Latest Pleistocene/Holocene Paleoenvironments at Heima He, southern Qinghai Lake, western China

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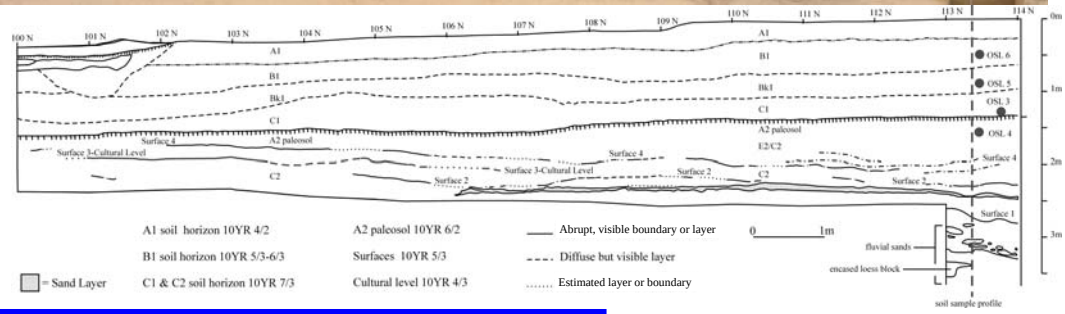
ABSTRACT

A 3.5-meter deep section of Latest Pleistocene and Holocene loess and fluvial sediments was exposed as part of archaeological excavations at Heima He, at an elevation of 3210 masl on the southwest side of Qinghai Lake, Qinghai Province, western China (1986 elevation 3194 masl) . Analysis of the sediment sequence includes magnetic susceptibility, carbonate content, and grain size. The sequence provides evidence for Holocene paleoenvironmental change directly associated with a record of human occupation in the Qinghai lake Basin. Radiocarbon dating of natural or anthropogenic burned layers, augmented by OSL dates on eolian sands, provides a preliminary chronologic structure for the sequence. The base of the sequence contains coarse grained sand and rounded pebbles inferred to be fluvial deposits of a small, fairly low intensity stream similar to tributaries of the Heima He River today. A coherent block of fine grained sands and silts located within this matrix, interpreted to be a chunk of collapsed overbank deposits, contained charcoal dated to 11,040 ± 70 rcybp (13,384-12,717 cal BP at 2σ). Fine grained sands and silts overlie this basal fluvial deposit. Charcoal from thin burned layers within these fines, up to 1 m above the fluvial layer, returned ages that suggest a local depositional transition from a low-intensity fluvial environment to the buildup of about a meter of fine grained eolian sands and silts within a brief interval between about 13,500-12,500 calendar years ago. The cultural deposit is securely dated within this brief time frame as well. Above this layer, approximately 2 m of loess was deposited in the past 12,500 years, containing one major paleosol and several probable incipient paleosols. These paleosols can be linked to regional soil-forming episodes in the Qinghai Basin and far western Loess Plateau.

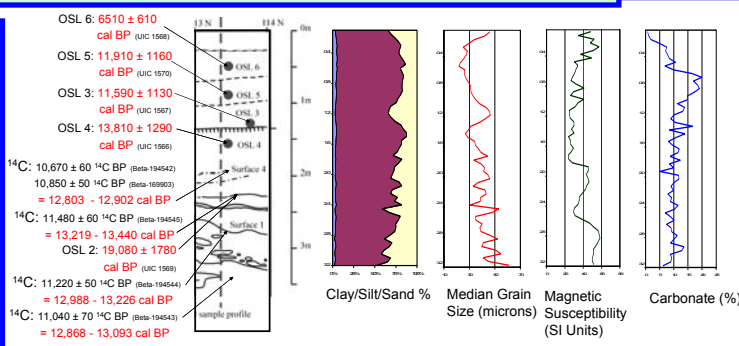
1. Heima He profile

We exposed a 14-meter long, 3.5-meter deep profile exhibiting multiple layers of loess-like sediments built up atop a bed of low-energy fluvial sands and gravels. Sediments appear to be a mix of eolian silts and sands, punctuated by layers of fine-grained overbank (?) sediments. At least one weathering zone (paleosol) is present about midway up the profile, and other more diffuse paleosols may be present. A well-developed late Holocene soil marks the top of the profile.



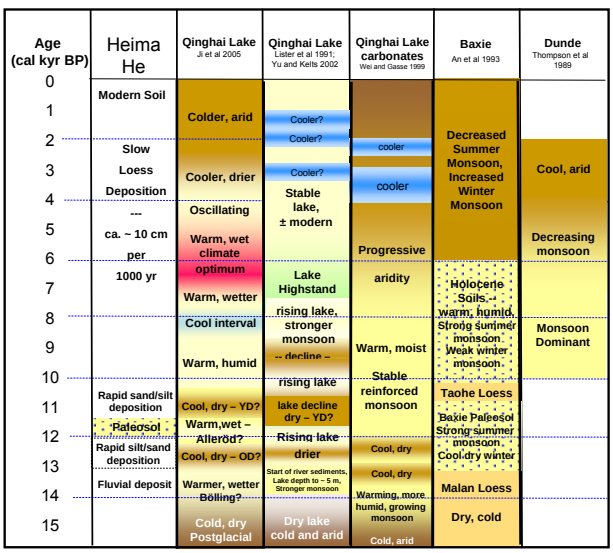
2. Chronology, sediment composition, and magnetic susceptibility

Radiocarbon and OSL dating suggest the basal sands and gravels were laid down ~13,300 cal BP, followed by rapid deposition of 1.5 m of silts and sands within a few centuries. The charcoal in these deposits is poplar wood (*Populus sp.*), indicating a climate warmer than today. The faintly visible paleosol may have developed in a few centuries of slow accretion. The rate of deposition increased after ~12,000 cal BP with 0.5 m of silt and sand accumulated. The uppermost meter of deposit accumulated slowly, since ~11,500 cal BP.



The proportion of silts and sands fluctuates through the lowest 1.5 m, trending toward greater silt content. Increased sand deposition occurs immediately above the paleosol, but silts dominate the uppermost meter. A high proportion of sand (and larger median grain size) may indicate localized overbank deposition, but may also signal greater winds and winter monsoon strength (An et al. 1993).

Magnetic susceptibility, an index of summer monsoon strength, suggests low summer monsoon intensity from about 13,000 cal BP through the period of paleosol formation, and increasing summer monsoon strength after 6500 cal BP.



3. Regional comparisons

At Qinghai Lake, strengthening summer monsoons and greater precipitation after ~14,100 cal BP initiated river flow and a rising lake, leading to rapid deposition of silts and sands at Heima He at 13,000 cal BP. The Heima He paleosol formed under enhanced monsoon as well. From about 12,800-11,900 cal BP the summer monsoon weakened and the region became more arid (coeval with Younger Dryas), corresponding with the rapid deposition of sand and silt above the paleosol. Subsequently, the summer monsoon front migrated west and Qinghai Lake filled to reach its Holocene highstand approximately 3106 m, 12 m above 1986 levels and just 4 m below the elevation of the study site. The climate cooled and dried in the past 6000 years, but the lake has been fairly stable. The Heima He profile suggests that deposition has been fairly slow and stable through this period as well.

The Heima He sequence fits well with other local exposures, and the paleosol's position and age correlates broadly with the Baxie paleosol in western Gansu. At Heima He, however, evidence of additional early Holocene soils is scant. The absence of such soils, coupled with low magnetic susceptibility readings, might suggest a weaker early Holocene monsoon in the Qinghai Basin than in Gansu, though sufficient to feed higher lake levels. In the Qinghai Basin, magnetic susceptibility may reflect sedimentation source and pedogenic process more strongly than summer monsoon intensity, but this proposition, and Heima He's Holocene record, requires further study.

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