Palaeoenvironmental Implications of Cultural Records from Glacial and Glacigenic Geological Contexts

Jiří CHLACHULA

Laboratory for Palaeoecology, Technical University FT VUT Brno, 762 72 Zlín, Czech Republic

ABSTRACT. Early cultural records buried under or in glacial and glacigenic geological contexts may produce in view to their unique stratigraphic position, except for a primary culture-historical information, a new evidence on the past climatic evolution in respect to the configuration of single glacial advances in areas affected by Pleistocene glaciations. Recently investigated palaeolithic sites in Alberta, Canada, sealed by thick (10+ m) surficial deposits derived under or close to the continental Laurentide ice-sheet or the Cordilleran valley glaciers during the last glacial stage have provided a definite evidence on the Late Pleistocene paleo-American occupation of the foothills and adjacent plains east of the Canadian Rocky Mountains, but also give new insights on the local geographical extent of the ice-masses during the last glacial maximum (OIS 2) in this part of North America.

Geoarchaeological research approaches integrating glacial geology and palaeolithic archaeology may significantly contribute not only to elucidation of the earliest human prehistory, particularly of the Pleistocene Beringia and other territories of the Northern Hemisphere, but also provide to a more reliable chronostratigraphic control on the spatial extent and timing of some regional glacial events. A cultural material recorded in its original geological context indicating an ice-free environment may serve as a significant source of proxy data on the past climates and climate change in the formerly glaciated areas.

KEY WORDS: Pleistocene glaciations, glacial and glacigenic deposits, geoarchaeology, early human occupation, past climatic change.

Introduction

Geoarchaeology has become an integral part of Quaternary studies, particularly in the "classical" areas of palaeolithic research in the Old World. Recently, new study approaches have developed in the course of field investigations in Alberta, western Canada, focusing on survey of early sites deeply buried under the present surface, with some fundamental implications about the natural history of the region and the past climatic change in the north-western part of North America. Although "pre-glacial" archaeological records may still be taken with some reservation because of the rather unusual geological context producing flaked lithics of a cultural oblique (which would normally be accepted as humanly made if found in a setting on or close to the present surface, as it is the case with post-glacial prehistoric sites in North America), multidisciplinary contextual studies can confirm not only the cultural character of the findings, but also provide a significant palaeoenvironmental information which may not be drawn from the geological record alone.

The investigations in western Canada have produced a clear evidence of early human presence in this part of the Pleistocene Beringia long before the appearance of the Palaeoindian cultures on the Interior Plains (< 12 ka BP), which are traditionally regarded as the earliest cultural manifestations of the prehistoric peopling of the New World. These pioneering studies, opening a completely new niche of future geoarchaeological research, show the necessity of implementing the Quaternary geology methodological approaches and survey techniques into the early prehistoric studies in the formerly glaciated areas of North America as well as in other territories of the Northern Hemisphere. Geological contexts of non-glacial deposits incorporating deeply buried Pleistocene-age sites have been subject of intensive studies in several parts of the World. In southern Siberia, for example, palaeolithic records originating from stratified, up to 50 m thick loess-palaeosol sections have been used as paleoenvironmental proxy data complementing the fossil biotic and palaeopedological evidence (Drozdov et al., 1999).

Study contexts, methods and approaches

Presently, there are several sites in the province of Alberta that have repeatedly produced the evidence of an early (pre-last glacial) occupation of western Canada. The sites are distributed in the present and former river valleys east of the Rocky Mountains over a territory spanning ca. 1000 km from north to south on the western margin of the Plains east of the Rocky Mountains within a geographically uniform belt of rolling prairie and parkland of an altitude of about 600–1100 m a.s.l. They are situated in eroded river sections, 10–100 m high along the former or still active river channel banks effected by erosion. Geologically, the sites show a patterned contextual stratigraphical location with cultural finds (stone tools) buried under the last glacial deposits (glacial diamictons and associated proglacial and glaciolacustrine sediments) related either to the Cordilleran Glaciation (Calgary 1–2) or the Laurentide glaciation (Grimshaw, Villeneuve, Edmonton, Medicine Hat, Lethbridge, Belly River) (Chlachula, 1996a, b, 1997; Chlachula and Leslie, 1998). The key sites in the Bow Valley (Calgary NW) represent the most significant and best-studied palaeolithic locality.

The initial geoarchaeological investigations focused primarily on the establishment of a local chronostratigraphic framework at the particular sites in terms of sedimentary environments, the contextual position of early cultural records and the age assessment of artefact-bearing deposits. The primary research objectives have gradually shifted from purely archaeological to geological because of the key issues related to the site stratigraphy and chronology, the natural occupation habitat and the past climate change. Because of the geological context of the evidence, the methodological and intellectual background for the field studies combines both the Palaeolithic archaeology and Quaternary geology. Stratigraphic and palaeoenvironmental studies at all localities have provided the principal information on the context and the approximate age of the flaked lithic assemblages. They have also produced some insights on the regional character of the Late Pleistocene glaciation in western Canada and the climatic evolution in this part of North America during the LGM.

Results and paleoenvironmental implications

The palaeolithic industry assemblages have been recorded in patterned geological contexts at all localities from eroded natural sections, where artifactually shaped quartzite and hard carbonate cobbles and flakes have been identified within the river erosions and subsequently exposed by archaeological excavations. At the Bow Valley sites, culturally flaked lithics originate from a primary context of (preglacial) fluvial sands and gravels, and secondarily redeposited in the overlying Late Wisconsinan Cordilleran till (Site 2). At Site 1, they are found *in situ (sensu stricto)* from the surface of the diamicton from an intact context under 24 m of glaciolacustrine sediments of Glacial Lake Calgary (Chlachula, 1996).

The stratigraphic sequence documents a gradual establishment of full glacial conditions in the former Bow Valley. Two disconformities in the geological sequence are manifested by the corresponding stratigraphic distribution of two stone tool assemblages, implying two episodes of the pre-Palaeoindian occupation in this area. The more recent disconformity defined by the contact of the Cordilleran till and the overlying Laurentide Glacial Lake Calgary sediments relates to the temporal hiatus elapsed between the two glacial events. The separating, ice-free time interval between the two glaciations is clearly manifested by the *in situ* position of the well-preserved palaeolithic record, including perfectly shaped tools with associated lithic waste. In view to the compositional uniformity of the cultural records and the stratigraphic configuration it is assumed that only a short time span separated the two glacial events.

The stratigraphic position of the cultural horizons indicates an interstadial Mid-Wisconsinan (OIS 3) occupation of the former Bow Valley (OSL dated by the overlying sediment to 31 ka) that was disrupted by the early last glacial valley ice advance emerging from the Rocky Mountains. Following deglaciation, the valley floor was re-occupied before it was flooded by a proglacial lake (Glacial Lake Calgary) dammed during the maximum Late Wisconsinan (OIS 2) continental ice advance from the north.

The stratigraphic and contextual position of the geoarchaeological data suggests that the area west of Calgary did not experience a major continental glaciation during the last glacial maximum. Relatively short-lived glacial events in the major river valleys spreading from local montane ice centres in the Rocky Mountains are assumed to have been the characteristic glaciation pattern in the SW Alberta Foothills. The *in situ* excavated stone artefact assemblage from Site 1, post-dating the Bow Valley glaciation, but pre-dating the first and maximum Laurentide ice-sheet advance in the eastern Calgary area, provides definite evidence for a local temporal asynchroneity of the Laurentide and Cordilleran ice advances in this area. The documented merger of the two ice masses during the last glacial maximum in the Athabasca Valley in west-central Alberta may have had little if any immediate impact on the Palaeo-American occupation in the south-western portion of the province. Environmental fluctuations during the early Late Wisconsinan probably did not significantly affect the local human habitat in the until the maximum Laurentide advance over the adjacent southern prairies. The Bow Valley sites suggest more localised glacial advances from the Rocky Mountains restricted to the major valleys on the eastern slopes, and more readily responding to climatic change, instead of a single large ice-mass covering most of western Alberta (e.g. Clayton and Moran, 1982; Rains et al., 1990).

Fig. 1. Edmonton, Riverside. A Late Pleistocene section exposed along the North Saskatchewan River with Glacial Lake Edmonton silts and clays (on top) overlying the Late Wisconsinan Laurentide till (in the middle part) and "preglacial" Mid-Wisconsinan and earlier sands (at the base).

Discussion

Pleistocene fluvial, glacial and glacigenic deposits being the most widely distributed in formerly glaciated areas of the World have a major potential for geoarchaeological studies. These, in turn, may provide significant implications about mapping of the regional climatic change. Although at most places the original lithic record is likely to be largely distorted and widely distributed in the incorporating sedimentary matrix (e.g. in periglacial braided river depositional environments), under favourable circumstances, the archaeological finds may become buried by fine sediments in the original contextual position without any major reworking (e.g. Calgary Site 1). Such occupation surfaces, defined as spatially limited places of association of cultural remains (lithic and other artefacts, patterned cultural material accumulation, etc.) may be expected to occur particularly in low energy fluvial and lacustrine sedimentary settings. In western Canada, the occurrence of deeply buried early prehistoric records at the base or partly entrained in glacigenic deposits is particularly anticipated in view of the regional geological character. A clear distribution pattern across the province with palaeolithic sites buried under a mountain or continental till is evident. In respect to this specific high-energy geological context, proper understanding of diagnostic cultural stone flaking attributes is especially important (Chlachula and LeBlanc, 1996).

Although the pre-glacial sites in Alberta are unique in North America in view of their age and unusual geological contexts, a perfect parallel from Europe - the Lower Palaeolithic site at High Lodge, England (dated to 0.5 Ma BP) with flint artefacts distributed in the Anglian till as a result of glacial transport over a former riverine setting (Ashton et al., 1992) shows that the concept of "glacial geoarchaeology" may be applied world-wide.

Conclusion

Despite a certain progress in the earliest American studies, there is still no consensus about the timing and conditions of the initial Palaeo-American migrations from NE Asia. Recent investigations show that a fundamentally different site survey approach must be taken with a focus on buried Pleistocene geological contexts. Not necessarily visibility, but primarily recognition of early cultural records is the main factor, which can significantly contribute to understanding the process of peopling of the New World. Especially the formerly glaciated areas and areas of a high sedimentation input should be surveyed for deeply buried palaeolithic sites. Introduction of progressive geoarchaeological research strategies incorporating glacial geology and palaeolithic archaeology can significantly contribute to elucidation of the earliest human prehistory in high latitudes. In turn, the early cultural records may be used as palaeoenvironmental proxy data "trace fossils" for mapping of past climatic events and reconstruction of Quaternary environments on local as well as regional scale. Application of geoarchaeological data may provide an alternative and more reliable geographical and chronostratigraphic proxy control of past climatic events than use of conventional geological and geomorphological methods alone. Even if obtained from a limited area, but a clear geological context, early cultural records may have significant local as well as regional palaeoenvironmental implications.

References

N.W. ASHTON, J. COOK, S. G. LEWIS, and J. ROSE (Editors), 1992. High Lodge. Excavations by G. Sieveking 1962-8 and J. Cook 1988. British Museum Press, London.

CHLACHULA J., 1996a. Geology and Quaternary environments of the first preglacial palaeolithic sites found in Alberta, Canada. *Quaternary Science Reviews*, 15: 285-313.

CHLACHULA J., 1996b. Environnements du Pléistocéne final et occupation paléo-américaine du sud-ouest de l'Alberta, Canada. *l'Anthropologie*, 100(1): 88-131.

CHLACHULA J. and LeBLANC R., 1996. Some artifact-diagnostic criteria of quartzite cobble-tool industries from Alberta. *Canadian Journal of Archaeology*, 20: 61-74.

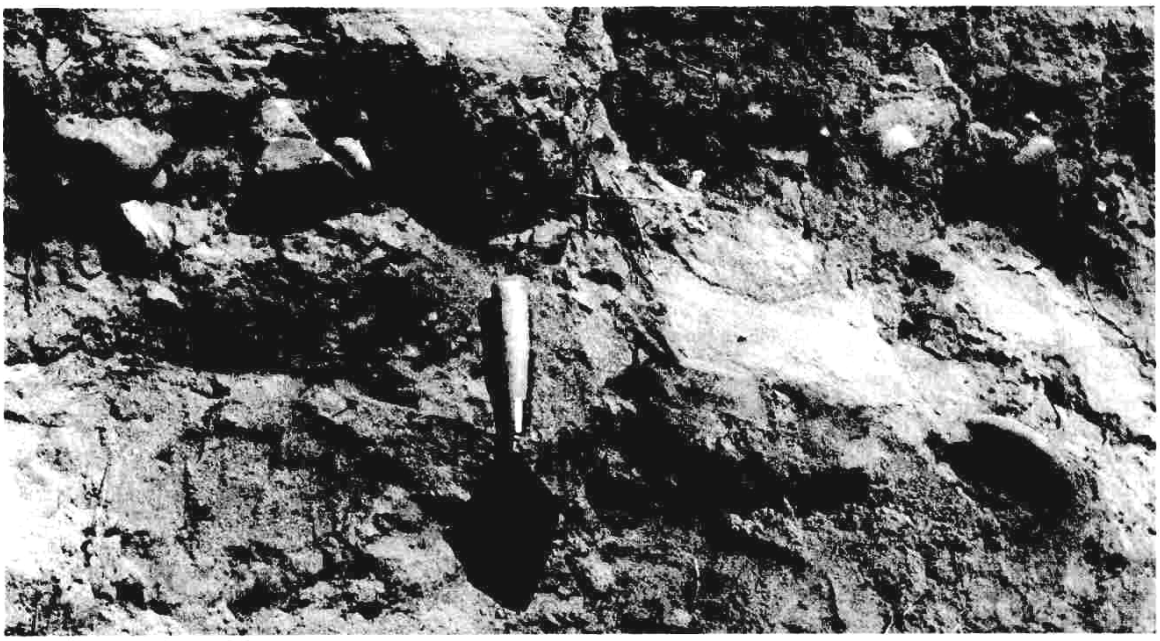

Fig. 2. Stratigraphic position of a cultural horizon (> 20,000 years BP) within a small sandy-gravely unit at the base of the till at the contact with the alluvial formation, with secondarily entrained palaeolithic stone tools from formerly occupied surface as a result of glacial erosion during the following continental glaciation.

CHLACHULA J. and LESLIE L., 1998. A pre-glacial archaeological evidence from Grimshaw, the Peace River area, NW Alberta. *Canadian Journal of Earth Sciences*, 35/8: 871-884.

CLAYTON L. and MORAN S.R., 1982. Chronology of Late Pleistocene glaciation in Middle North America. *Quaternary Science Reviews*, 1: 55-82.

DROZDOV N.I., CHLACHULA J. and CHEKHA V.P., 1999. Pleistocene environments and palaeolithic occupation of the Northern Minusinsk Basin, southern Krasnoyarsk region. In: J. CHLACHULA, R.A. KEMP and J. TYRÁČEK (Editors), Quaternary of Siberia, *Anthropozoikum*, 23: 141-155.

RAINS B., KVILL D. and SHAW J., 1990. Evidence and some implications of coalescent Cordilleran and Laurentide glacier systems in Western Alberta. In: P.J. SMITH and E.L. JACKSON (Editors), A World of Real Places, University of Alberta, Edmonton. pp. 147-161.

Thermal and Humidity Variations over East Europe and Asia during the Last 2500 Years by Proxy Data

Andrei SELIVANOV

Geography Department, Lomonosov Moscow State University, 119899, Moscow, Russia

ABSTRACT. Basing on various kinds of historical (documentary) and other kinds of proxy data (glaciological, limnological, faunistic, palynological etc.), an analysis of climate changes during the last 2500–3000 years over the whole extratropical Asia and East Europe was conducted. Major phases of thermal changes during this period, Iron Age cooling, Medieval climate optimum, and Little Ice Age, can be traced over the whole Eurasia, but they are usually aged from earlier times in eastern sectors of the continent. The similar pattern of set in with the larger time lag (up to 3–6 centuries) characterizes periods of increased precipitation and river runoff.

Negative correlation of temperature and humidification anomalies appears to be the important feature in the arid sectors of Eurasia, whereas in most other regions correlation of these parameters is usually positive, but less intensive. As a first approximation, eight regions can be discerned in the extratropical Asia and East Europe by the differences in their humidity response to the large-scale changes in air temperature during the last millennia.

KEY WORDS: aridity, humidity, historical data, proxy data, Medieval climate optimum, Little Ice Age.

Introduction

Historical, or documentary, data serve as an important independent source of information on past climates, including humidity, precipitation, and river runoff. Together with the other kinds of proxy data covering time scales of several hundreds to several thousand millennia, they fill in the gap between data of direct, instrumental, observations and palaeodata. Extensive data bases of such proxies have been compiled from the Chinese, Russian, and other historical sources. However, a variety of human-induced factors (national mentality, wars, etc.) that affected registration of climatic and hydrological events often prevent scholars from application of such data to the quantification of past climate changes.

Methods and material used

China and Russia, the most severe and stable former totalitarian empires in the whole world, are notable for the duration, continuity, and reliability of their chronicles. They cover time periods from AD 1000–1100 in Russia and from the 3rd century BC in China. In Russia, chronicles were held in cloisters, whereas in China state officials were responsible for their entity and truthfulness. Occasional climatic data from AD 800–850 are contained in Japan chronicles. The present author analysed all available data (over 3000 registrations) on extreme climatic events in East Europe, Central Asia, China and Japan during the last millennia. The respective methodology for estimation of reliability, climatic interpretation and cross-verification of documentary and other kinds of proxy data (glaciological, limnological, faunistic, palynological, etc.) was elaborated (Selivanov, 1994). Fractions of climate extremes of certain kinds among all extremes registered during the time interval were used to evaluate summer, winter, and annual values of surface air temperature, precipitation, and river runoff. This technique was applied to different regions of European Russia for three decade-long time intervals beginning from 1120 (Selivanov and Voronov, 1988; Klige et al., 1993; Selivanov, 1994). Further investigations in this field for Central and East Asia will be published elsewhere (Selivanov, 2000).

Results and discussion

It is widely known the Holocene thermal history has a worldwide character. Three major climate phases can be distinguished during the last 2500 years roughly covered by the Late Holocene in a geologic periodization. They are Iron Age cooling (IAC), Medieval (Little) climatic optimum (MCO), and Little Ice Age (LIA). Our analysis demonstrates that the periods can be traced over the extratropical Eurasia. Nevertheless, air temperature changes did not coincide in details over the whole region. Thermal culminations usually occurred several decades or even cen-