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Climatic, geomorphic, and archaeological implications of a late Quaternary alluvial chronology for the lower Salt River, Arizona, USA

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ABSTRACT

Recent archaeological excavations along the lower Salt River, Arizona resulted in the unexpected discovery of buried late Pleistocene soils and cultural features dating 5800–7100 cal YBP (Early Archaic), the latter representing the earliest evidence of human activity in the lower Salt River floodplain thus far identified. Because the lower Salt River floodplain has been heavily impacted by recent agriculture and urbanization and contains few stratigraphic exposures, our understanding of the river's geological history is limited. Here we present a late Quaternary alluvial chronology for a segment of the lower Salt River based on 19 accelerator mass spectrometry ^{14}C and four optically stimulated luminescence ages obtained during two previous geoarchaeological investigations. Deposits are organized into allostratigraphic units and reveal a buried late Pleistocene terrace inset into middle-to-late Pleistocene terrace deposits. Holocene terrace fill deposits unconformably cap the late Pleistocene terrace tread in the site area, and the lower portion of this fill contains the Early Archaic archaeological features. Channel entrenchment and widening ~900 cal YBP eroded much of the older terrace deposits, leaving only a remnant of fill containing the buried latest Pleistocene and middle-to-late Holocene deposits preserved in the site area. Subsequent overbank deposition and channel filling associated with a braided channel system resulted in the burial of the site by a thin layer of flood sediments. Our study confirms that the lower Salt River is a complex mosaic of late Quaternary alluvium formed through vertical and lateral accretion, with isolated patches of buried soils preserved through channel avulsion. Although channel avulsion is linked to changes in sediment load and discharge and may have climatic linkages, intrinsic geomorphic and local base level controls limit direct correlations of lower Salt River stratigraphy to other large rivers in the North American Southwest.

1. Introduction

Widespread valley entrenchment beginning in the late 1800s throughout much of the North American Southwest (herein Southwest) exposed large sections of floodplain deposits that have been used to reconstruct late Quaternary landscape dynamics linked to changes in climate (Waters and Haynes, 2001; Hereford, 2002; Mann and Meltzer, 2007) and human settlement (Bryan, 1941; Euler et al., 1979; Waters, 1988; Huckleberry and Duff, 2008; Anderson and Neff, 2011). Most of this valley entrenchment occurred along low to intermediate order drainages located above 600 m elevation. Considerably less is known regarding the alluvial history of higher order drainages located in low elevation floodplains such as the lower Colorado, Rio Grande, Salt, and Gila Rivers due in large part to a paucity of stratigraphic exposures. Much of our understanding regarding the behavior of these rivers comes from relatively short historical records, most <150 years in length (e.g., Burkham, 1972; Graf, 1983; Huckleberry, 1994). Knowledge of floodplain dynamics prior to Anglo-European settlement is limited and requires stratigraphic analysis and geological dating of alluvial deposits. In lieu of natural stratigraphic exposures, such investigations generally require costly mechanical excavation. However, improved understanding of the late Quaternary history of these large rivers—several which pass through urban areas—may provide an important frame of reference for assessing flood hazards and anticipating geomorphic responses to future climate change (Goudie, 2006; Church et al., 2009).

In Arizona, most stratigraphic investigations of high order streams with large drainage basins like the Gila, Salt, and Verde are associated with archaeological and geoarchaeological excavations (Birnie, 1994; Huckleberry, 1995; Johnson et al., 1997; Waters and Ravesloot, 2000, 2001; Powell and Boston, 2004; Onken and Joyal, 2005). Geoarchaeological interest in these rivers centers on defining the environmental context for ancient human settlements and on elucidating how floodplain processes affect archaeological site visibility and preservation. This is particularly true for the lower Salt River (LSR) where

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the Hohokam (A.D. 600–1400) constructed extensive prehistoric canal systems that supported interconnected agricultural communities (Masse, 1981; Howard, 1994; Hunt et al., 2005), but where little evidence is available for earlier human activity on the floodplain. The apparent absence of preceramic archaeology along the LSR strongly suggests erosion or deep burial has destroyed or hidden evidence of earlier human activity (Waters and Kuehn, 1996; Waters, 2008). Recent excavations along the LSR, however, have demonstrated that pre-Hohokam archaeological components do occur, including the remains of Early Archaic period seasonal habitations (Onken and Ciolek-Torrello, 2005; Graves et al., 2009a).

Here we present an alluvial chronology for a segment of the LSR near its confluence with the Gila River in south-central Arizona based on accelerator mass spectrometry (AMS) ^{14}C and optically stimulated luminescence (OSL) dating of archaeological features and flood deposits. This chronology is based on two recently conducted stratigraphic investigations. An initial geoarchaeological survey was conducted along the north side of the LSR and part of the Gila River in association with an ecological restoration project resulting in a preliminary alluvial chronology (Onken et al., 2004). Subsequent archaeological testing in part of the original survey area at archaeological site AZ T:11:94 (ASM), herein referred to as site 94, resulted in the identification of an archaeological feature AMS ^{14}C dated to ~6800 cal YBP (Onken and Ciolek-Torrello, 2005) leading to a subsequent geological study during data recovery excavations at the site (Huckleberry, 2009). Data recovery excavations confirmed that cultural features dating 5800–7100 cal YBP exist at site 94, thus representing the earliest human occupations identified along the LSR and arguably the oldest known habitation structures in the southern Southwest (Graves et al., 2009b). Combining the results of these previous investigations, we present an alluvial chronology for the LSR based on 19 AMS ^{14}C and four OSL ages. The combination of AMS ^{14}C and OSL dating provided sufficient chronological control to demonstrate previously undocumented, latest Pleistocene and early Holocene channel dynamics and soil formation. Recognition of buried landscapes is key to fully assessing the archaeological record (Mandel, 2008), and the results presented here indicate that fluvial geomorphic processes play a significant role in the visibility of archaeological sites along the LSR. The climatic implications of past channel dynamics and soil formation along the LSR, however, are difficult to fully ascertain due to local geomorphic factors.

2. Geomorphic setting and Salt River channel behavior

Site 94 is located at an elevation of 294 m near the convergence of the Salt, Gila, and Agua Fria Rivers (Fig. 1). The Gila River is the primary drainage in southern Arizona, and the Salt River is its largest tributary with a catchment area of 38,850 km^2. Site 94 is located on the north bank of the LSR at 91st Avenue within the city of Phoenix, ~4 km upstream from the river's confluence with the Gila. Phoenix has modern mean annual precipitation of <20 cm (Western Regional Climate Center, 2011), and natural vegetation outside the riparian zone consists of drought-adapted species typical of the lower Colorado River subdivision of the Sonoran Desert (Turner and Brown, 1994). The Salt and Gila receive much of their water from forested, high elevation mountains and plateaus in eastern New Mexico and central Arizona, and the rivers were perennial prior to dam construction and diversions for agriculture. Historically, the floodplains contained an extensive riparian woodland (Rea, 1983) dominated by mesquite (*Prosopsis* sp.) and would have been a desirable place for both foragers and farmers. Today both the Gila and LSR in the study area are mostly dry except for short segments that are supplied with irrigation runoff and treated effluent from wastewater facilities.

The LSR flows between normal fault-bounded mountains and is flanked by Quaternary stream terrace and alluvial fan surfaces (Demsey, 1989; Fig. 1). Four Quaternary river terraces have been identified along the LSR (Péwé, 1978; Table 1). Three Pleistocene terraces (Sawik, Mesa, and Blue Point) are topographically distinct in the eastern Phoenix metropolitan area and converge downstream into a single terrace in the vicinity of the Salt–Gila confluence, a geomorphic phenomenon linked to possible uplift of the Central Highlands relative to the Basin and Range province (Menges and Pearthree, 1989).

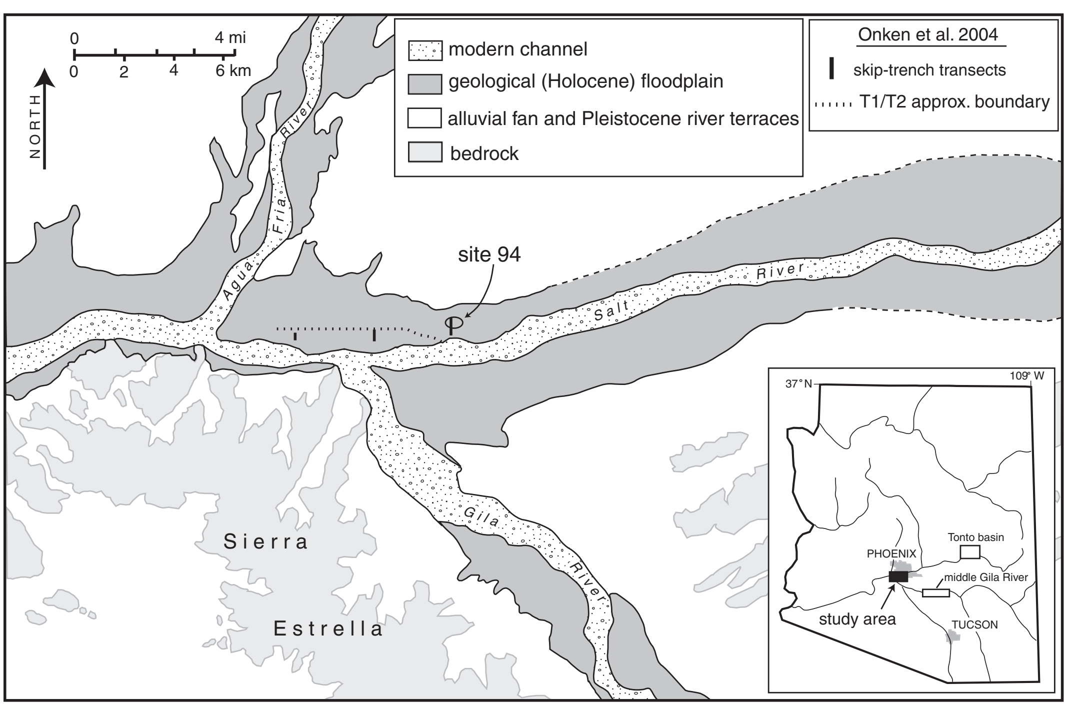

Fig. 1. Study area at the confluence of the Salt and Gila Rivers in south-central Arizona. Surficial geology adapted from Demsey (1989). Mapping within the Salt River floodplain (Onken et al., 2004) indicates a low (T1) terrace below a higher (T2) terrace on which site 94 is located. In this study, site 94 is compared to alluvial chronologies in the Tonto basin and middle Gila River study areas shown in the inset map.