Title
FINAL REPORT: Human-environment interactions and the

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FINAL REPORT: Human-environment interactions and the origins of agriculture in northwest China.

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Project Objectives

The independent origin of agriculture in several regions of the world during the early Holocene (10,000-8000 years BP) represents a major transition in human adaptive strategies. Within a relatively short period of time, mobile foraging populations, possessing flexible, but generic Upper Paleolithic adaptations, succeeded in domesticating a range of plants and animals, irreversibly altering both the relationship between humans and the natural environment and the subsequent course of human evolution.

Despite the long-standing recognition that North China was one of the centers for the independent development of agriculture, very little is actually known about the processes underlying the transition in this area of the world. Research in other regions of the world such as the Levant and Mesoamerica suggest that several interrelated factors were likely involved in the emergence of agriculture, most notably extreme changes in climate and environment, demographic pressure, and novel technological innovations. The relative importance of each of these variables, and the specific nature of their interaction, is poorly understood, however. Indeed, it is not at all clear which of these variables is necessary and which merely sufficient for pushing foraging populations in the direction of agriculture.

We proposed a collaborative, multidisciplinary research project to examine the roles of climatic, demographic and cultural adaptations in the origin of agriculture in Gansu Province, Northwest China. This semi-arid region is unique for having extensive wind-blown loess deposits which have been demonstrated to yield high-resolution climatic information stretching back over hundreds of thousands of years. Archaeological sites buried within these loess deposits suggested to us the possibility of conducting a "natural experiment" comparing human adaptations across two major climatic events during the late Pleistocene and early Holocene where the climatic, cultural and demographic conditions were thought to be similar, but the outcomes of adaptation were dramatically different. The later of these two climatic events, the Younger Dryas (ca. 12,300-11,200 years ago), was a brief period of extreme cold-dry glacial conditions that, in some regions of the world, appears to have pushed human populations towards agricultural adaptations based on domesticated plants. The preceding glacial maximum, with two millennium-long extreme cold-dry events at ca. 24,200 and 15,700 years ago, though theoretically capable of having the same impact on hunter-gatherers, did not culminate in the development of agriculture. We hypothesized that the reason why agriculture did not emerge until the early Holocene was that: (1) the necessary demographic conditions were absent during the earlier period of extreme climate; or (2) subtle differences in the character and timing of the

Younger Dryas compared with the preceding events of the Last Glacial Maximum meant that it had a qualitatively different impact on human populations.

Three major findings have resulted from the research conducted with the support of the Pacific Rim Research Program:

- It now appears that the human demographic conditions during the Last Glacial Maximum and Younger Dryas were far more similar to one another than previously thought. In particular, populations were 'concentrated' at particular points on the landscape during both cold-dry events. Therefore, differences in initial population conditions, such as radically different populations sizes or distribution, do not appear to explain the disparity between the post-LGM and post-YD cultural evolutionary trajectories.
- Cultural responses to the extreme climatic conditions during the Last Glacial Maximum appear to have been qualitatively different from those during the Younger Dryas. During the Last Glacial Maximum we find a "devolutionary" trend towards extremely simple technologies compared with the complex extraction and processing technologies developed during the Younger Dryas. The cause of this trend is not clear and deserves further research.
- Archaeological deposits have been found that stratigraphically underlie the development of the Dadiwan Neolithic, the earliest full-scale agricultural adaptations in the region, which arose around 7900 years ago. The earlier cultures appear to represent a continuation of the intensified late UP or Epi-Paleolithic hunter-gatherer adaptations seen first during the Younger Dryas.

This research reported here has led to two major papers in press in a volume on climate change and human adaptation in arid China and the successful funding of a National Geographic Society research grant to continue work on the precursors of the Dadiwan Neolithic. Preliminary results of the research funded by NGS have now been submitted for publication.

Research Activities

Research activities consisted of field work and laboratory analyses conducted in China and laboratory analyses and write-up conducted in the United States. Fieldwork in China was conducted over a period of three months in July-September 2004 and consisted of (1) field survey for new archaeological sites, (2) excavation at the Dadiwan Neolithic complex, and (3) geological sampling and excavation at archaeological sites in geological loess deposits thought to date between ca. 25,000 and 7000 years ago. Laboratory analyses in China were conducted between the end of fieldwork in October 2005 and July of 2005 at the Center for Arid Environment and Paleoclimate Research (CAEP) at Lanzhou University and consisted of sedimentary analyses and optically stimulated luminescence (OSL) dating. Laboratory analyses activities in the United States were performed in Fall 2005 at the University of California Davis and Los Angeles campuses and consisted of work with stone tool samples and statistical treatments of radiocarbon dates and sedimentary data. At the same time work began on two papers (now in press) and a successful grant application to the National Geographic Society for continued research in this area of northwest China.

Findings

Our survey for archaeological sites on the Western Loess Plateau in Gansu Province succeeded in identifying new archaeological sites in the regions around Zhuang Long, Guyuan and Tongxin as well as new evidence for human occupation in a previously unstudied area of northern Gansu near Qingyang (Figure 1). We concentrated our survey activities along transects running between the low-lying river valleys to the east and west of the Liu Pan Mountains and the higher elevation passes. We failed to find early Holocene or older archaeological materials in the upland areas and most of the known dated sites in lowland areas appear to be concentrated within particular time periods.

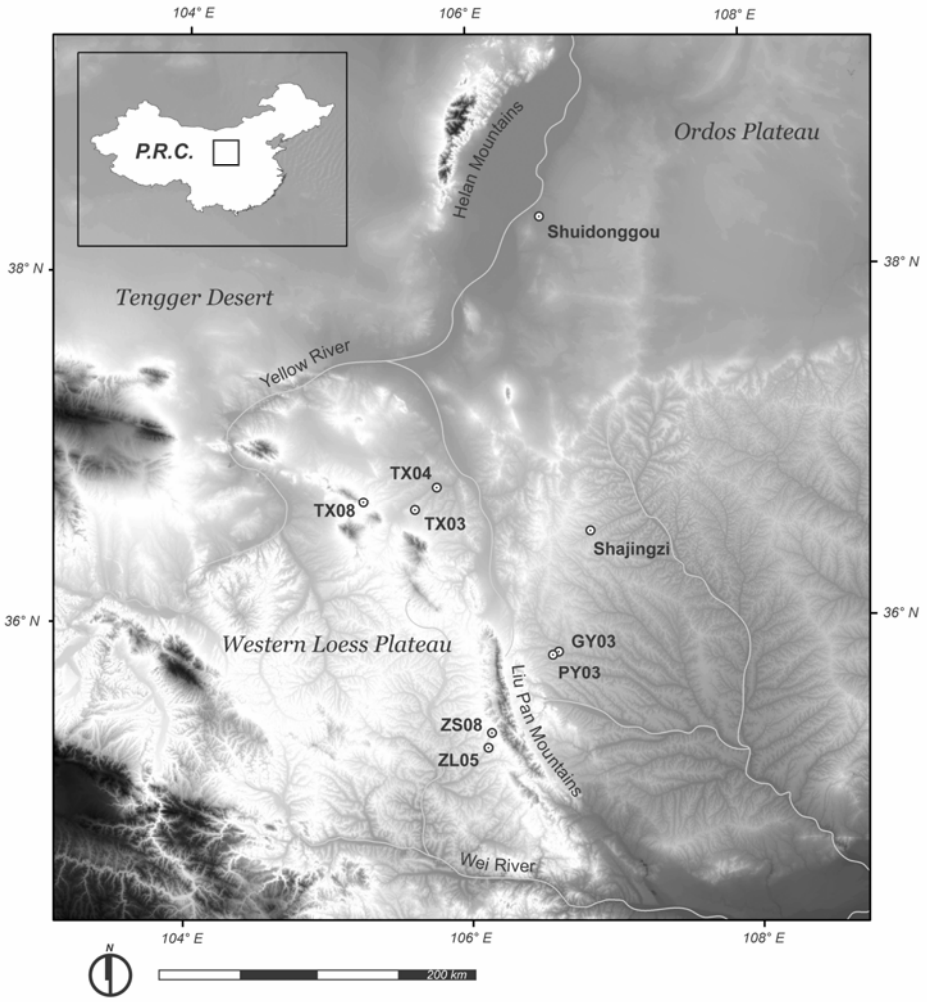

Figure 1. Map of northwest China showing the location of late Pleistocene forager sites investigated as part of the PRRP funded research. Shajingzi is a new pre-Last Glacial Maximum site identified in northeast Gansu. The Dadiwan Neolithic site, also investigated in 2004, is located ~20km SE of Zhuang Lang 5 (ZL05).

The survey results, though necessarily preliminary, are consistent with an emerging settlement pattern model that has populations concentrated in river valleys during cold-dry events, including both the Last Glacial Maximum and Younger Dryas. summarizes our findings. The summed probability distribution of calibrated radiocarbon dates indicates peaks in the intensity of archaeological site formation at ca. 31,000, 20,000, 15,000 and 11-12,000 years ago, all times identified as periods of cold temperatures on a global scale. These results are provocative in that they completely reverse the broadly accepted picture of population dynamics in north and northwest China during the latest Pleistocene and early Holocene periods. In particular, the standard model holds that most of northeast Asia, including north and northwest China, was completely abandoned during the Last Glacial Maximum at 25-15,000 years ago because populations were unable to cope with the extreme cold-dry temperatures of this glacial event. The evidence derived from the present PRRP project is that the opposite is true: Populations persisted through the Last Glacial Maximum and, in fact, may have been in larger, more socially concentrated groups. This finding is the subject of a paper by Barton, Brantingham and Ji in a forthcoming edited volume.

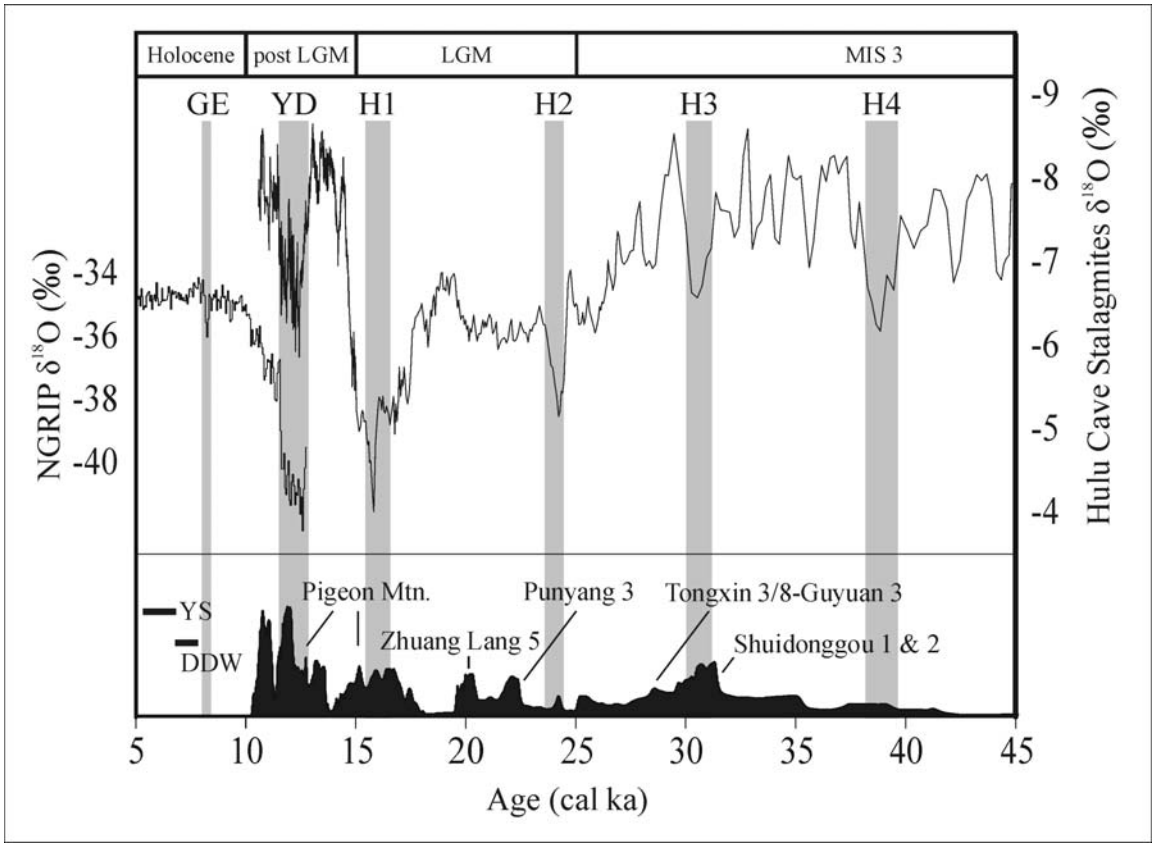

Figure 2. Radiocarbon dated archaeological sites from north and northwest China show concentrated activities during cold-dry Heinrich events (H4-H1) and the Younger Dryas. The Hulu Cave stalagmite $\delta^{18}O$ record is a proxy for the strength of the Southeast Asian Summer Monsoon, which reaches minima during Heinrich events. NGRIP $\delta^{18}O$ provides a broad measure of global temperatures. The summed probability distribution of calibrated radiocarbon dates (bottom), which is sometimes interpreted as a proxy for population size or occupation intensity, includes sites studied as part of the PRRP funded research include Zhuang Lang 5, Punyang 3, the Tongxin and Guyuan localities, and the Dadiwan Neolithic site (DDW). The

results of this analysis are presented in Barton, Brantingham and Ji (in press), Brantingham et al. (in press), and Brantingham and Gao (2006).

also implies that thedistribution of human populations during the Last Glacial Maximum was more similar to that during the Younger Dryas than previously known. Not only were populations found in the same low-lying river valleys, but population sizes and occupation intensities were very similar during both intervals. Because of these similarities, the emergence of agriculture cannot be attributed merely to population change, as such changes were not unique to the Younger Dryas. . This suggestion remains a tentative working hypothesis open to further testing based on the results of this PRRP project.

Zhuang Lang 5

An alternative hypothesis for the rise of agriculture only after the Younger Dryas points to differences in initial cultural conditions. In particular, we hypothesized that, despite the possible similarities in population sizes and distributions in both of these time periods, the types of adaptations that were deployed prior to and during the Last Glacial Maximum and Younger Dryas were sufficiently different to lead to radically different outcomes. It has long been known that the archaeological assemblages dating to the period preceding the Last Glacial Maximum were technologically distinct from those of the following period; the pre-LGM period being characterized by Upper Paleolithic large-blade assemblages and the post-LGM period by microlithic assemblages and the use of some limited grinding technologies But, how these technological differences led to different adaptive responses during the extreme events of the LGM and Younger Dryas was unknown.

We conducted targeted archaeological and sedimentological studies at five archaeological localities around Zhuang Lang, Guyuan, Pengyang and Shajingzi (Liujiacha). Unfortunately, excepting Zhuang Lang 5, detailed sedimentological analyses failed in each of the targeted locationsbecause all proved to be finely bedded alluvial sequences of redeposited loess, where use of standard paleoclimatic proxy measures of grain size distributions, magnetic susceptibility, stable isotopes and pollen profiles are inappropriate.

Excavations at Zhuang Lang 5 (ZL05) were organized to study: (1) the behavioral attributes of hunter-gather occupation during the Last Glacial Maximum; (2) the local environmental context of this occupation; and (3) potential connections between human populations living in the Western Loess Plateau during the LGM and other Late Pleistocene populations before and after the LGM, both locally and in adjacent regions. Located near the confluence of the Bei Shui Luo and Shui Luo Rivers which drain the western slope of the Liu Pan Mountains and eventually feed into the Wei River to the south, Zhuang Lang 5 is buried under more than 6 meters of late Pleistocene loess and Holocene soil cut by the Bei Shui Luo River (While the top few meters of the section are disturbed by agricultural activity and historic burials, the lower levels are not.

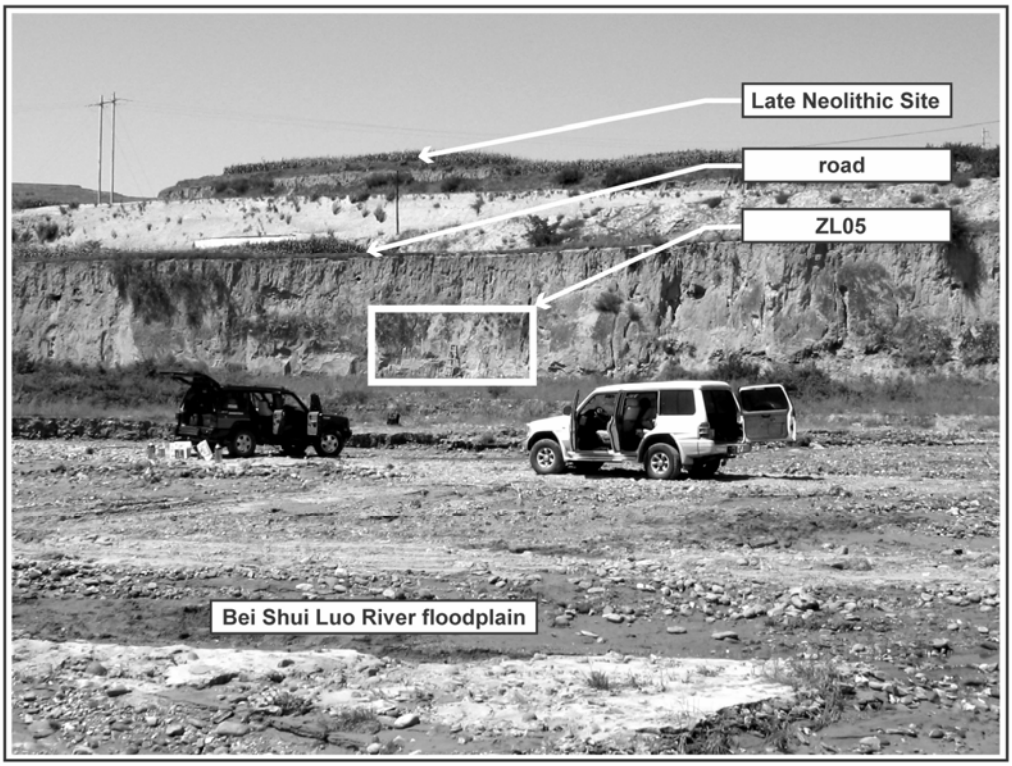

Figure 3. Looking north to the south-facing profile at ZL05 across the Bei Shui Luo River. (Photo by D.B. Madsen). Closeup views of the boxed area are shown in and .

The primary component of the site (, Component X) of the ZL05 site is a long bed of quartz flaking debris, suspended in fine-grained Malan Loess approximately 2 meters above the river floodplain. In the center of this dense, 1.5 meter-long scatter of quartz debitage is a large, quartz slab. The upper surface of this slab is flat but heavily pitted with compression scars, presumably generated through a stone-tool manufacturing strategy called “hammer-and-anvil” or “bipolar” percussion. Several geomorphological characteristics suggest that this feature has been undisturbed since its initial and rapid burial: the size distribution of the loess particles indicate primary eolian deposition rather than secondary fluvial or colluvial re-deposition; there is no evidence for soil formation and therefore little chance of significant bioturbation by roots; and there are no gravel stringers or rolled cobbles nearby to indicate fluvial disturbance.

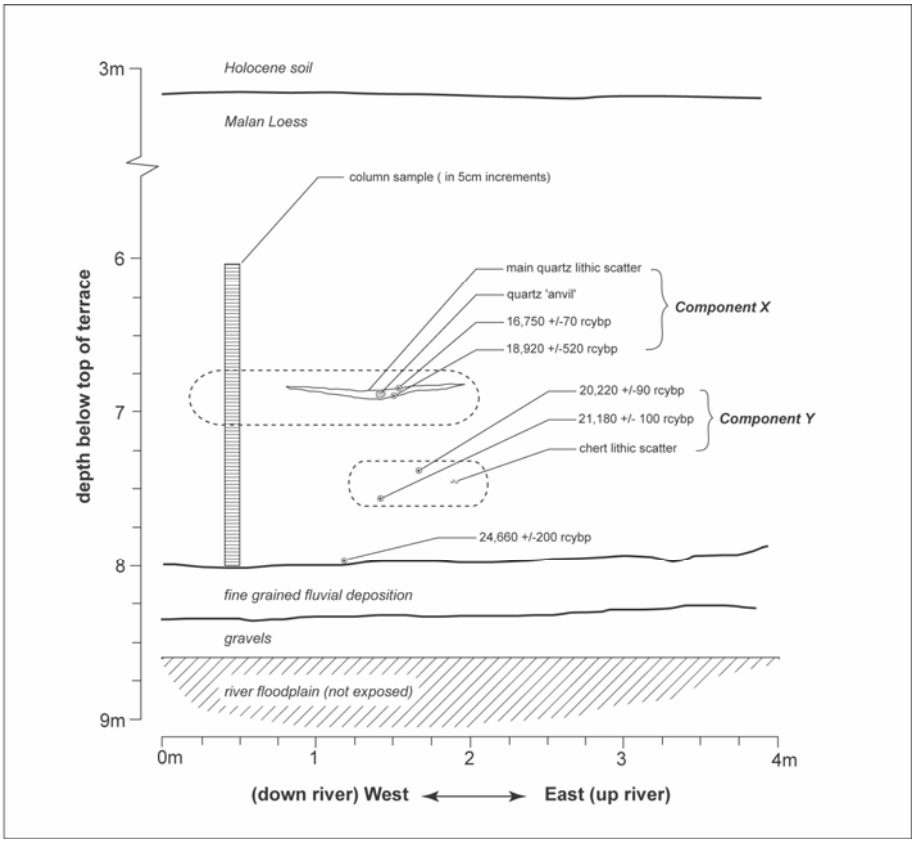

Figure . Schematic stratigraphic section of the ZL05 site showing the location of the main archaeological components, associated radiocarbon dates and location of the sampling column for sedimentary analyses (see).

We excavated Component X from the side by carving out 5-liter samples that were then dissolved in a box of water and poured through 3mm stainless steel mesh. This method produced thousands of small pieces of quartz debitage as well as larger quartz core fragments. In the laboratory, these samples were size-sorted with a nested series of geological test sieves to establish the waste flake size distribution characteristic of bi-polar tool-stone reduction. No formal or retouched tools were recovered from Component X. In the process of cleaning the section to interpret the geological history of Component X we encountered several additional scatters of lithic debitage. Most were isolated finds of quartz debris, but one (Component Y) was a dense scatter of chert – a material likely imported from beyond the Shui Luo River drainage.

Because most of the deposit was identified as undisturbed Malan Loess, a late Pleistocene loess common across much of northern China, the section offered an excellent opportunity for high-resolution paleoenvironmental reconstruction in the Shui Luo River basin. We therefore collected 2 vertical meters of loess deposition in 5cm increments. These samples were later analyzed at the CAEP laboratories of Lanzhou University for grain size and magnetic susceptibility, both of which are established proxies for humidity.

To provide chronological anchors for the archeological and paleoenvironmental data we collected samples for both radiocarbon analysis and optically stimulated luminescence (OSL).

Radiocarbon age estimates were taken from charcoal samples embedded in the loess profile and sent to Beta Analytic Inc. in Florida, U.S.A. for AMS dating. The OSL samples were collected by driving 3 separate PVC tubes (30cm by 5cm) horizontally into the loess profile. Because OSL dating measures the time elapsed since the last instance where sand grains were exposed to light, the outer 15cm were removed from the profile before driving the collection tubes, and both ends were sealed with heavy vinyl tape. The collection tubes were densely packed to prevent mixing of exposed and unexposed sediments, and were later analyzed by the OSL dating laboratory at Lanzhou University.

The PRRP research confirms the presence of human hunter-gatherers in the Shui Luo River basin of the Western Loess Plateau during the Last Glacial Maximum. The calibrated radiocarbon dates for Component X (Table 1) fit squarely within the established age range for the LGM, 24,000 – 18,000 years BP, while Component Y falls immediately prior to it. Unfortunately, the OSL dates cannot corroborate the radiocarbon age estimates. The OSL estimates from ZL05 produced ages tens of thousands of years earlier than expected, and do not fall in sequence. The reason for these errors are the subject of current study.

Table 1. AMS radiocarbon age estimates from ZL05. "rcybp" indicates radiocarbon years before present, based on a 5568 year half-life. "2s mid BP" is the midpoint between the 95% confidence intervals generated using the CalPal_2005_SFCP calibration curve provided by CalPal calibration software.

site	Lab.#	survey	material	rcybp	+/-	2□ mid BP	2□ STD	note
ZL05	Beta 197631	2004	charcoal	16750	70	20080	360	top of Component X
ZL05	CAMS 95088	2002	charcoal	18920	520	22700	1300	bottom of Component X
ZL05	Beta 197633	2004	charcoal	20220	90	24140	240	top of Component Y
ZL05	Beta 197632	2004	charcoal	21180	100	25310	520	bottom of Component Y
ZL05	Beta 197630	2004	charcoal	13940	60	na	na	out of sequence
ZL05	CAMS 93172&3	2002	charcoal	24660	200	29770	480	bottom of Malan Loess

Two studies of the ZL05 paleoenvironmental sequence have been completed. Analysis of grain size in windborne loess serves as a proxy indication of monsoon intensity. As the intensity of the humid, Pacific summer monsoon declines, eolian transport of dust from the northern deserts to the Loess Plateau increases. Therefore larger mean and median grain-sizes in loess profiles suggests reduced annual humidity, and perhaps colder, drier winters on a broad regional scale. The LGM in northern China should be marked by an increase in dust transport, and the ZL05 sequence confirms this (). Similarly, magnetic susceptibility is an established proxy for trends in regional humidity but also tracks local environmental trends as a marker of soil formation. Though the details of the process are the subject of considerable debate, magnetic susceptibility is known to increase with soil formation, which, in turn, accelerates in response to increases in local humidity. At ZL05, the LGM is marked by a decline in soil formation - a localized phase of reduced humidity corresponding to the larger pattern of reduced summer monsoon intensity suggested by the grain-size analysis.

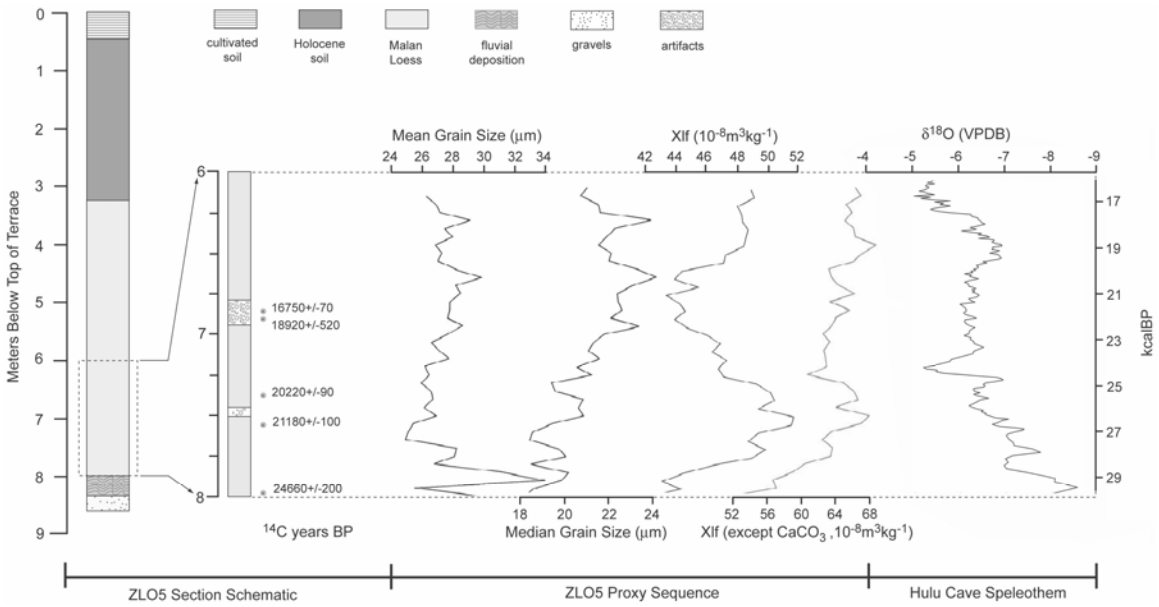

Figure . Results of grain size and magnetic susceptibility analyses of the ZL-5 section place the main occupation (Component X) in the height of the Last Glacial Maximum cold-dry event (grain size maximum, magnetic susceptibility minimum). The Hulu Cave $\delta^{18}O$ sequence shown in Figure 2 is presented on the right for comparison.

While the Shui Luo River basin was clearly occupied by human hunter-gatherers during the cold, dry LGM, it was also occupied during a warmer, wetter phase of the preceding MIS 3 interstadial. Figure 5 illustrates the relationship between the occupation defined at ZL05 as "Component Y" (the lower component) and a pronounced spike in both local and regional humidity. In the future, pollen analysis will help to characterize the local ecology in terms relevant to the subsistence economies of human foragers.

The cultural remains from ZL05 are interesting for a number of reasons. First, the pristine condition of Component X establishes a quantitative baseline for assessing bipolar, hammer-and-anvil reduction of local, massive quartz cobbles from other sites in the Western Loess Plateau (Second, changes in the use of raw-materials through time may suggest changes in the ways in which hunter-gatherer populations gain access to these raw-materials. Third, that the assemblage bears closer resemblance to other roughly contemporaneous archaeological sites in the Western Loess Plateau than to sites from the northern deserts or points further east, helps to build an understanding of regional interaction spheres and regionally-specific behavioral adaptations.

Table 2. Size distribution of lithic manufacturing debris from ZL05.

	> 10mm	10-5mm	5-2.5 mm	<2.5 mm	blade	core	core frag	anvil	N
Component X	203	537	1241	247	2	7	11	1	2249
Component Y	0	2	3	0	0	0	0	0	5
other	0	3	14	0	1	0	0	0	18
surface	27	8	3	1	0	0	7	0	46
total	*230*	*550*	*1261*	*248*	*3*	*7*	*18*	*1*	*2318*

SUMMARY OF ZHUANG LANG 5 RESEARCH. ZL05 is the first well-dated late Upper Paleolithic assemblage assigned to the Last Glacial Maximum from the Western Loess Plateau, and it is the only site of this age in all of North China with a corresponding high-resolution local environmental record. As more sites from the region with similar archaeological controls become known, our ability to examine the impact of climate change on human mobility, subsistence, and technological evolution will only increase.

Dadiwan Neolithic

As part of the PRRP research program, we obtained permission from the Chinese Institute of Archaeology to conduct test excavations at the Dadiwan Neolithic site in Shao Dian village, Gansu Province. The purpose of our excavations were threefold: (1) to explore the possibility of a pre-Neolithic occupation at the earliest agricultural site in northwest China; (2) to establish a local paleoclimate sequence spanning the transition from foraging to farming; and (3) to characterize changes in the composition and frequency of cultural effects (stone tools, ceramics, faunal remains, and plant macro-fossils) marking this transition.

We chose to investigate Dadiwan for several reasons. First, though Dadiwan is not the oldest agricultural site in North China, it is the oldest of the Laoguantai culture – the westernmost of the early agricultural Neolithic traditions in North China. Therefore, if an independent transition to agriculture occurred in the west, then Dadiwan was the most obvious place to look for it. Second, Dadiwan is closer in time and space to existing evidence for Late Pleistocene – Early Holocene hunter-gatherers than are any other Neolithic sites anywhere in North China. This project is part of a much larger effort to investigate the connections between these hunter-gatherer populations from the deserts north of the Yellow River, and the early agricultural Neolithic in the Western Loess Plateau. Lastly, the landscape ecology of the region surrounding Dadiwan in the Western Loess Plateau is far more sensitive to environmental change than anywhere else in the Yellow and Wei River drainage. Therefore, if environmental change was critical to the emergence of agriculture, it was likely to matter most in the areas most sensitive to it.

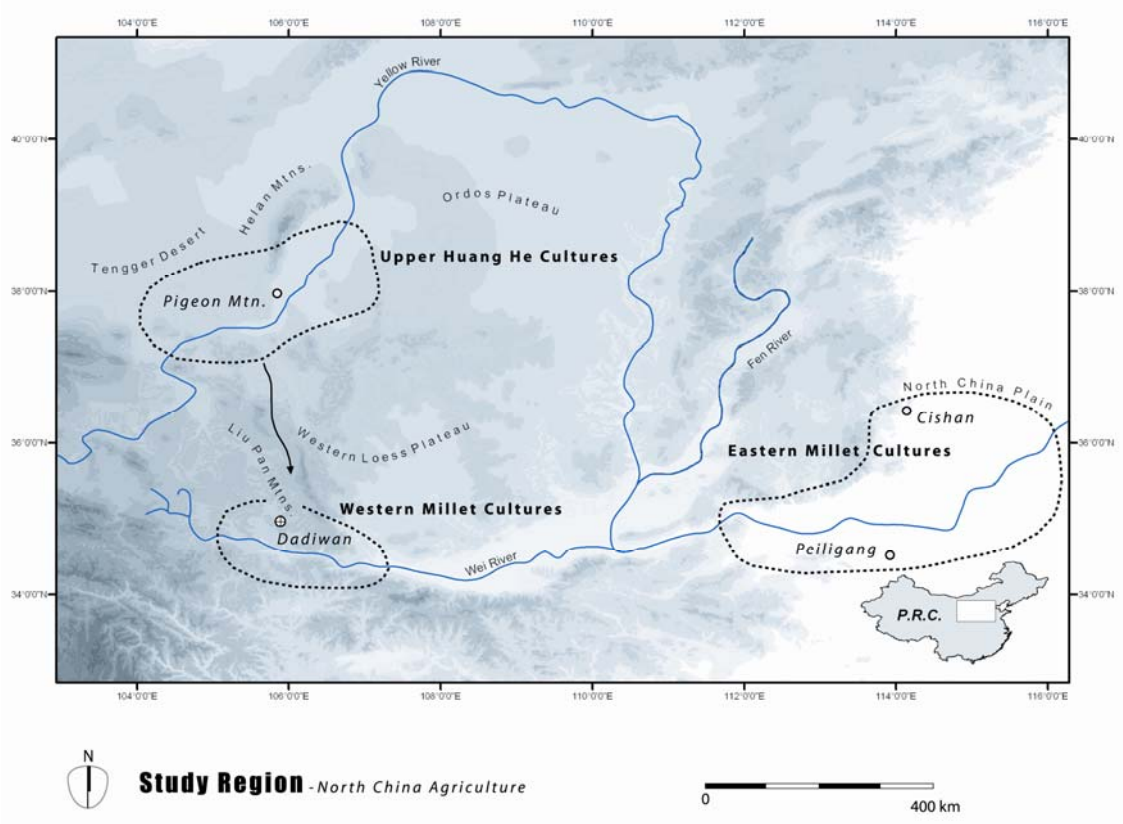

Figure . Centers of early agriculture in North China. We hypothesize a connection between the origin of agriculture on the Western Loess Plateau and the southward movement hunter-gatherer populations from the desert environments north of the Huang He during the extreme Younger Dryas event. The eastern agricultural complexes at Cishan and Peiligang are thought to have their own trajectory with possible antecedents on the North China Plain.

At Dadiwan, we dug two vertical 1x2 meter columns to look for evidence of hunter-gatherer occupation prior to the earliest agricultural Neolithic occupation. The first excavation unit, DDW01, did not fulfill our objectives because the top 2 meters contained a mixed deposit of Late Neolithic debris filling a deep cavity likely created during construction of a Late Yangshao (Late Neolithic) kiln. Below the level of the kiln we did encounter a seemingly undisturbed deposit, but as the unit reached 3 meters in depth we abandoned the effort because we lacked the equipment necessary to keep the sidewalls from collapsing. The second excavation unit, DDW02, proved far more successful. Underneath the disturbed topsoil, the deposit seemed in-tact, with approximately 1 meter of dark Neolithic midden subtended by yellowish loess (

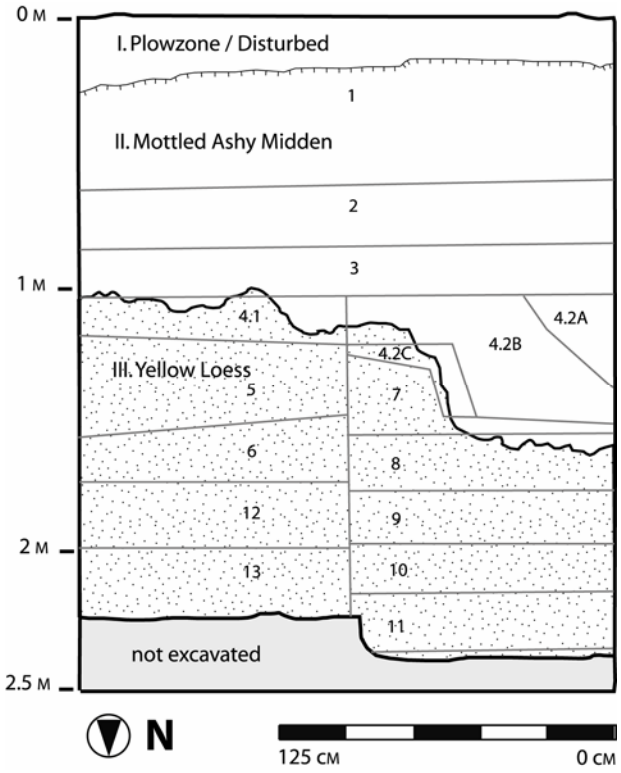

Figure . DDW02 Profile of South Wall

We did not screen every level of excavation because our goal was to collect data from the earliest Neolithic and pre-Neolithic levels. To control for culture change with depth we excavated DDW02 in arbitrary 20cm levels. As the frequency of Late Yanghao pottery per level declined, and fragments of Banpo and Dadiwan sherds (both representing the Middle Neolithic of Chinese culture-history) began to enter the artifact assemblage of each level, we began to screen everything with 3mm mesh. At a depth of 2.3 meters, the density of artifacts per level declined precipitously and we abandoned the excavation. Once the unit was complete, both flotation samples and column samples for environmental proxies were extracted from the side-walls of the excavation.

Unfortunately, the data collected from DDW01 were unsuitable for addressing the questions we set out to answer. The cultural data, most of which belong to the Late Yangshao period - a much later and better documented phase of occupation at the Dadiwan site - were tabulated and are currently stored at Lanzhou University. The stratigraphic sounding at DDW02 however was extremely successful. A frequency seriation of ceramics from this unit (is in accordance with the well-established culture-history sequence of the Western Loess Plateau. In the upper meter of the unit, the deposit is dominated by a dark, ashy, Late Neolithic midden. The lowest levels of the midden (between 1 and 1.5 meters in depth) are dominated by Late Banpo and Dadiwan period ceramics. Below this is a sharp contact between the dark, ashy midden and yellowish, fine-grained loess. At most excavations of Neolithic sites in northern China, this yellow, featureless loess is considered “sterile” and marks the end of the excavation. However, when the loess is removed in arbitrary levels and screened through 3mm mesh to reveal small chipped-stone tools,

animal bone, shells of fresh water mollusks and small pieces of un-fired clay, it becomes clear that the loess is not at all sterile. We termed this aceramic cultural complex located immediately below the earliest ceramic-bearing Neolithic deposit “Dadiwan Ling” (Dadiwan 0) to suggest the presence of a pre-agricultural hunter-gatherer occupation.

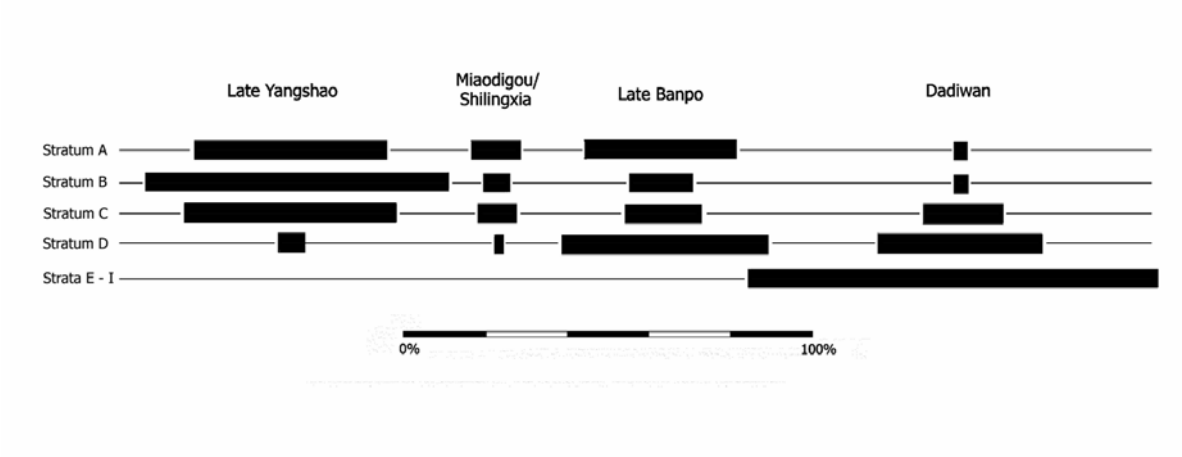

Figure . Frequency seriation of ceramics by cultural horizon, DDW02.

Perhaps the most distinctive elements of the Dadiwan 0 assemblage are tools and manufacturing waste from exotic stone. In the Neolithic levels at Dadiwan, chipped-stone tools are rare, but when they do appear they are fashioned, rather crudely, from locally abundant quartz cobbles. Quartz debitage also appears in the Dadiwan 0 assemblage, but so do finely shaped tools made from exotic chalcedony. Both the tools and the raw material resemble those found in the late Pleistocene – early Holocene hunter-gatherer assemblages north of the Yellow River, suggesting possible cultural connections worthy of further investigation.

With some exceptions, the faunal remains from these early levels were too small or too degraded for proper identification. Flotation samples from these early levels did not produce enough charred botanical remains for meaningful quantitative analysis. Unfortunately, the size of both the animal and plant samples are currently insufficient to characterize the subsistence behavior of this early occupation at Dadiwan. Whether or not these early occupants were cultivating millet or even harvesting wild plants remains a question open to further research.

Lastly, though we did collect three carbon samples for radiometric dating, the stratigraphy of each sample was problematic and therefore the absolute dating of the pre-ceramic, pre-agricultural component was unsuccessful. Furthermore, since the sequence of radiocarbon dates is problematic, further investigation of the paleoclimatic sequence, as collected from DDW02, was abandoned.

SUMMARY OF DADIWAN RESEARCH. The sample of cultural material from the loess is currently too small to characterize the nature of the Dadiwan 0 occupation in the detail needed to understand the hunter-gatherer system out of which early agriculture developed in the Western Loess Plateau. Furthermore, the current sample is insufficient for testing the possible connections between the early agriculturalists at Dadiwan and the earlier hunter-gather developments known

from north of the Yellow River. However, the results of excavation at DDW02 are enticing, and the pre-agricultural occupation at Dadiwan offers new possibilities for understanding the transition to agriculture in North China.

Accordingly, with new funding acquired through the National Geographic Society, we return to Dadiwan in the summer of 2006 to excavate a promising, and previously unexcavated area adjacent to DDW02. This will increase our sample for Dadiwan 0 at least a hundred fold. It will, in addition, permit us to obtain a very fine-grained record of climatic change, registered in loess that bridges the gap between the early Holocene observed in DDW02 and late Pleistocene loess that must subtend it.

Publications and Grants

Two major papers summarizing the PRRP work are in press in a volume to be published in May of 2007 from the Elsevier series Developments in Quaternary Science:

http://www.elsevier.com/wps/find/bookseriesdescription.cws_home/BS_DQS/description

The results of survey of late Pleistocene deposits in Gansu and research at Zhuang Lang 5 are presented in:

> Barton, L., P. Jeffrey Brantingham, and Duxue Ji. in press. Late Pleistocene Climate Change and Paleolithic Cultural Evolution in Northern China: Implications from the Last Glacial Maximum. In D.B. Madsen, X. Gao, F.H. Chen (eds.), *Human Adaptation to Late Pleistocene Climate Change in Arid China*, Elsevier Press.

The results of studies at the Dadiwan Neolithic site and the surrounding region are presented in:

> Bettinger, R.L., L. Barton, P.J. Richerson, R. Boyd, H. Wang, W. Choi. in press. The transition to agriculture in Northwestern China. In D.B. Madsen, X. Gao, F.H. Chen (eds.), Human Adaptation to Late Pleistocene Climate Change in Arid China, Elsevier Press.

The PRRP provided supplemental funding in 2005 to Loukas Barton ($3000, UC Davis PhD student) for his related dissertation work in Gansu province on a dissertation entitled:

> From frontier foraging to floodplain farming: cultural ecology and agricultural intensification in China's Wesern Loess Plateau.

The work funded by the PRRP was instrumental in helping to secure a new research grant from the National Geographic Society Committee for Research and Exploration ($19,440, PI:Bettinger):

The Preagricultural Components at Dadiwan, Shao Dian Village, Gansu Province, Northwest China.

Fieldwork on this NGS-funded project commenced in June 2006.

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Research Photographs

Subsurface testing at RS01. Excavations at this rockshelter in the Liu Pan Mountains produced only recent historic material – all earlier deposits likely covered by sandstone deadfall from above. (Photo by D. Rhode)

Water-screening on the banks of the Bei Shui Luo River during excavations at ZL05.(Photo by D. Rhode)

Column sampling for environmental proxies at ZL05. (Photo by D.B Madsen)

Survey and sampling in the uplands above the Shui Luo River valley. (Photo by R.L. Bettinger)

The DDW02 excavation unit at the Dadiwan site. (Photo by R.L. Bettinger)

Survey region in the hills above Guyuan, on the east side of the Liu Pan mountains. (Photo by L. Barton)