Earth science – especially aspects of stratigraphy, pedology, geochemistry, palynology, geomorphology, soil science, climatology, geophysics, and Quaternary geochronology. In the field and laboratory, we employ a diverse array of applied science and engineering methodologies, including archaeological prospection, soils mapping, survey, excavation, lab analyses, and computer modeling. Such investigations impact cultural heritage management strategies for

discovery, site assessment, mitigation, preservation and public engagement.

This thematic volume of *Quaternary International* presents papers that illustrate the breadth and depth of geoarchaeology and the trans-disciplinary observations that are transforming our understanding of human–landscape interactions, behavior, and activities. Each of these papers presents new research involving the analyses of sediment records to reconstruct ancient landscapes and paleoenvironments of the Late Neogene–Quaternary in North America. One common thread is that we assess the sediments themselves, and the various geomorphic and pedogenic impacts on archaeological site formation and preservation.

The original idea for compiling this volume took root in 2008, during the International Year of Planet Earth, when the Geological Society of America (GSA) convened its Annual Meeting in association with the American Society of Agronomy (ASA), the Crop Science Society of America (CSSA), and the Soil Science Society of America (SSSA). This “mega-conference” was held in Houston on 4–9 October 2008, and brought together a noticeably diverse array of geoscientists, practicing consultants and soil scientists, which allowed for meaningful collaboration with those interested in more recent surficial dynamics rather than the deeper geologic timescales.

Energy and excitement from meeting participants transformed the field trips and technical sessions in 2008. With sponsorship of the GSA Archaeological Geology Division and the Gulf Coast Association of Geological Societies, Andrea K.L. Freeman and David Cremeens convened a well-attended session on the “The Changing Role of Geoarchaeology in Environmental and Cultural Resource Management.” Papers in this session explored the ways in which changes in the energy industry and in environmental policy affected environmental and cultural resource management methods, the workforce employed, and the resources impacted. Much of the discussion nucleated around practical issues and the importance of integrating broad geoarchaeological planning and investigations into consulting projects at every level – from the research design to excavation, fieldwork, assessment, and mitigation.

Another topical session at the 2008 meeting was “Soils as Components of Archaeological Landscapes,” convened by Rolfe D. Mandel, E. Arthur Bettis, and Vance T. Holliday with sponsorship of the GSA Archaeological Geology Division, the GSA Quaternary Geology and Geomorphology Division, the Pedology section of the Soil Science Society of America, and the Gulf Coast Association of Geological Societies. Papers in this session demonstrated the utility of pedology in various archaeological investigations. Topics covered a range of applications, including how soils can be used to

reconstruct archaeological landscapes at a variety of spatio-temporal scales, and how soils preserve physical and chemical evidence of human occupation. These themes were echoed in a fantastic field trip (and another technical session) co-led by Rolfe D. Mandel, Donald L. Johnson, and Charles Frederick on the topic of “The Origin of the Sandy Mantle and Mima Mounds of the East Texas Gulf Coastal Plain: Geomorphological, Pedological, and Geoarchaeological Perspectives.” Some of the related papers presented in 2008 were collated in a GSA volume focused on Mima Mounds (Burnham and Johnson, 2012).

Having attended the 2008 GSA meeting and fieldtrip, Kathleen Nicoll and Laura Murphy (the co-editors of this thematic volume) joined forces to continue the momentum and spirit of collaboration. At the GSA Annual Meeting in Minneapolis on 9–12 October, 2011, they convened the technical session “Topics in Geoarchaeology: Reconstructions of Ancient Landscapes and Paleoenvironments” with co-sponsorship of the GSA Archaeological Geology Division, GSA Sedimentary Geology Division, GSA Quaternary Geology, and Geomorphology Division and GSA Limnogeology Division. The 2011 presentations at GSA developed into many of the papers appearing in this volume.

## 2. Highlights of the volume

The authors contributing to this volume are geoarchaeologists working in consulting, cultural resource management, government, and academia. These papers are prime examples of the multidisciplinary and field aspects of geoarchaeology, involving stratigraphy, geomorphology, and landscape reconstruction through the lens of environmental change and site formation – the processes or events that create and preserve archaeological sites (Wood and Johnson, 1978). Each paper employs trans-disciplinary approaches to interpret the material culture, proxy records, and landscape. Common goals of the investigations include assessing the regional geomorphic architecture and sedimentary history of archaeological sites in order to resolve the spatio-temporal distribution of biotic environments in context of processes that have buried, mixed, altered, or destroyed archaeological deposits. This multi-scalar informed approach is essential for accurately interpreting the archaeological record, with all its complexities and limitations.

The fourteen articles span the cultural periods across North America and focus on human environments in landscape settings, including fluvial environments (i.e., ephemeral or perennial streams), colluvial–alluvial–fluvial facies (i.e., places with hillslopes and valley fill sedimentation), and landform sequences with paleosols (sediments affected by weathering and pedogenesis). The papers are organized geographically, from west to east.

- The volume opens with a paper about the regional applications for pre-contact archaeological site burial in delta sub-environments around Puget Sound in the Pacific Northwest. Rinck's contribution offers a geoarchaeological perspective derived from a CRM project. Her paper reconstructs the late Holocene Puyallup River delta history using lithostratigraphic data to inform site formation processes, and to constrain potential human occupation from the midden site Xaxtl'abish 1 (45PI974) on the Hylebos Creek distributary in Tacoma, Washington. Results presented show the lower delta aggraded at an average rate of ~15 cm/year during the middle to late Holocene. Hence, late Holocene archaeological sites may be buried within the upper 11 m of sediment on the delta front, and are younger than 3140 cal. BP (Rinck, 2014).
- Nicoll et al. (2014) present a synthesis of site formation, soil formation, and Archaic geoarchaeology along terraces of the Jordan River in the Great Salt Lake Valley, Utah. This paper

reports findings from a community archaeology survey project that engaged hundreds of volunteers and schoolchildren at the “the Prison Site” (42SL186). A series of test pits and trenches revealed subsurface stratigraphy of on a large prehistoric open-air site. The area preserves several thousands of prehistoric artifacts and many pithouse dwelling structures, one of which is securely dated by replicate AMS to ~2500–2300 cal BP, confirming it as the oldest pithouse discovered in the eastern Great Basin thus far.

- The paper by Onken et al. (2014) presents a new radiocarbon chronology for Holocene stream terraces along the San Pedro River in southeastern Arizona. The geoarchaeological work was conducted in association with a geological mapping project at the Arizona Geological Survey. Using a combination of field mapping and other iterative techniques (e.g., stratigraphic description, archaeological correlation, geochronology, and terrace elevation relationships), they differentiated three Pleistocene and four Holocene floodplain terraces, and describe the chronostratigraphic and archaeological significance of these important landforms. Archaeological chronometric data helped to refine age estimates for the surfaces, some of which had been initially based only on geomorphic and pedologic criteria.
- Goman et al. (2014) conducted archaeological work in the lower Río Verde Valley, Oaxaca, Mexico. They reconstructed the formation, occupation, and land use history at Río Viejo, a dynamic floodplain that has played a pivotal role in the political and social history of the valley region. Paleoenvironmental (e.g., pollen, charcoal) and geoarchaeological data from the Mound 2 feature have informed a 3000-year synthesis of multi-proxy data from the Late Formative to Postclassic periods. The depression associated with Mound 2 originally was a borrow pit on the floodplain that was enhanced and augmented by monumental mound building; the area around Mound 2 was the focus of domestic and agricultural use during the Terminal Formative. Goman et al. (2014) identified periods of significant demographic expansion by the Late Formative period, following floodplain aggradation resulting from a change in stream hydrology and morphology. Then, during the Classic and Postclassic periods, major shifts in settlement and land use occurred, primarily from the productive floodplain to the piedmont.
- Ferrand et al. (2014) examined an Archaic settlement in El Tebernal, Veracruz, Mexico from a geoarchaeological perspective. They describe paleosol development, paleoenvironmental conditions, and resource exploitation in eastern Mexico between 9000 and 4000 BP. Although observed paleosol properties (i.e., total organic carbon, grain size distribution, carbon stable isotope composition, magnetic susceptibility, and micromorphology) indicate a long period of landscape stability under humid and temperate conditions, volcanic eruption events from Pico de Orizaba, located several kilometers away, may have ended a phase of pedogenesis around 4100 BP. The authors also describe post-Classic materials and activities associated with an upper paleosol at the site, and suggested that these societies caused erosion and the activation geomorphic process.
- Murphy et al. (2014) contribute a paper on late-Quaternary landscape evolution, soil stratigraphy, and geoarchaeology of the “Caprock Canyonlands” or “Escarment Breaks” in Northwest Texas, USA. The paper presents the results of extensive field study of the geomorphic elements, soil and sediment analyses, and radiocarbon determinations in an area that has undergone intensive erosion in an archaeologically rich area. They found that high rates of erosion and geological controls have hindered the discovery of deeply buried soils and *in situ*

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