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Geoarchaeological Investigations of Pre-Yangshao Agriculture, Ecological Diversity and Landscape Change in North China

Pre-Yangshao agriculture; ecological diversity; landscape; geoarchaeology; micromorphology.

It has been recently proposed that the origins of agriculture in China might have undergone an equally prolonged process as that observed in the Near East and other parts of the world.¹ The Pre-Yangshao period² (8000–7000 BP) is considered as typical Neolithic in north China, and it is a critical time in our understanding of such a process. Plant cultivation and animal husbandry had started,³ but a great diversity of economic subsistences and cultures was maintained. This intrinsic ecological and agricultural diversity was quickly lost in the succeeding Yangshao period when both cultural and economic activities witnessed homogeneity at a huge scale.

The geographical locations, archaeobotanical discoveries and chronologies of five Pre-Yangshao cultures in north China are presented in Table 1. Of particular interest is that most of these cultures are located in transitional landscapes, either from the mountainous area to central plain or from the loess area to central plain. In addition, there seems to be a close relationship of annual precipitation and crop species that may have been intensively gathered or cultivated. The precipitation pattern of vast areas of north China has been largely shaped by the moving routes of monsoons.⁴ The southern Chinese Loess Plateau, the southern North China Plain and the Lower Yellow where three Pre-Yangshao cultures (Laoguantai, Peiligang and Houli) are located, respectively, are situated around the boundary that divides areas that have annual precipitation of more or less than 800mm.⁵ Assemblages containing millets are only discovered to the far north of this boundary, whereas those containing rice remains are found to the south of the boundary. Those comprised of both millet and rice are located roughly around the boundary. How did the Pre-Yangshao people practice their economic subsistences? How did they manage such diversified landscapes? Were the crops domesticated in one place and then introduced to other places? If so, how did the introduced crops adapt to local environments? Archaeobotany has provided valuable information for this series of questions. For instance, the archaeobotanical data at Xinglongwa is characterised by the low percentage of millet grains and their ambiguous morphological features. Zhao⁶ suggests that they were

1 Bar-Yosef 2011, S175–S193; Fuller, Harvey, and Qin 2007, 316–331; Fuller et al. 2009, 1607–1610; Fuller, Willcox, and Allaby 2011, 1–17; Zeder 2011, S221–S235; Zhao 2011, S295–S306.

2 The “Pre-Yangshao” here is used as a time concept, referring to those cultures in north China predating the Yangshao period (7000–6000 BP). The Pre-Yangshao cultures usually include five contemporary cultures dated to about 8000–7000 BP, located in different parts of north China: Laoguantai, Peiligang, Cishan, Xinglongwa, and Houli, although great diversity within each culture has also recently been illustrated.

3 Liu 2004; Underhill 1997, 103–160.

4 An et al. 2000, 743–762; Hoyos and Webster 2007, 4402–4424; Yuan et al. 2004, 575–578.

5 Crawford 2011; Jin 2011.

6 Zhao 2006.

Cultures	Geographical locations	Archaeobotanical discoveries	References
Xinglongwa	Eastern Inner Mongolia and West Liao River; intermediate zone between the loess belt and the Central Plain	<i>Panicum</i> millet; <i>Fox-tail</i> millet; many grassy seeds	Zhao 2006; Zhao 2011, S295–S306
Cishan	The Ming River; transitional area between the East Taihang Mountains and the Central North China Plain	<i>Panicum</i> millet; <i>Fox-tail</i> millet; walnut; hazel; <i>Coryliu leterapluylea</i>	Sun, Liu, and Cheng 1981; Lu et al. 2009, 7367–7372
Peiligang	Central North China Plain and the intermediate areas between the Yellow and Yangtze River	<i>Panicum</i> millet; <i>Fox-tail</i> millet; rice; water chestnut; soybean; lotus; etc.	Liu et al. 2010, 816–833; Zhao and Zhang 2009
Laoguantai	Guanzhong Basin; areas between mountains and southern Chinese Loess Plateau	<i>Panicum</i> millet	Archaeology and Gansu 2006
Houli	Lower Yellow River	<i>Panicum</i> millet; <i>Fox-tail</i> millet; rice; many other grassy seeds.	Crawford 2011; Jin 2011

Tab. 1 | Geographical locations and archaeobotanical discoveries of the five Pre-Yangshao cultures in North China.

probably just starting to be cultivated, and the transitional environment between the loess area and the central plain is one of the key places for the origin of millet farming. Similarly, Jin⁷ examines the archaeobotanical assemblage at Xihe and proposes an initial stage of rice farming here. But the low equability of carbonised rice remains and the low percentage of mature rice should be factored in. Lu et al.⁸ also offer new chronological evidence for the long-standing speculation that Cishan is one of the earliest places where millet was domesticated, although these new data have recently been questioned due to the controversial sampling strategy.⁹ Geoarchaeology, a core methodology which integrates environmental studies with archaeology, should be applied to augment these new archaeobotanical discoveries. As many successful examples carried out in other parts of the world have proved, geoarchaeology is an essential means to investigate the interaction of people and landscape and how such interaction eventually leads to the domestication of crops and the establishment of agricultural society.

The two studied sites, Guobei and Yuezhuang, are located in transitional environments, the southern Chinese Loess Plateau and the Yellow River, respectively. At Guobei, complete sequences from the terminal Pleistocene to Holocene are well preserved, from

7 Jin 2011.

8 Lu et al. 2009.

9 Zhao 2011, S295–S306.

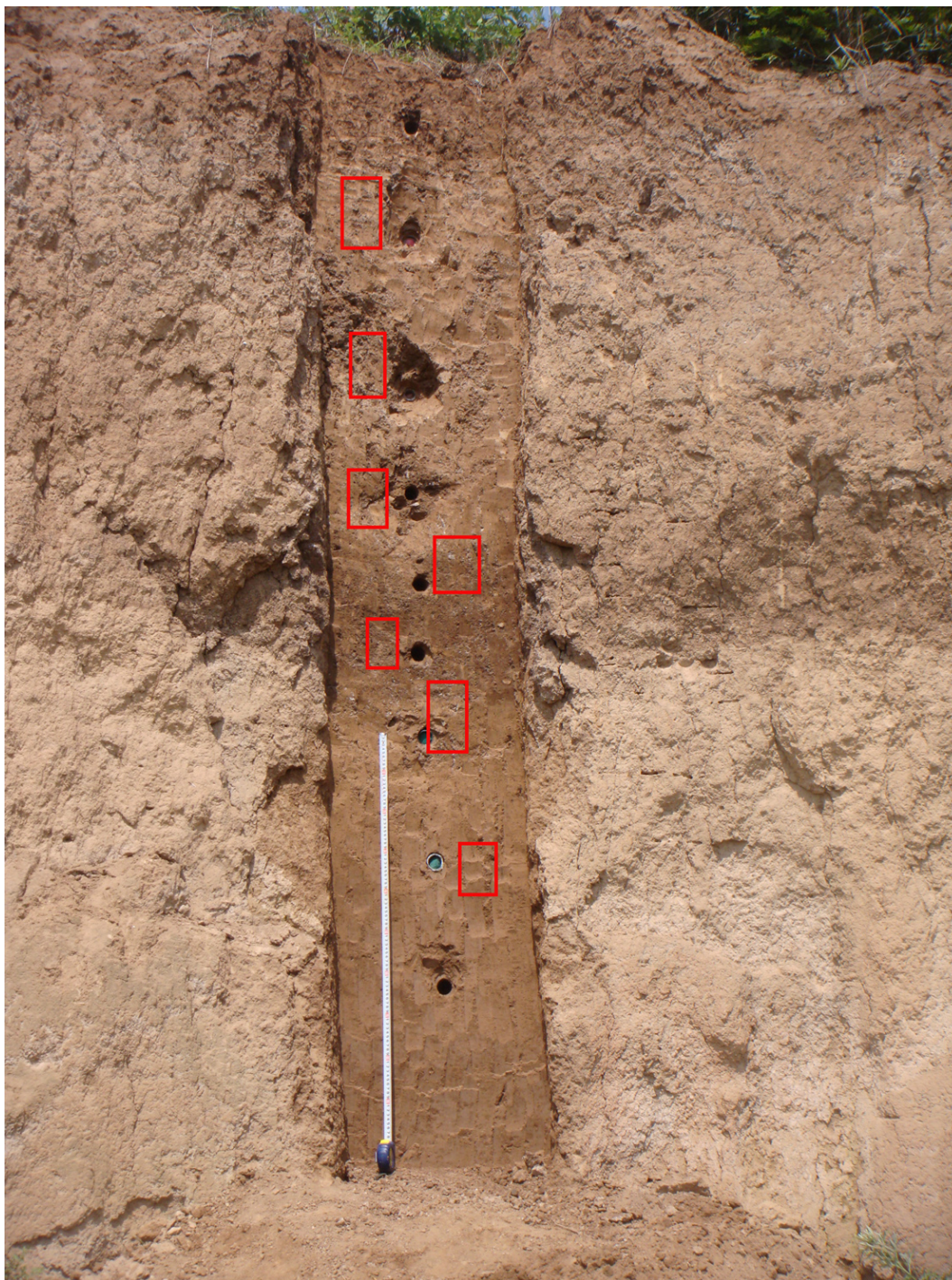


Fig. 1 | Profile 6 of the Guobei site in the southern Chinese Loess Plateau. Red rectangles are sampling locations for micromorphology; black rounded spots are sampling locations for OSL dating; bulk samples for geophysical analyses were collected from 30cm below surface downwards. Profiles 5 and 7 both have a similar stratigraphy to Profile 6. The same sampling methods were applied to the examination of the two profiles (Profile 1 and 3) at Yuezhuang in the Lower Yellow River.

which typical Laoguantai pottery is found from the early-Holocene level. At Yuezhuang, which is located very close to the river floodplain, a similar archaeobotanical assemblage as Xihe consisting of carbonised millet and rice is found. These two sites thus provide an excellent opportunity for geoarchaeological investigation to throw new light on the questions mentioned above. 59 bulk samples, 25 thin section samples and 14 OSL dating

Sample no.	GBP 7:1	GBP 7:2	GBP 7:3	GBP 7:4	GBP 7:5	GBP 7:6	GBP 7:7	GBP 7:8	GBP 7:9	GBP 7:10	GBP 7:11	GBP 7:12
Clay content (%)	20.307	36.480	36.997	36.142	19.362	18.541	17.463	17.743	18.119	32.848	missing	19.043
Total organic (%)	2.139	2.347	2.601	2.335	2.128	2.140	1.845	1.885	1.928	missing	1.387	1.430

Tab. 2 | Results of clay particles and total organic of bulk samples of Profile 7 at Guobei.

samples were collected from three exposed profiles at Guobei. 59 bulk samples, 20 thin section samples and 13 OSL samples were collected at Yuezhuan from two profiles. Thin sections were made following methods described by Goldberg and Macphail;¹⁰ particle size analysis and loss-on-ignition were processed at the Department of Geography (<http://www.geog.cam.ac.uk/facilities/laboratories/techniques/>); OSL samples were tested following procedures given by Duller¹¹ at Peking University.

Micromorphological features of slides collected from the early-Holocene palaeosol of P6 at Guobei are characterised by a highly-disrupted microstructure. This mainly includes abundant dusty clay features (coatings, infillings and silty clay concentration features), *in-situ* or disrupted crusting features, and the occasional appearance of coarse, angular-shaped quartz. The pedo-features of slides collected from contemporary level at both Profile5 and Profile7 are dominated by limpid or less-dusty clay coatings and infillings. The slides at Profile5 have a typical bioturbated microstructure. Those at Profile7, apart from having many limpid clay features, also have abundant dendritic manganese features.¹² All the slides have enriched calcitic features, with their quantity changing according to their depth and horizon. The results of particle size analysis confirm stronger clay illuviation in samples at Profile7 (Tab. 2). High organic contents appear at the same level, suggesting a positive correlation between clay-sized material and organic accumulation.¹³ However, no significant difference of particle-size-distribution and loss-on-ignition has been found between Profile5 and Profile6. The micromorphological features of samples from both Profile1 and Profile3 at Yuezhuan are characterised by frequent alternations of poorly-sorted alluvial/colluvial materials with short-period surface stabilities indicated by the formation of very thin dusty clay coatings¹⁴ at the onset of human occupation. Abundant animal bones frequently appear in slides at Profile1, but they are absolutely absent at Profile3. The ensuing period at Profile3 witnesses prolonged surface stability as evidenced by abundant limpid clay coatings and infillings, whereas at Profile1, the amount of clay features also increase, but are still interrupted by regular alluvial sedimentation in the form of poorly- to moderately-sorted deposits. Apart from slightly higher organic contents of samples from Profile1 which might have been washed into the river and re-deposited, there is no significant difference in the results of particle-size-distribution and loss-on-ignition.

These results suggest different land use managements within and between the sites. The features observed at Profile6 at Guobei are most likely derived from farming disturbance, as similar features are also found in modern cultivated soils in the same area. The highly-bioturbated microstructure and the presence of less-abundant limpid clay coatings

10 Goldberg and Macphail 2006.

11 Pre-treatment, dose rate and some of the results have been completed; all of the results are expected to be completed by mid-May, 2012. Duller, Botter-Jensen, and Murray 2000, 453–457; Duller et al. 1999, 293–301.

12 Kovda and Mermut 2010.

13 Connor, Loomis, and Gassman 2011, 175; Konen et al. 2002, 1878–1881.

14 McCarthy, Martini, and Leckie 1998, 87–110.

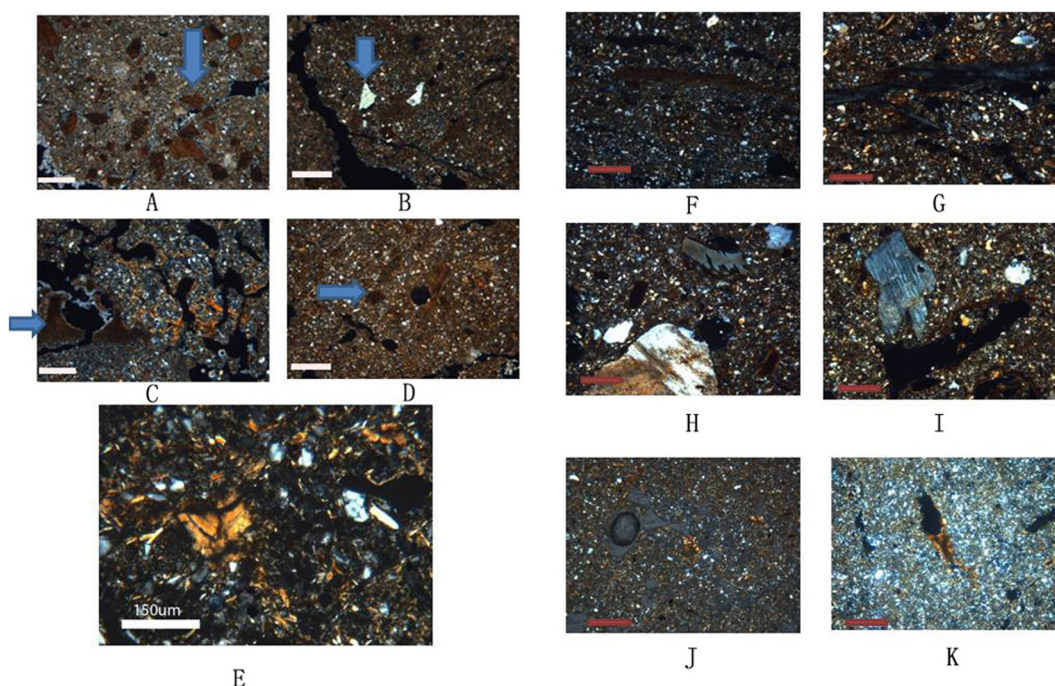


Fig. 2 | Micrographs for thin sections collected from Guobei and Yuezhuang. A–D from the Profile 6 (no. 4 and 5) at Guobei; E from the Profile 7 (no. 2) at Guobei. A: disrupted crustal features, probably caused by physical disturbance (XPL); B: Coarse-sand-sized quartz, possibly as anthropogenic inclusions (XPL); C and D: clay coatings and associated features; note there are two episodes of clay illuviation seen in C, i.e., the limpid, bright clay coatings were possibly formed first, which were followed by the formation of dusty clay coatings (as the arrow points to, XPL); E: Limpid clay coatings (XPL). F–I from the Profile 1 (no. 6 and 7) at Yuezhuang; J and K from the Profile 3 (no. 4) at Yuezhuang. F: surface crustal features (XPL); G: animal bones, with very angular shape and medium degree of mineralization (XPL); H: bones (upper part of the image) and coarse mineral (lower part of the image), the coarse mineral is moderately-sorted, sub-rounded (XPL); I: angular, poorly-sorted, coarse minerals (XPL); J and K: limpid clay coatings and infillings. Bar-scale 0,5mm unless stated specifically.

at Profile5 probably suggest soil fauna dominated soils, probably associated with grassland and/or sparse tree-growth surface at the time. Similarly, Profile7 also reflects tree-growth in the past, and the abundant manganese features imply this place was once water-saturated.¹⁵ The sequence of Profile1 at Yuezhuang suggests typical seasonal alluviation. This, together with the presence of abundant animal bones and occasional pottery sherds possibly indicates frequent revisits to the site on a seasonal basis, during which minor landscape management (e. g. firing which generates dusty particles) was probably carried out. This seasonal occupation is also confirmed by settlement pattern study at Xihe of the same area.¹⁶ The place where Profile3 is located which is about 200m away probably experienced much less disturbance.

This geoarchaeological investigation provides fundamental insights for a better understanding of the archaeobotanical discoveries at these Pre-Yangshao sites. It confirms a mixed, yet diversified land use pattern, which would have gradually created a mosaic landscape pattern as people were moving around. It was possibly this economic subsistence that played an important role in the shaping of the early-Neolithic landscape in north China. However, this research is just a starting point, more research needs to be done to integrate discoveries from individual sites with regional data (archaeological, ecological and geological) and to enable a robust switch of landscape perspective from the site-based level to the regional level.

¹⁵ Kovda and Mermut 2010.

¹⁶ Sun 1985.

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