

Geoarchaeology of Palaeo-American Sites in Pleistocene Glacigenic Deposits

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1. Introduction

Initial prehistoric peopling of the Americas is one of most discussed archaeological themes. The Pleistocene human occupation of the continent predating the well-known Palaeoindian cultures that suddenly emerged after 13,000-12,000 years ago is still a rather problematic if not controversial for many American archaeologists. The traditional model envisages a one-wave migration of modern people from northeast Asia across the exposed Bering Land-Bridge and represented by big-game hunters equipped by sophisticated fluted bifacial stone projectile points that decimated in few centuries the Final Pleistocene megafauna. Their expansion onto the Western Interior Plains south of the continental ice-sheet is perceived as linked with re-opening of the „ice-free corridor“ - an unglaciated land in the upland prairie along the eastern flanks of the Canadian Rocky Mountains. Its existence has been viewed as a major precondition for the southern movement of the Palaeoindian groups from Eastern Beringia, i.e. the ice-free Alaska and the western Yukon Territory (Fagan, 1987). This term was introduced to explain the sudden appearance of the archaeologically distinct Clovis bifacial projectile point tradition at the very end of the Pleistocene (Haynes, 1980; 2002).

The emerging scenario arguing for a "pre-Clovis," or a pre-13 000 year-old Palaeo-American occupation, implies an earlier date of the initial entry to the New World during some of the climatically moderate Pleistocene stages with the sea-shelf palaeo-geography of low-water levels connecting the Chukotka and the Alaska Peninsulas. Just because of the exceptional nature and unusual geological contexts, that may imply a high age of potential early cultural sites, some reservations and reluctance to accept evidence that does not fit the long-established culture-historical paradigm may still persist. There is a general tendency to question, often by using very simplistic arguments, the potentially early cultural records represented by rudimentarily flaked tools from controlled stratified positions, just because they may differ from the well-known cultural manifestations such as fluted projectile points.

The views on the earliest North American prehistory may be partly challenged in the light of some recent discoveries (Waters et al., 2011), but this seems to be a slow process before the once-trendy “Clovis-first model” is fully dropped. There is no reason to discard earlier

cultural evidence that complies with all the standard archaeological, contextual and dating criteria routinely applied at the Palaeolithic sites in Europe, Africa or Asia. In fact, there may be no problem with the archaeological authenticity of some of the potential "pre-Clovis" American sites, but at the first instance, with a limited experience and training of the opponents lacking the requisite background in the Palaeolithic studies and the stone-flaking techniques. The absence of rigorous scientific and data-supported arguments addressing the well-reported Pleistocene cultural records represents a certain form of the North American culture-anthropological folklore (e.g., Driver, 2001). Contrary to the European schools where the Pleistocene studies are in-framed in the multi-disciplinary Quaternary investigations, the North American archaeology is traditionally a part of cultural anthropology with very weak if any ties to Quaternary geology. This fact may result in incapability to locate and evaluate objectively the potential Pleistocene cultural evidence, particularly if manifested by simply worked lithic implements in unusual and/or deeply buried old geological contexts. A survey for the Palaeo-American sites in the Pleistocene geo-settings, radically different from the presently studied, may thus still be problematic for some archaeologists because of the long-lasting traditional models and perceptions on the initial peopling of the continent.

The northern part of North America was repeatedly glaciated with ice covering the areas of plausible (or sometime the only possible and passable) spatial movement such as the NW coast of British Columbia and the western Alberta prairies (Fig. 1). Despite a certain progress in the earliest American studies indicating human presence in distant regions on the Great American Plains between 15 300-13 000 yr BP, i.e., prior to the Clovis complex (McAvoy & McAvoy, 1997; Adovasio et al., 1990, 1998; Webb, 2005; Holen, 2006; Joyce 2006; Collins & Bradley, 2008; Gilbert et al., 2008; Lowery et al., 2010), no consensus has been reached about the timing of the initial human migrations entering the Americas, the level of technology and the associated typological variety of stone tools the early inhabitants of the new continent brought with them. The North American archaeologists still tend to look for assemblages with bifacial or micro-blade flaking patterns in geologically recent deposits, assuming a possible continuity with the Siberian Upper Palaeolithic projectile point and palaeo-Arctic technologies, respectively, or follow possible evolutionary links with the Clovis complex in immediately timely preceding archaeological inventories (Waters et al., 2011). On the other hand, there is still a persisting and unfounded resistance to the notion that there could be anything earlier on the Upper - Middle Palaeolithic technological stage.

This reluctance to accept cultural evidence consisting solely of crudely flaked tools, which are radically different from the easily diagnostic stone projectile points such as Clovis and the associated lithic complexes, is one of the main reasons for the debate. The situation is more complex, since in eastern Beringia (Alaska and Yukon), where the oldest cultural evidence would be anticipated, the earliest archaeological manifestations recorded so far relate to the Palaeo-Arctic Tradition with micro-blade stone industries linked to the east Siberian Dyuktai Culture. The earliest local stone projectile points date to about 11 700 yr BP (Hoffecker et al., 1994, Kunz & Rainier, 1994). This fact largely reflects the research focus on shallow, near-surface final Pleistocene / early Holocene geoarchaeological contexts, but not on earlier deposits, and illustrates difficulty to recognize cultural records with more simple stone-flaking technologies (Dixon, 2001). These rudimentary modified lithics, however, would normally be accepted as humanly made if found in a contextual setting on or close to the present surface chronologically post-dating 12 000 years as it is the case with most "post-

glacial" prehistoric sites in North America (Chlachula & LeBlanc, 1996). A refusal of a Pleistocene-age cultural evidence on these grounds is therefore fully unsubstantiated.

In fact, simply flaked core and flake stone artifacts represent the most abundant form of archaeological remains in the Canadian Interior Plains and possibly other areas as well, because of their time-cultural technological indifference and a high preservation potential. In the study area of western Alberta, similarly as in North Siberia, pebble tool assemblages are chronologically distributed in varying proportions to other types of cultural material in all archaeological cultures throughout prehistory and persist until the historical times (the 18th and 19th Century). The broad geographical and chronological distribution of these (occupation or workshop) sites with such implements is accentuated and typified by exploitation of widely available raw materials, mostly of quartzose rocks, derived by fluvial and glacial processes from the Rocky Mountains. Yet, probably because of the high frequency of occurrence and association with the more eloquent archaeological inventories (such as elaborate stone tools made on exotic raw materials, ceramics or metal objects), there has been much less attention paid to these marginal cultural lithic assemblages and for most archaeologists less attractive finds. Although time-transgressive in both the mode of production and the resulting forms, the rudimentary flaked core and flake industries, however, encompass more than 99% of human prehistory in both the Old and New World.

In this perspective, particularly the most durable instruments made of stone thus logically provide the key information about all these issues related to the early American adaptation to the new environments. One of the principal problems concerns the recognition of these artifactually flaked lithics and other cultural remains deeply buried under or within glacial and glacigenic (glacial setting-associated) deposits presently extensively distributed as surface-exposed or covered in the formerly glaciated areas of the Pleistocene Beringia. This fact largely reflects the lack of appropriate geoarchaeological investigations focusing on field survey and research of early prehistoric (Palaeolithic) American sites deeply buried under the present surface, as well as on the contextual Quaternary research and the related geomorphological, stratigraphical, sedimentological and rock-mechanical investigations. Introduction of innovative and open-minded geoarchaeological research techniques and strategies incorporating glacial geology and Palaeolithic archaeology, and a more active role of natural sciences (substituting speculative culture-anthropological discussions) may thus significantly contribute to elucidation of the earliest New World prehistory (Bryan, 1986). For *early* sites must be searched in *early* geological formations! This very simple idea, applied routinely in Africa, Europe and Asia (including the gateway to the Americas – Siberia), seems not to be fully compatible with the American archaeological thinking.

The archaeological material recorded *in situ* in the (pre-glacial, i.e. pre-Holocene) geological context in Eurasia and Americas may also deliver a significant source of proxy data on the past climates and climate change in areas of the Northern Hemisphere that experienced the Pleistocene glaciations, in terms of their timing and the geographical extent. Investigations in Alberta, west Canada, at the Palaeolithic sites sealed by thick (10+ m) deposits derived underneath or close to the continental ice-sheet and the Cordilleran valley glaciers during the last glacial stage have provided the first definite evidence on the palaeo-American occupation of the foothills and the adjacent plains east of the Canadian Rocky Mountains as well as the local extent of the ice during the Last Glacial Maximum (ca. 21 000-18 000 yr BP).

Although any potential "pre-glacial" archaeological record pre-dating the Last Glacial interval (24 000-12 000 yr BP) may be taken with some reservation because of the rather unusual geological context producing flaked lithics of a rude unsophisticated cultural oblique (which are normally accepted as humanly made if found in a setting on or close to the present surface, as it is the case with most Holocene prehistoric sites in North America), multidisciplinary contextual studies can confirm not only the cultural character of these findings, but provide a significant palaeogeography and palaeoenvironmental information which cannot be drawn from the geological record alone. Because of the nature of this cultural evidence, the methodological intellectual background for the field investigations should imperatively entail both the Old World-style Palaeolithic archaeology as well as the Quaternary geology. Particular attention should be paid to complex contextual and palaeo-ecological aspects of early site investigations that relate to provenience of raw material used for production of stone tools, the site stratigraphy and chronology, and the Quaternary environments and related past climate change. Pioneering investigations at the pre-glacial Late Pleistocene occupation sites in western Alberta have produced a clear evidence of early human presence of this part of North America long before the appearance of the traditional Palaeoindian cultures on the Great Plains, which may be regarded as one of the earliest manifestations of the prehistoric peopling of the New World (Chlachula 1996a, 1996b, 1997; Chlachula & Leslie, 1998). The multidisciplinary geoarchaeological studies, implementing the "pre-glacial" geoarchaeology concept thus open a fundamentally new and broad niche of geoarchaeological research in completely unexplored geological formations extending over the vast and formerly ice-covered areas of the Northern and Southern Hemisphere. Open mind is equally important as a professional training and introduction of flexible methodological approaches and analytical techniques (Chlachula & LeBlanc, 1998).

This contribution provides some perceptions on the geological contexts, methods and approaches of the geoarchaeological investigations of the Late Pleistocene cultural occurrences associated with deeply buried geological contexts, following the pioneering research of the pre-Last Glacial Palaeolithic occupation sites in Alberta, west Canada (Fig. 1). It also raises some principal issues relating particularly to fieldwork strategies dealing with archaeological evidence embedded by Pleistocene geological processes, more particularly in periglacial or glacial settings. Although these are discussed on the example of the cultural sequences from Canada, the methodological aspects and field reconnaissance implications are valid also for other formerly glaciated regions of northern Eurasia. The chapter brings up and highlights some fundamental questions that are overlooked or ignored by many North American researchers, bearing on identification of the potential artifactual remains in various geological contexts of diverse ages and genesis. In conclusion, it is argued that a high number of Palaeo-American localities can be readily found sealed in deeply stratified formations by using the standard "Old World Palaeolithic" survey techniques, despite the fact that some of these locations were subsequently exposed to major erosional processes and/or redeposition, but still may deliver undisputable traces of actual human presence antecedent of the Clovis horizon and other Final Pleistocene Palaeoindian complexes largely clustering in the south-western portion of the U.S. Most of the photographs from the field research in the principal study area of western Canada carried out in 1990-1998 are here published for the first time in order to demonstrate the authenticity and technological range of the Alberta Upper Palaeolithic Complex. This should give an impetus for new systematic Quaternary geoarchaeology studies aimed at cognition this fascinating prehistoric period.



Fig. 1. A. Geographic map of Beringia (the exposed Bering landbridge) during the last glacial; B. present Bering Strait environment (Chukotka); C. Geographic dispersal of people from NE Siberia to North America along the eastern flanks of the Rocky Mountains (the interior route) and the NW coast, with location of the Palaeolithic occupation sites (1. Bluefish Cave, north Yukon; 2. Grimshaw, 3. Villeneuve, 4. Edmonton-Riverside, 5. Calgary - Silver Springs & Varsity Estates, 6. Medicine Hat, 7. Lethbridge, 8. Eagle Cave, Crownest Pass, Alberta).

2. Contextual studies of the Palaeo-American occupation sites

2.1 Methods and approaches

Investigations of deeply-buried archaeological sites in unusual geological contexts, such as glacial and glaciogenic settings, pre-requisite adequate knowledge of corresponding research methods and approaches that may differ to some extent from the standard techniques applied at most American prehistoric localities that have been documented until now. Awareness that a *different* kind of archaeological records in *different* and till now undiscovered and fully unmapped contexts may actually exist is *a priori* a main pre-condition for objective, matter-of-fact perceptions of discoveries that are not in compliance with the established culture-historical paradigm on the initial peopling of the New World. Although the methods and approaches may not be dissimilar to those routinely applied at the Old World Pleistocene archaeological sites (e.g., Chlachula et al, 2003; 2004; 2011), their elaboration and adjustment to particular on-site geological, geographic and environmental conditions may be necessary.

Because of the contextual positions of the potential early cultural Palaeo-American finds that may be buried up to several ten of meters under the present surface (opposite to shallow-sealed sub-surface sites) (Fig. 3), these should be treated and evaluated primarily by geology and stratigraphy standards analogously as "trace fossils" for establishment of their original / secondary contextual positions, age and (post-)depositional and/or taphonomic histories. Quaternary geology studies, knowledge of physical properties of raw materials applied for stone tool production, anthropogenic/natural lithic flaking and use-wear analyses are of utmost importance for demonstrating cultural authenticity of these sites and records (Chlachula, 1994a; Dillehay, 1997). Introduction of well-defined geoarchaeological research strategies incorporating glacial geology and Palaeolithic archaeology, and a more active role of other natural sciences can thus significantly contribute to elucidation of the earliest human prehistory in the formerly glaciated regions of mid- and high latitudes.

In the frame of the initial investigations of the Palaeo-American ("pre-Clovis") sites in western Alberta, Canada, the geoarchaeological research carried out in 1990-1998 focused on establishment of the locality chronostratigraphic framework with 10-25 m buried cultural horizons in terms of sedimentary environments, contextual occurrences of diagnostic lithic industries and chronology of the artifact-bearing deposits (Chlachula, 1994b, 1996a, 1996b). Stratigraphic studies and the local palaeoenvironmental reconstruction at the pre-last glacial (> 20 ka BP) localities from the western interior plains provided fundamental information on the technological characteristics, the geological context, and a relative age of the Palaeolithic stone tool assemblages. For the field documentation of sedimentary geological structures, several criteria were applied to differentiate between deposits of a glacio-fluvial and glacio-lacustrine genesis, specify their sedimentological history and palaeo-current direction, and provide the site stratigraphy control. Particle size analyses of shape, size and the lithological composition of clasts (sandy-gravel deposits) was applied for a lithostratigraphic correlation of deposits and study of the dominant mechanism of sedimentary transport and deposition (Gale & Hoare, 1991). Fabrics (orientation of sedimentary particles), primary / secondary textures of deposits, principal physical characteristics of each sedimentary unit and forms and surface texture of selected rocks in sedimentary units provided together with the directional measurements information on current flow of clast-supported and fine-grained laminated sedimentary structures. Finally, a genetic assessment and stratigraphic correlation together with a contextual interpretation of individual sedimentary facies was performed.



Fig. 2. Present landscapes & ecosystems of NW North America. A. the North Cordillera range ice-fields (the Kaskawulsh glacier, the NW St. Elias Mountains, Yukon); B. sub-arctic forest-tundra, central Yukon; C. mountain boreal forest (Emerald Lake, the Watson River basin, SW Yukon); D. mountain desert (Carcross Desert, SW Yukon) – sand deposits of the last-glacial Lake Bennett; E. mountain valley (the Bow River valley, southern Canadian Rocky Mountains, west Alberta); F. semi-arid prairie (the Oldman River, southern Alberta).

The palaeogeographical setting at all the sites is reconstructed from the geological record and comparative studies of actualistic sedimentary (fluvial, colluvial and glacial / glacio-fluvial) processes and their facies in various sedimentary environments in Alberta. Genetic analyses of the past sedimentary settings from the study sections constitute a crucial component for determining mechanism of flaking / edge damage of the lithic assemblages. Application of the general concept of sedimentary facies models is thus a prerequisite for the reconstruction of the dynamics and interaction of natural forces acting during deposition of sediments in a particular environment (Fig. 2) and assessment of their kinetic potential for simulating cultural stone flaking patterns. The past depositional geological environments reconstructed through facies models (Harms et al., 1982; Reading, 1989; Walker, 1986) provide key information about the palaeoecology of the study area. Internal textural and structural changes within a particular facies sequence controlled by shifts of the local sedimentary environment are evident in the grain size distribution, thickness of single deposits and variability of mineral composition. These, in turn, are governed by external environmental factors, such as climate change, tectonics, change in vegetation cover, *etc.*, ultimately influencing the rate of input, transport and deposition of sediment (Anderton, 1985; Walker, 1986; Brodzikowski & van Loon, 1991). Accordingly, a facies model must be implemented as a general summary of specific characteristics within a sedimentary environment and the related processes of deposition in any geoarchaeology studies of buried cultural sites.

2.2 Geological contexts

Because of the time focus, geoarchaeological contextual investigations are crucial to demonstrate the chronological and cultural authenticity and integrity of any particular Late Pleistocene archaeological record, especially if this is represented only by rudimentarily flaked cultural lithics. Specific characteristics of local depositional environments, associated with the occurrences of lithic industries, being the most likely archaeological inventories to be anticipated, should be studied for the primary position of cultural evidence, but also of their natural potential for production of possible geofacts that can be mistaken for authentic stone tools. The geographically most distributed geological settings in Western Canada, which is likely to include buried early cultural record (Fig. 3), are the old river systems with subsidiary valley channels and related fluvial deposits; alluvial fan, slopewash and other gravity flow settings; glacial and glacialic (glacio-fluvial, glacio-colluvial, ice-contact, *etc.*) depositional environments; lacustrine and glacio-lacustrine settings, sea-shore areas and raised marine beaches (along the Pacific coast), and caves (in the Rocky Mountains).

2.2.1 Fluvial settings

Particularly the fluvial and glacial deposits are the most widely distributed in western Canada (plains and foothills), as well as in other formerly glaciated areas of North America, and provide the major potential for geoarchaeological early site's survey. These, in turn, may have significant implications about the regional as well as territorial climatic change. Recognition of simply flaked stone tools in a riverine (fluvial-channel and river-bank) setting may be rather problematic, particularly if these are found within thick and massive clast-supported sedimentary units composed of heavy-load gravels (e.g., Tricart & Vogt, 1967). On the contrary, flaked artifacts in fine-grained interchannel and overbank deposits should be identifiable without major difficulties even if produced on local raw materials. Periglacial river basins represented the most occupied Pleistocene natural environments.

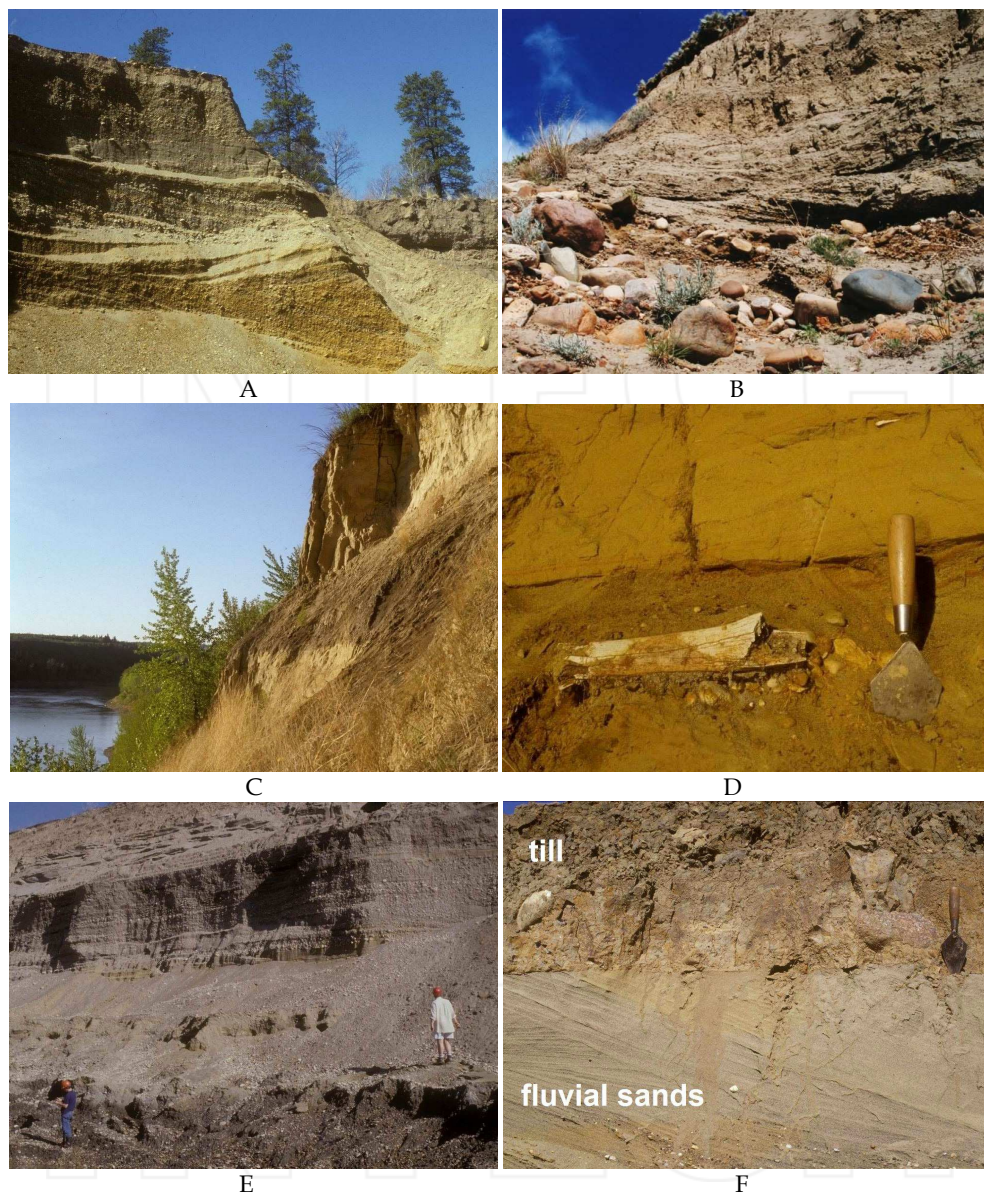


Fig. 3. Geological contexts of buried Pleistocene archaeological records in Alberta, Canada, associated with the documented Palaeo-American lithic artifact distributions: A. interstadial (Mid-Wisconsinan) gravels (Grimshaw, Peace River); B. a massive alluvium truncated by a glacial diamicton (Medicine Hat, S. Saskatchewan R.); C. the Late Wisconsinan Laurentide clayey till (Edmonton-Riverside, N. Saskatchewan R.); D. interstadial fossiliferous sands (Edmonton-Riverside); E. the Mid-Wisconsinan fluvial deposits ^{14}C -dated by fauna to 40-21 ka BP (Villeneuve); F. an erosional contact of the fluvial and glacial formations (Villeneuve).

Evaluation of authenticity of flaking of an early lithic assemblage should take into consideration the following aspects: determination of sedimentary dynamics, including energy level, periodicity and palaeo-current direction; density of the fluid, and the amount and composition of the saturated matrix; velocity of the current and rate of sedimentation; structural unconformities and depositional irregularities in sedimentary units; secondary post-depositional disturbances; assessment of the mechanical potential of the present high-energy natural factors in the vicinity of a site and the surrounding area to imitate cultural modification patterns on local rocks and clastic minerals, identification of specific natural stone-modification factors in the same geological context, etc. Understanding of the basic principles of fluvial processes is therefore essential for critical assessment of the source and the extent of modification of flaked lithics in a buried geological context, as well as for interpretation of the past palaeoenvironment and its early human inhabitation potential at the moment of the enclosing deposit formation.

A separate contextual study issue is the concentration of archaeological inventories within the sealed deposit. A patterned spatial distribution of the flaked lithics is one of the most important aspects which may support, although not conclusively establish, the cultural nature of flaking of a lithic assemblage enclosed in a geological context. However, a more or less homogeneous dispersal of flaked lithics within a deposit does not *a priori* exclude their artifactual origin. The degree of spatial compactness in particular (glacio-)fluvial settings is governed by several factors, including the distance of re-deposition, dynamics (velocity and density) of the stream, character of the local topographic setting, etc., all of which can significantly contribute to a high mixing of the original cultural assemblage with the derived sediment. At most of the mapped Alberta Palaeolithic locations (Chlachula, 1996a; 1997), a random dispersal of flaked lithics within a deposit was documented in fluvial and glacio-fluvial settings (Calgary 2, Edmonton 1 - Riverside). Under favorable circumstances, the archaeological material may be horizontally spatially dispersed within a small area on top of the originally subaerially exposed layer (e.g., a river bank deposit), and subsequently buried by fine sediments without any major reworking and redeposition. Such occupation surfaces, defined as spatially limited places of association of cultural remains (lithic and other artifacts, patterned cultural material accumulation, etc.) may be expected to occur in low energy fluvial and lacustrine sedimentary settings potentially sealing many early Palaeo-American sites. Distribution of the cultural record at the Bow Valley locality at Calgary confirms the fact that deeply buried artifacts and other cultural remains are likely to be preserved, but are largely dispersed by high energy streams within braided periglacial floodplains. The Calgary Site 1 (the uppermost cultural level on top of the till) is currently the only Palaeolithic site in western Canada with a spatially well-defined occupation area.

2.2.2 Alluvial fan settings

Pleistocene cultural finds are commonly associated with alluvial fans which proved to be a rich source of Early Palaeolithic sites in the Old World (e.g., Isaac 1977; Clark et al., 1984; Bar Yosef, 1988; Chlachula, 1993). Alluvial fans accumulated near mountain fronts and formed by interstratified sands and gravels are likely to incorporate early cultural records within inter-bedded sequences of sandy-gravelly strata. Periodic precipitation variations, climate-related changes in vegetation cover and tectonics are the most important agents affecting the alluvial fan formation, especially if acting concomitantly. Particularly inter-bedded sandy and gravelly strata cyclically accumulated by sheet-flows and perennially active, laterally

shifting braided streams in the American mountain fronts should be a subject of a close geoarchaeological field survey. The likely complex geological histories of these geomorphic formations possibly including deposits of various ages may complicate exact chronological assessment of the enclosing cultural records (e.g., Calico Hills Site) (Bischoff et al., 1981).

Periods of intensive debris accumulation usually coincide with accelerated erosion in the source area as a result of disturbance of slope balance due to subsidence and orogenic activity, change in regional precipitation patterns or as a result of a progressing bedrock weathering due to increased insolation and/or frost action. Differences in clast composition and varying amounts of fractured rocks in a vertical profile in the deposit have a direct bearing to the above factors. Debris flow processes are common in the semiarid as well as periglacial zones of North and South America. The specific character and intensity of these phenomena and physical properties of incorporated clastics have a direct bearing on assessment of the potential of an early stone industry distribution in the deposit and degree of its preservation. The resulting alluvial fan facies can be highly variable, depending on the amount of water-saturated / dry debris introduced to the particular locality, their lithology, periodicity of deposition, stability of the local geological bedrock, etc. Accordingly, alluvial fan deposits can occur as chaotically supported paraconglomerates formed by mudflow activity, or orthoconglomerates with interbedded and subsequently cemented fine sandy and gravelly strata periodically laid down by sheetflows and perennially active braided streams (Reading, 1989; Nemeč & Steel, 1984).

In respect to the wide geographic distribution of alluvial fan formations and their dynamic genesis character susceptible to climate change in the framework of the Pleistocene history, deeply buried early American sites in the formal ice-marginal settings along the Alaska – British Columbia / Alberta Rocky Mountain foothills as well as in the southern extra-glacial regions must be anticipated. These transitional regions between the mountain fronts and the plains provide most potential for location of deeply buried Palaeolithic sites.

2.2.3 Glacial and glacigenic settings

The occurrence of early cultural records in glacial and glacigenic (glacial setting-associated) deposits is not perceivable for most archaeologists. These geological formations have not been researched for early sites till now also in the traditional areas of Palaeolithic research in Europe and Asia, with just a few exceptions (Ashton et al., 1992; Lauhkin, 1990; Pitulko et al., 2004). Yet, the discoveries of a series of pre-Holocene archaeological localities in western Canada in patterned geomorphic settings and geological contexts open a completely new niche of geoarchaeological research that can put the earliest human history of the Americas in a completely new light (Chlachula, 1996a, 1996b, 2003). In view of the emerging evidence, numerous early Palaeo-American Late Pleistocene cultural records, represented principally by diagnostic Palaeolithic artifacts positioned below or partly entrained in glacial deposits throughout the eastern foothills of the Canadian Rocky Mountains is to be expected in view of the Quaternary history and dominant regional geological structure with extensive, deeply buried, yet relatively young, non-glacial mid-last glacial fossiliferous formations covered by the overlying tills laid down by the last glacial mountain and continental ice-advances.

Past ice-marginal and periglacial settings provided rich biotic potential for human occupation – a fact that seem to be neglected by most archaeologists despite the documented

archaeological evidence from Siberia (e.g., Pitulko et al. 2004, Chlachula & Serikov 2011) and modern analogues from the northern regions of the American and Eurasian continent.

In respect to the high-energy dynamics of ice-advances over a formerly ice-free landscape, a proper understanding and interpretation of the structural sedimentary facies is essential for the palaeoenvironmental reconstruction and geoarchaeology evaluation of incorporated cultural records. Glacial processes are the most effective high-energy agents in a terrestrial environment responsible for erosion of quantities of surficial materials, their large-scale and long-distance transport, subsequent reworking, and final distribution over large areas. Eroded rock debris of varying form and size are secondarily transported by meltwater or in the form of saturated deposits as gravity (mass-)flows, all significantly contributing to a progressive modification and a marginal edge damage of derived clasts. However, the main source of a variety of fractured clastic materials, particularly close to the mountain areas, is the glacial diamicton (till), being a massive, unstratified, poorly sorted deposit accumulated during an ice advance. Except for simple fracturing, the resulting damage patterns on entrained and transported and differentially abraded rocks carried by a glacier from its source area, or incorporated from former non-glacial deposits into its basal part in form of sub-glacial debris, include polishing, faceting and striating (Hambrey, 1994).

Other processes of mechanical disintegration and mechanical modification of pebble-cobble clasts, especially encountered under periglacial conditions, are related to seasonal temperature fluctuations in permafrost regions, thawing of a buried ice, causing subsequent disturbance of surrounding deposits, frost action and thermal stress, periodic freezing of capillary water in rocks and migration of the fluid in the supporting matrix, movement of unconsolidated surficial materials over partly frozen ground (solifluction), cryostatic pressure (involutions and cryoturbation), glaciofluvial processes of episodic nature active at peaks of thaw seasons, and drastic desiccation of rocks exposed on a barren land by strong periglacial winds during minimal precipitation conditions. Yet, a surficial clast (cobble) modification by all these phenomena can be positively discriminated from the controlled anthropogenic flaking. Stone artifacts, however, may be difficult to detect in a buried context within a glacial deposit, particularly if generally recognizable cultural attributes are lacking. In such cases, comprehensive contextual as well as actualistic studies are useful to carry out, even if the results obtained are not fully conclusive or are limited to an assessment of a degree of probability (Schnurrenberger & Bryan, 1985; Chlachula, 1994a).

Although glacio-fluvial outwash may be considered as a rather unlikely geological depositional environment to incorporate early cultural inventories, even this should not be completely discounted as shows the evidence from the Bow Valley sites at Calgary West (Chlachula, 1996a). Particularly in Alberta, the occurrence of Palaeolithic finds represented by flaked quartzite artifacts at the base of glacial deposits or partly entrained within the till body attest to complex archaeological site formation processes. In view of the regional surficial geology characterized by deeply buried Quaternary non-glacial (last interglacial or mid-last glacial) formations covered and partly distorted by the overlying last glacial tills, contextual inclusion of early cultural records in these geological contexts must be logically expected. A regularity pattern of the early prehistoric (pre-Palaeoindian) cultural occurrence distribution across the province under the Cordilleran or Laurentide tills, analogous to the Silver Spring Site (Calgary 2) and the Edmonton-Riverside Site, is well evident. The cultural nature of the recorded lithic specimens from the western Alberta Pleistocene-age glacial and

glacigenic sections is inferred on the basis of their *recurrent patterning*. In both the flake- and the cobble-core components of the artifact assemblages, the cultural nature of modification is witnessed by technological stone flaking procedures diagnostic for Palaeolithic cultures.

2.2.4 Lacustrine settings

Lake basins were preferred places for human settlement since the earliest times of human prehistory. Apart of lakes occupying depressions formed by tectonic, volcanic, landslide or other geomorphic processes, which are marginally distributed in western Canada, old glacial and glacio-fluvial lake settings, on the contrary, have a major importance for the Palaeo-American geoarchaeology investigations. Periglacial agents were especially active over the vast areas bordering the major mountain ice-fields and continental ice-masses of the Pleistocene North and South America. Gravity-slope erosion, glacial debris mass-flows or active glaciers dammed parts of river valleys that were transformed into glacial lake basins filled by glacial meltwaters as documented from other mountain regions (Baker et al., 1993; Chlachula, 2010). A varying sedimentation rate in the Pleistocene glacio-lacustrine basins reflects fluctuation of the former lake shoreline and/or the blocking/releasing ice margin, and a relative abundance of river-derived clasts, which can be used as an unlimited source of raw material for stone tool production. Humanly flaked lithics from the early Palaeo-American sites should be readily identified in lacustrine settings as these differ significantly from the enclosing fine-grained matrix in size and composition. Besides this, stone artifacts should be preserved in a relatively fresh condition and a spatial concentration because of low-energy sedimentary environments (i.e., the Late Wisconsinan Calgary Site 1).

Coarser clastic materials as well as lithic artifacts, originally distributed along the lake shore, can be affected to some extent by reworking by wind-generated waves, and, on a larger scale, by landslides or glacial calving. High-energy lake drainage currents may also secondarily modify deposited materials, although only exceptionally in shallow shoreline waters. On the contrary, in lakes with an interior drainage, fluctuation of the lake level may cause much reworking of the sediments in the proximal shoreline zone. However, all these actions are more a source of abrasion and rounding of larger clastic materials than fracturing leading to a geofact production that should be discernable from the authentic stone tools.

2.2.5 Sea-shore settings

The only, though principal area where the Pleistocene-age (>12 000 year-old) American sites associated with glacial and glacigenic deposits can be expected is along the northwest coast of Alaska and British Columbia, which may have repeatedly served during the non-glacial intervals as another passage to early human immigrants to the New World alternative to the intercontinental route along the eastern slopes of the Rocky Mountains. Both tides and waves produce mass drifts of water due to coastal currents that are the principal agents of shoreline sedimentary transport. However, only in exceptional locations are tidal currents capable of eroding coastal rocks (Selby, 1985). As in lacustrine environments, wind-induced surface waves are the main source of kinetic energy, but acting here on a much larger scale. Accordingly, the natural modification of clastic rocks (as well as potential cultural remains) is expected there to be more effective. Coarse pebbly rocks occasionally used for stone tool manufacture until the late historic periods are being re-deposited mainly by on-shore water movement during periods of ocean transgression, or originate from the eroded portions of

exposed cliffs. Recognition of artifactual flaking patterns on lithics scattered on raised ancient beaches and terraces, or incorporated in marine glacial sediments, therefore, can be extremely complicated by two factors: a high degree of abrasion of a possible culturally-produced implement; and a high probability of pseudo-artifact occurrences, particularly where rocks fall from eroded cliffs, and where frequent and violent storms occur.

Another significant aspect involves the accessibility, visibility and preservation potential of potential early sites located on or near a sea-shore. It is likely that most of these sites, for example on the Northwest Coast (Mandryk et al., 2001) may have been completely scoured off by fjord glaciers during later glacial advances and/or subsequently submerged by a rising sea-level during the Final Pleistocene and Early Holocene. A detailed study of the Pleistocene coarse-grained coastline deposits, subsequently uplifted and exposed above the present sea-level, reconstruction of the past depositional processes, and comparative observations on the frequency of naturally produced fractures in the local area, all these aspects should significantly contribute to understanding of the true nature of modification of a lithic sample whose artifactual character is suspected but not proven.

The Pleistocene coastal environments were closely associated with human resource exploitation and repeated migration processes leading to the pre-historic colonization of the regions along the Pacific Rim. In fact, the major geographic passage to the New World was represented by the Bering land-bridge – the periodically exposed sea-shelf connecting the Chukotka and Alaska Peninsulas. Logically, many early Palaeo-American sites are now submerged under sea-water (ca. -70 m) or sealed in deposits of various ages and genesis along the present coastline at the formerly higher topographic elevations (by considering the Bering Sea-level drop by ca. 100 m during the Last Glacial Maximum) (Hopkins, 1973). By implementing a proper geoarchaeological approach in combination with palaeogeographic and palaeoenvironmental spatial and temporal analyses, the latter sites that are currently absent in Alaska (...) should be discovered as their existence is undisputed. Discontinuous early human movements from Asia to America (and *vice-versa*) may have taken place for up to several ten of thousands of years as a part of natural biotic exchanges between the two major continents. The cultural vestiges of these initial passages, however, are still rather sporadic, mainly in respect to the Late Pleistocene Palaeolithic dispersal (e.g., Pearson, 1999).

2.2.6 Hillslope settings

Preservation and recovery of early prehistoric sites in hill-slope locations is less likely than at other, more stable landscape settings in respect to acting dynamic geomorphic processes. In terms of recognition of rudimentarily flaked artifacts, it must be kept in mind that downslope movement of coarse unconsolidated sediments can also produce fracturing, marginal flaking and other casual damage on individual clasts. In more cohesive deposits, creep may trigger stresses leading to an increased deformation of rocks, eventually resulting in their structural fragmentation. The same applies for other high-energy gravity-slope phenomena including talus accumulations, rock-falls near steep cliff faces, and slope-wash, all causing breakage of incorporated rock debris to form a variety of geofacts, especially if fine-grained, matrix-supported deposit is absent. The scale of these processes depends on several factors, the most important of which are the relief gradient, presence and type of vegetation, amount and frequency of seasonal rainfall, and tectonic activity. Accordingly, contextual studies

clarifying the origin of clastic rock fracturing at the Palaeo-American sites, where a cultural activity is disputed and other compelling evidence is missing, are of the utmost importance.

2.2.7 Cave settings

Caves were a natural habitation place of people since the beginning of humankind. In NW America, in the area of passage into the New World, an early human presence in a cave setting (Bluefish Cave) was documented in the north Yukon Territory (Cinq-Mars, 1990). Because of the geological structure, there are only a few cave sites in the Canadian Rocky Mountains, which may have served as refugia for Palaeolithic people during the Pleistocene Period, such as Eagle Cave, SW Alberta (Chlachula, 1997). In a cave setting in general, the possibility of natural production of lithics that would resemble genuine stone tools is relatively limited. This is because the natural intra-cavernal milieu *a priori* excludes presence of other non-indigenous clastic material, unless these were secondarily derived by gravity slope processes, or external stream and glacial actions. Chert nodules, occasionally occurring in limestone formations, may be an exception. Except for sudden structural underground cavern disturbances resulting in roof falls, and presence of cave streams, there are no other natural forces which could contribute to clast fracturing. Thus, even a very "primitive" lithic industry made on mediocre-quality rocks showing rough "undiagnostic" flaking excavated from undisturbed cave deposits suggests a cultural origin (e.g., Belle Roche site, Belgium; de Lumley, 1969). This is particularly true if the raw material does not naturally occur in or near the particular cave. Perfectly spherical siderite concretions, originating from the Cretaceous shales in the Rocky Mountains ca. 90 km distant from Eagle Cave, Crownsnest Pass, SW Alberta, found 50 cm beneath the late Wisconsinan glacial deposit, may be another example.

2.2.8 Sub-aerial sediment settings

Sub-aerial (sand and loess) sediments, constituting a part of the mid- and high-latitude periglacial formations, are traditionally associated with a high number of the Palaeolithic sites particularly in Europe and north-central Asia (Siberia). Primary massive or slightly bedded loess-facies display an average size of single grains 30-50 μm . Recognition of the cultural inventories (bone or stone industries) of any size, form and concentration is thus less problematic since, regardless of the artifactual modifications, these *a priori* represent an allocthonous element (manuport) in undisturbed sedimentary contexts evidently brought by people if seen from the geological (sedimentological) viewpoint. Subsequent colluviation processes mixing surficial materials of various genesis and provenance can contribute to an increased sediment heterogeneity and distortion of the original aeolian matrix with a secondary inclusion of other small-size natural clasts (coarse sands to small gravels). This process specifically applies for fossil soil horizons. Palaeolithic sites sealed in sandy and particularly in loessic formations can be located several ten of meters (Chlachula, 2001b), i.e., in the stratigraphic contexts deeply buried underneath the present surface depending on thickness of the particular stratigraphic units reflecting the overall sedimentary dynamics of the catchment area. By applying this logical and elsewhere widely practiced Quaternary geology approach to the New World archaeology, many areas of the extensive loess deposit distribution, particularly along the Pleistocene continental ice margin south of Canada, provide an unexplored niche potentially enclosing many Pleistocene-age occupation sites.

In sum, a proper understanding of geological contexts of pre-Holocene habitation localities represented solely by rudimentary flaked stone inventories is crucial, particularly where no other evidence exists in support of the cultural character of the particular site. This is especially important since the early sites found in a direct, conformably stratified and undisturbed geological contexts, *in situ (sensu stricto)*, are likely to be discovered very rarely. Interdisciplinary contextual studies of depositional environments thus constitute a crucial part of any geoarchaeological research. Unusual or directly unique geo-contexts delivering potential cultural records should not be *a priori* discounted just because they do not fit into the range of well-documented geo-contexts of (more recent) American archaeological sites.

2.3 Analytical rock-flaking studies

In addition to contextual geological investigations, studies on physical properties of rocks constitute an integral part of Palaeo-American geoarchaeology. A logically-structured analytical methodological framework for a critical assessment of a potential Palaeolithic stone industry should comply with a specific depositional context, particularly if the lithic record represents the only alleged cultural manifestation. An adequate knowledge of physical properties of particular clastic rocks and minerals in their natural depositional environment as a potential source of prehistoric raw material exploitation is one of the primary and key requirements for determining the cultural origin of a lithic assemblage.

2.3.1 Physical properties of raw material

Structural strength of a specific lithic raw material is to be tested in terms of its ability to resist deformation by tensile, shear and compressive stresses. Especially in glacial and mass-wasting sediments, a study of once-active frictional forces at the contact between bedrock (or underlying geological materials) and the transported deposits may provide information about the potential of natural fracturing of individual clasts. Other aspects of the structural analysis relate to the mode and frequency of modification (i.e., breaking, crushing, chipping, cracking, grinding, polishing) identified in a local depositional setting, and the resulting dominant clast surface patterning (fissures, striations, grooves, etc.). The latter study aspects are especially useful by reconstructing the history of the clastic deposits in terms of geology provenance and transport mechanism, and the character of the most recent depositional processes imposed on the rock surface. Similarly, the actual state of weathering, textural homogeneity, and other physical aspects should be included in every comprehensive study. Geological context of a lithic collection becomes important in determining if nature might have had the probable capacity of fracturing the specific lithic sample, especially in a direct percussive manner (Patterson, 1983). This analytical field of study deserves much attention in frame of the earliest New World prehistory linked to the initial peopling of the Americas.

2.3.2 Experimental and functional analysis

Detailed technological analyses and experimental flaking is necessary for an independent critical assessment of a possible cultural origin of rudimentary modified lithics from buried geological contexts. Both analytical aspects imply a testing of the available raw material, including the production of stone tool replicas by using indigenous, deposit-forming rocks, and their comparison with possible artifactual specimens. Experimentation must be carried

out on a variety of available raw materials occurring in the local deposits within the entire size range and physical qualities of clasts in order to deduce the cultural technological stone-flaking limits and the degree and modes of potential cultural adaptation in working the particular raw material. Finally, comparative studies on (cobble/pebble-sized) support-reduction flaking, retouching, utilization traces and degree of overall standardization of the resulting sample with applying specific stone-flaking procedures is of principal importance. Experiments in rock fracturing implemented to a variety of clastic raw materials for specific depositional environments, observations on naturally broken clasts of a very ancient (pre-Quaternary) geological provenance and comparative simulations of damage patterns can provide very important analytical proxy data. It is evident that the potential of fluvial and alluvial depositional settings for direct percussion is strongly overestimated without any reasonable grounds (Kuenen, 1956; Schumm & Stevens, 1972). As a matter of fact, the majority of clasts in gravel beds are broken by pressure of overburden without additional marginal artifact-simulated flaking, whereas the principal factor of the syndepositional clast modification is rolling leading to gradual shape reduction of coarse fluvial clastic materials.

Since natural forces act in a random manner, the resulting stone (clast) modification features are arranged in irregular patterns. In demonstrating the artifactuality of a lithic assemblage, it is necessary to document all consistent and progressive modification traits separately for the clastic rock or its fragment, pre-form and the final product (the stone tool). Although many elaborate geofacts may also occur in natural, high-energy settings, they are generally characterized by a rather limited number of casual morphological forms arranged in chaotic and random manner differing from the logically placed and recurrent functional working edges of authentic stone tools. Thus, a frequency of the repeatedly occurring lithic forms with identical flaking patterns is a very important factor to support the cultural origin of the scrutinized sample. Solely technological criteria, as well as the use of individual "diagnostic" attributes are, however, only of limited value. "Objective" statistical evaluations such as by chi-square tests will, because of their nature, discard even perfectly-shaped single stone tools if these do not reach the "quantitatively significant" values (Gillespie et al., 2004).

Finally, use-wear analysis is a very useful technique in assessing the likely function of a particular tool (Beyries, 1988), but also the authenticity itself of a cultural lithic specimen as humanly produced and/or used (e.g., d'Erico 1985; Vaugham, 1985; Grace, 1996). The application of the use-wear analysis may be considerably limited by the fact that during re-deposition processes of a particular lithic assemblage, microscopic as well as macroscopic utilization traces may be effaced by rolling and abrasion (e.g., Knutson, 1988). Another main controlling factor is the specific physical quality of a raw material. Distinction of patterned, non-accidental micro-flaking from accidental "pseudo-retouch" randomly distributed on morphologically functionless edges should be reliably determined in most cases.

2.3.3 Natural/cultural stone flaking

Criteria specifying "diagnostic" flaking patterns of early prehistoric stone industries, and distinguishing them from naturally induced fractures in a particular geological context, are only exceptionally a part of a description of the alleged culturally modified lithic collections. In both the Old and the New World, only a few attempts were made to address this issue (e.g., Dies, 1981; Patterson, 1983; Schnurrenberger & Bryan, 1985; Peacock, 1991). Most of those, however, concern very fine-grained, high-quality isotropic raw materials, and some of

the defined attributes may not be observable on coarse-grained rocks and minerals. It is therefore imperative to derive *a priori* specific stone flaking criteria for the particular lithic assemblages, as any uncritical generalization may be rather misleading and non-objective.

Authenticity of the Late Pleistocene Palaeolithic stone industries (Fig. 5) from the investigated "pre-glacial" Canadian sites is based on a rigorous quantitative and qualitative comparison of the stone tools and artifacts with geofacts (pseudo-artifacts) naturally produced from the present fluvial and glacial environments from the broader study area, the analogous Holocene-age Indian industries from the surface context and the experimental stone tool specimens. The identical raw material in all data sets contributes to the objectivity of the study in terms of a general scheme of the nature and arrangement of flaking patterns, and the specific edge modification (flaking, retouching). Surface texture, i.e., the range of features found on the surface of flaked specimens, is considered to be equally informative.

2.3.4 Artifact-diagnostic stone flaking attributes: General aspects

The Palaeolithic stone tool assemblages from western Alberta are characterized by specific flaking and edge retouching features, which proved to be absent in patterned associations in any of the comparative and naturally-produced clastic rock assemblages (Fig. 4) of identical geological origin and mechanical properties. In respect to their dominant occurrence in the unequivocal stone industries made on quartzite cobbles, these specific formal, textural and edge-modification attributes are considered to be diagnostic for the cultural flaking of the tested lithic assemblages, especially if they occur in identical patterned combinations of the Palaeolithic as well as Holocene Indian sites (Chlachula & LeBlanc, 1996). In both the flake- and the cobble-core – stone industry components, the cultural nature of modification is well-documented if several independent early technological stone flaking procedures are present. However, none of the particular attributes defined as "diagnostic" can be considered as a reliable cultural indicator if found in isolation on flaked lithics. The cultural nature of any recorded and presumably cultural lithic specimens from the Pleistocene-age glacial and glaciogenic sections is inferred on the basis of their *recurrent patterning* in the assemblage.

The artifactual nature of the lithic assemblages from the Late Pleistocene sites in Alberta, the Bow Valley sites, is based on the following general criteria (Chlachula, 1994a):

- a. regularity and control of flaking (Figs 5A-E, 11A);
- b. recurrent and technologically coherent patterns of modification (Fig. 12);
- c. standardized size range of the resulting forms;
- d. presence of a set of associated flaking attributes diagnostic for the Palaeolithic stone tool production (Fig. 6), which are absent in assemblages of identical lithological compositions from glacial and fluvial settings (Fig. 4), despite the similarity of contextual environments.

The association of the above general criteria on flaked clasts in respect to particular geological contexts excludes any possibility of modification of these lithic assemblages by natural forces acting during the accumulation of fluvial and glacial deposits. In view of the characteristic flaking patterns and surface texture on the Bow Valley site's lithic specimens contextually incorporated on top of fluvial gravels below glacial diamictons, the actual working must have occurred *after* deposition of the gravel beds by braided streams and *before* the subsequent disturbance of the fluvial sedimentary context in the superimposed

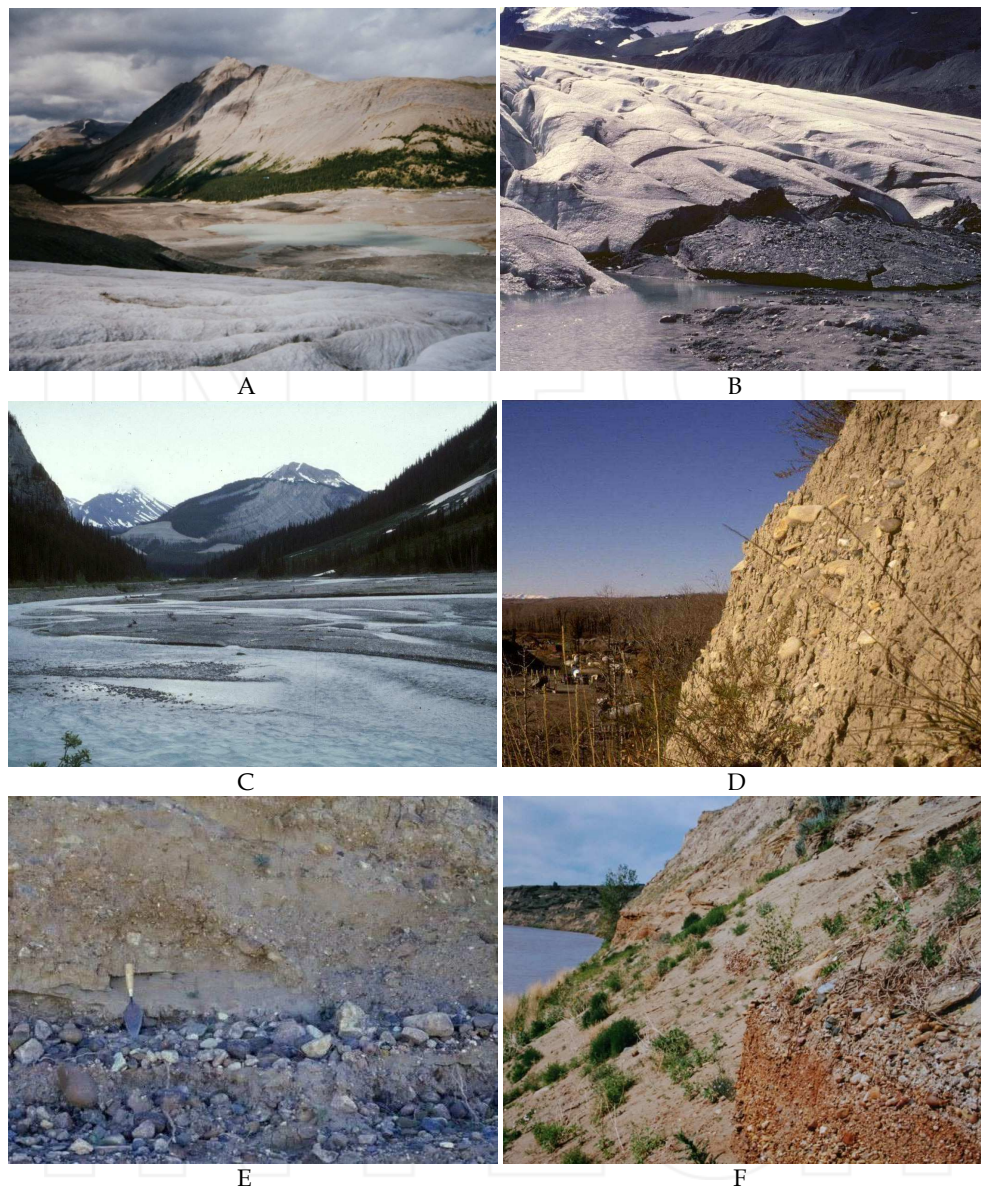


Fig. 4. Past and present natural settings subjected to analyses of natural and cultural clast-modification attributes made on identical raw materials as used for stone tool production: A. rock-fall at the Athabasca glacier, Alberta; B. sub-glacial debris at the Athabasca glacier retreating ice-front; C. braided channels of the upper Bow River; D. the Bow valley till, Calgary, Varsity Estates; E. alluvial gravels washed from a base of a glacial diamicton (South Saskatchewan R.); F. Fe-hydroxide-cemented Late Pleistocene gravel beds (S.Saskatchewan). Unambiguous differentiation of the two study groups (geofacts and artifacts) can be made.



Fig. 5. Some characteristic stone flaking attributes of the Palaeo-American stone industries. A. a unifacial flaking with overlapping negative flake scars (a controlled hard percussion); B. a regular alternating bifacial flaking; C. a unifacial distal-edge retouching on a thick flake (a transverse side-scraper); D. a steep edge retouching on primary cortical flake (end-scraper); E. a regular one-direction faceting (a single-platform cobble-core preparation for a flake extraction); F. concentrated indentation marks on a cobble surface (a cobble hammer-stone). A-C: Silver Springs (pre-last glacial alluvial formation), D-F: Varsity Estates (the till surface).

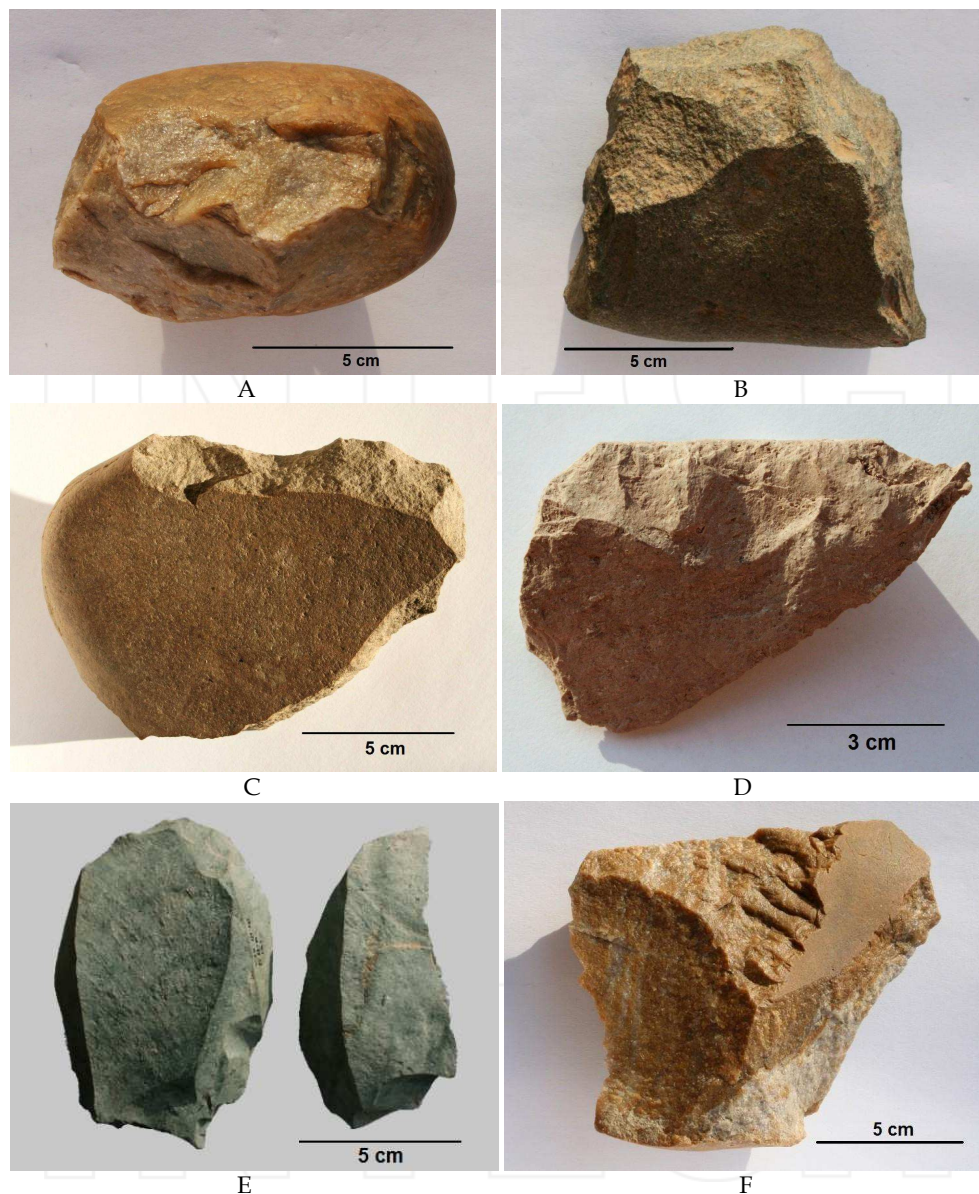


Fig. 6. Examples of the Old World Palaeolithic (A-E) and the prehistoric North American (F) lithic industries made on quartz (A) and quartzite (B-F) with the identical flaking patterns as at the Alberta pre-glacial sites: A. a Lower Palaeolithic bifacial tool (the Dyje River basin, southern Moravia, Czech Rep.); B. a Middle Palaeolithic utilized core (the Kama Basin, Fore-Urals, Russia); C. an Upper Palaeolithic cobble scraper & D. a side-scraped flake (Primorie Region, the Russian Far East); E. retouched /left: burin-scraper/ Upper Palaeolithic flakes (Primorie, the Russian Far East); E. an unmodified flake (the Milk River, southern Alberta, Canada).

glacio-fluvial and glacial environment (Menzies, 2002). Although there are many specimens at the sites which can be easily recognized as tools/artifacts without any formal comparative lithic analysis, the stated criteria address specifically those variably reworked exemplars the cultural authenticity of which could be subject of debate. It is reasonable to argue that their cultural origin might be supported because they are directly associated with an undisputed Palaeolithic industry. In fact, these "less convincing pieces" do not change geoarchaeology implication about the early Palaeo-American settlement of western Canada. The assumption is maintained that if definite stone tools are present, then it is an archaeological site.

In sum, the characteristic artifactual attributes, recurrent technological procedures, patterned typological variability, and a variety of utilization traces clearly document the cultural origin of the pre-last glacial lithic assemblages from the investigated Alberta sites. *The specific mode and intensity of retouching when associated with other diagnostic attributes, and the appearance of distinct tool types produced in patterned technological ways explicitly differentiate the stone industry from naturally fractured clastic materials.* The variety of rock flaking methods on a different technological level and common recurrence of classifiable forms is the most characteristic trait of the authentic stone artifact assemblages (Chlachula & LeBlanc, 1996).

2.3.5 Formal characteristics of the Palaeolithic industries from Alberta

The artifact assemblages from the mapped pre-last glacial sites in Alberta are defined by the most diagnostic technological aspects and corresponding typological forms of stone tool production and lithic inventories that are found in the Eurasian Palaeolithic. Under the term industry is meant a set of lithic instruments chronologically and contextually associated in one technologically and typologically coherent cultural assemblage defined by recurrent tool types produced by a set of specific flaking procedures. The term "Palaeolithic" is used to refer to the particular technological stage as well as the contextually documented Late Pleistocene time interval corresponding to the traditional European and African concept. It must be agreed with the argument that "it is illogical for archaeologists to bar the term Paleolithic from crossing the Bering Strait if the evidence indicates that people bearing simple stone and bone industries of the Old World ancestry entered in Pleistocene times" (Bryan & Gruhn, 1989:83). The term "Palaeolithic" has been avoided in the North American archaeology in order to "preclude any attribution of great antiquity to New World lithic assemblages, as well as any indication of a direct cultural relationship with specific Old World lithic traditions of the Pleistocene" (op. cit.:82).

There is no reason why the lithic industry from the Late Pleistocene sites in Alberta should be formally described and named differently than the analogous lithic assemblages from the Pleistocene contexts in Europe or Siberia, just because they were found in North America (Fig. 6). Since the Late Pleistocene age of the local artifact assemblages is firmly established, this fact entitles to speak about the *Palaeolithic industry* in the traditional culture-historical terms equivalent the Old World concept, where the upper chronological limit is determined by the Pleistocene / Holocene boundary, i.e., 12 000 years ago. From this perspective, the Clovis points are archaeological manifestations of a specific final Pleistocene American Palaeolithic culture as well. The question is not whether or not existence of an American Palaeolithic has been demonstrated, but whether an Old World formal stone tool-classification system can be used in the New World. It is evident that evolutionary pathways were different in the Americas than in the areas of the "classic" Palaeolithic research, but

probably not dissimilar from cultural developments in parts of Siberia and Eastern Asia. Accordingly, in compliance with the Old World Palaeolithic concept, the stone industry from the investigated sites in western Canada includes principal technological elements of "pebble-tool" or core and flake industries dominated by the unifacial flaking techniques, a more elaborate bifacial flaking, a variety of flake-based technologies, and an elaborated blade-extraction stone flaking technique. The typological variety within the stone tool assemblages corresponds to the technological level of their production. In this sense, numerous forms can be found which have direct parallels with the Old World Early, Middle as well as Late Palaeolithic stone tool inventories as it is the case at single Siberian localities. These stone tool forms occur together without any particular association with each other, what is the principal characteristic trait of the Pleistocene artifact assemblages from Alberta.

The "Early Palaeolithic" level of technology includes rudimentary unifacial / bifacial flaking in the form of direct percussion (including an anvil percussion flaking and a bipolar flaking). The "Middle Palaeolithic" technological elements are exemplified in a more specialized polyhedral core preparation. In accordance with the overall technological trend, the application of hard-hammer flaking is also indicated by hammer-stone percussion marks (5F), short flake negative scars on cores, the well-developed bulbs, and the thick basal parts of detached and secondarily retouched flakes. The typical "Late Palaeolithic" technological features are less frequently encountered in the lithic industry, but are nonetheless apparent. This particularly concerns the cores with one or two non-cortical flaking platforms with a series of parallel and well-organized negative blade scars after blade removals, as well as small blade fragments and some micro-blades. Numerous *débitage* recorded at the key Bow Valley locality (Calgary 1) demonstrates that stone flaking actions took place at the very site.

At all the sites, only local clastic raw materials transported by fluvial and glacial processes from the Rocky Mountains area and forming the Quaternary glaciofluvial deposits at the site sections were used for stone tool flaking. An exception is a large, white-patinated flake on a fine-grained quartzite originating from the base of the South Saskatchewan River erosion near Medicine Hat (Fig. 7A). The principal stone tool types of the western Alberta Palaeolithic Complex include a patterned series of unifacially and bifacially flaked choppers, bifaces, specific side-scrapers on fractured cobbles and cobble cores. Typologically variable small scrapers, burins and retouched flakes prevail in the small lithic inventories (Figs 5, 11).

The well-defined and diagnostic artifactual attributes, recurrent technological procedures, the patterned typological variability, and the variety of SEM utilization traces clearly document the cultural origin of these unique lithic assemblages sealed in the pre-last glacial geological formations (>20 000 year BP). The specific modes and intensity of edge retouching associated with other diagnostic attributes of stone working and the appearance of distinct tool types produced in patterned technological sequences explicitly differentiate the lithic industry from naturally fractured clastic materials. The variety of the applied rock flaking procedures, the technological modes and a common recurrence of readily classifiable tool forms is the most characteristic trait of the local lithic artifact assemblages referred to as the Alberta Palaeolithic Complex (Chlachula, 1994a). Because of the patterned contextual geological and spatial geomorphic distribution across the province, the stone industries are clearly part of a *Palaeolithic*, pre-Palaeoindian (>13 000 yr BP.) cultural tradition and not an isolated phenomenon. Further research on the lithic artifact / geofact differentiation criteria may significantly contribute not only to resolving questions about the antiquity of human culture in the Americas, but also the early human dispersal in the Old World.

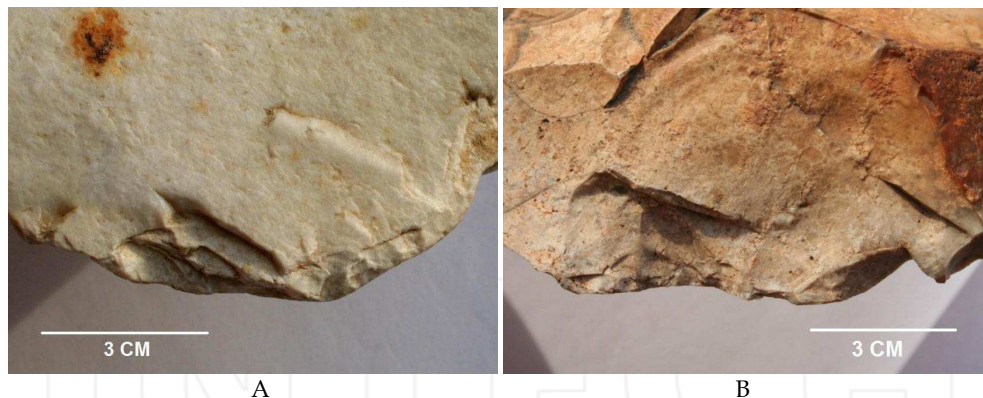


Fig. 7. Anthropogenically worked and utilized edges of quartzite stone tools with cut-marks. A: a flake /utilized core from pre-glacial gravels (the Oldman River Site near Medicine Hat); B: a handaxe from a prehistoric Indian surface site (the Mohave Desert, southern California).

3. Geoarchaeology of the Palaeolithic (pre-glacial) sites of western Canada

The north-west North America, including Alaska and the adjacent west Canadian provinces (the Yukon Territory, British Columbia and Alberta) have a fundamental bearing for elucidating migration processes, adaptation strategies and environmental contexts of the Pleistocene expansion of Palaeolithic people from Siberia, the Far East and the northern Russian Arctic areas into the New World. Interactions of past climate change and a regional relief modeling by cyclic glaciations and related eustatic sea-water fluctuations controlled transformations of the East Beringian Pleistocene ecosystems. Dynamics of the Late Quaternary landscape development and the extent of lands allowing a free passage ultimately governed timing and the spatial distribution of the Palaeo-American occupation in the new territories (Fig. 1).

The contextual geology, palaeoecology and palaeontology records from the investigated pre-glacial archaeological sites and the deeply-stratified geological sections of glacial and non-glacial deposits provide evidence of pronounced (palaeo)environmental and biotic shifts triggered by the global climate evolution and the time-related glacial and interglacial geomorphic processes (Brigham-Grette, 2001). The Quaternary climatic cycles regulated the spatial and temporal movements of prehistoric people migrating from the high latitudes of NE Asia through Chukotka and the Bering Strait / the continental land-bridge. Integrated palaeoecology multi-proxy databases document trajectories of evidently a complex and long occupation history of this extensive, but still a very marginally explored part of the World.

The term “pre-glacial”, with a direct chronostratigraphic connotation (Chlachula 1996a,1996b), refers to the human occupation sites positioned stratigraphically under the last glacial deposits and, more specifically, pre-dating the Last Glacial Maximum (21 000 yr BP). Discoveries of these sites in the patterned geological settings provided definite evidence for the Palaeo-American occupation in this part of North America within the postulated “ice-free” corridor area and pre-dating the “Clovis-horizon” (ca. 13 000-12 000 yr BP) associated with the Final Pleistocene cultural development on the Great Interior Plains. The Canadian Palaeolithic sites are sealed by thick (10-50 m) last glacial deposits accumulated under or

close to the continental Laurentide ice-sheet or the Cordilleran valley glaciers during the last glacial stage (24 000-12 000 yr BP). These occupation sites are unparalleled in the Americas in respect to their rather exceptional geological contexts, *a priori* fixing the Late Pleistocene age. Systematic geoarchaeology investigations delivered evidence of a previously fully unknown American Palaeolithic tradition inhabiting the Pleistocene Western Canadian Plains and the adjacent Rocky Mountain Foothills as manifested by *in-situ* recorded stone tools reminiscent of the NE Asian Middle and Upper Palaeolithic cultures.

At the present time, there are several localities in the western part of the province of Alberta distributed in the river (and former glacial) valleys east of the Rocky Mountains over a broad territory extending ca. 1,500 km from north to south (Fig.1). Geologically, the buried early Palaeo-American occupation sites are characterized by the patterned contextual stratigraphic (and palaeoenvironmental) location with the archaeological finds buried under the last glacial deposits (glacial diamictons and associated proglacial and glacio-lacustrine sediments) related either to the Cordilleran glaciation (Calgary Sites 1-3) or the Laurentide glaciation (Grimshaw, Villeneuve, Edmonton, Medicine Hat, Lethbridge) (Chlachula, 1997; Chlachula & Leslie 1998; Chlachula, unpublished data). The key sites in the Bow Valley (Calgary 1-3) (Chlachula, 1996a) represent the most significant and best-studied Palaeolithic locality in Alberta with fundamental palaeoenvironmental and palaeogeographic contextual implications on the last glacial history of the "ice-free corridor" (Chlachula, 2002, 2003).

3.1 Geography and natural setting of the study area

The south-western margin of the Interior Canadian Plains, being the principal study area, is formed by a gently rolling terrain rising from 900 m asl in the east to 1200 m asl. in the west at the Rocky Mountains front. The open landscape is transected by deeply incised valleys with drainage pattern oriented in the W-E/SW-NE direction following the continental slope (Fig. 10A-B). To the west across the foothills, the Eastern Cordillera Range creates a natural boundary with maximum elevations above 3000 m asl. Most of the surficial geology cover is formed by unconsolidated Late Pleistocene deposits of non-glacial as well as glacial origin (Moran, 1986; Jackson, 1987; Fulton et al., 1986; Fulton, 1986). The earlier Quaternary fluvial sediments are distributed on high plateaus and local uplands, and occasionally fill bottoms of pre-glacial valleys. Most of the area is covered by grasslands with isolated communities of scrub (mainly aspen and willow) in the river valleys. Parklands with spruce and poplar are distributed in the foothills; boreal coniferous forest dominated by pine and spruce in the Rocky Mountains, with alpine meadow vegetation at the higher elevations (Fig. 2E-F).

Quaternary climate fluctuations and geomorphic processes modeled the present topography of relief. Originally broad and shallow river valleys were carved by glaciers and subsequently filled up with glacial, glacio-fluvial and glacio-lacustrine deposits. During the ice-advances as well as ice-retreats, proglacial and periglacial lakes formed in former fluvial basins and local topographic depressions. In the interglacial and interstadial periods, rivers largely re-established their original drainage patterns, or partly shifted their flow into newly excavated valleys scoured by glaciers. The characteristic hummocky terrain, covering a large part of the western prairie, developed during the latest deglaciation. Repeated erosion of the former surficial deposits of various pre-Quaternary ages and genesis as well as large-scale excavations of bedrock formed of unconsolidated shale exposed by glacial-scouring during glacial advances accumulated massive quantities of glacigenic (mostly till and glacial lake)

deposits reaching in places up to several tens of meters per a glacial advance (Figs 3C, 4D). These fine matrix (sand, silt and clay)-supported tills either of the Cordilleran or Laurentide origin underlain by non-glacial fluvial or proluvial formations (Fig. 4E) are most prominent for the last glacial stage attaining thickness of 5-50 meters depending of a particular location.

All the mapped Palaeolithic sites are located on the western to SW margin of the Interior Canadian Plains east of the Rocky Mountains within a geographically uniform belt of a rolling prairie and open parkland of an altitude of 600-1100 m asl (Figs 1C, 10A). The sites are situated in eroded river sections, 10-100 m high along the former or still active river channel banks affected by erosion (Figs 3, 8). The principal Bow Valley locality comprises a series of natural exposures along the NW-SE oriented northern side of the Bow River, with surface altitude of 1070-1084 m. Two principal places near Calgary with the actively eroding Late Pleistocene-Holocene sections, referred to as Site 1 (Varsity Estates) and Site 2 (Silver Springs) are located 2.5 km apart (with the latter site being farther upstream) within steep sections along the river valley 35-51 m high. Varieties of glacial (moraine), glacio-lacustrine, glaciofluvial, alluvial and colluvial deposits form the local Quaternary geological formations overlying the Tertiary sandstone over the Cretaceous sedimentary rocks (Fig. 8). Most of the surficial materials distributed on the present surface are geologically young, being largely derived during the last glacial (Late Wisconsinan) mountain and continental ice advances (Moran, 1986). Lithology of the coarse clastic deposits (and lithic tools produced from them) is more or less uniform throughout the broader investigated area, comprising mostly rocks derived by fluvial and glacial processes from the nearby Rocky Mountains (Fig. 4C-D).

3.2 Geological context and stratigraphic position of pre-glacial cultural records

The Palaeolithic industry assemblages in the west Alberta prairies and the adjacent Rocky Mountain foothills are recorded in patterned geological contexts defining the "pre-glacial" localities from eroded natural exposures delivering humanly flaked quartzite and carbonate cobbles and flakes exposed by the Holocene river erosions in the Bow, South and North Saskatchewan, Oldman and Peace River basins (Fig. 3). The stratigraphically documented archaeological material was incorporated in various contexts, including stratified non-glacial Late Pleistocene fluvial deposits (Medicine Hat, Lethbridge and Villeneuve sites), partly entrained into the basal part of the overlying glacial diamictons / till (Edmonton-Riverside, Calgary 2 and the Peace River sites), in the top part of a till at the contact with glacial lake deposits (Calgary 1) and possibly within an interstadial facies in a cave setting (Eagle Cave) (Chlachula, 1997). Depth of burial of the particular cultural horizons, some of them associated with fossil fauna, ranges from about -5 to -50 m below the present surface.

The first and principal Palaeolithic locality was found in 1990 during a field survey in the Bow River valley at the SW margin of the Plains about 100 km east of the Canadian Rocky Mountain Front Range (Fig. 10A-B). Two natural exposures extending for 70-100 m 2.5 km apart referred to as the Calgary Site 1 (Varsity Estates) and Site 2 (Silver Springs) are situated on the north side of the valley at the western periphery of the city, at the altitude of 1070-1085 m asl. During the early postglacial, the valley wall was exposed by erosion of the Bow River cutting through a series of glaciolacustrine, glacial, and pre-glacial deposits to bedrock to form the present 35-50 m high, cliff-forming slopes. The stone industries are associated in a primary context with the Mid-Wisconsinan fluvial sands and gravels, but also secondarily redeposited at base of the overlying Late Pleistocene glacial diamicton (Site 2)

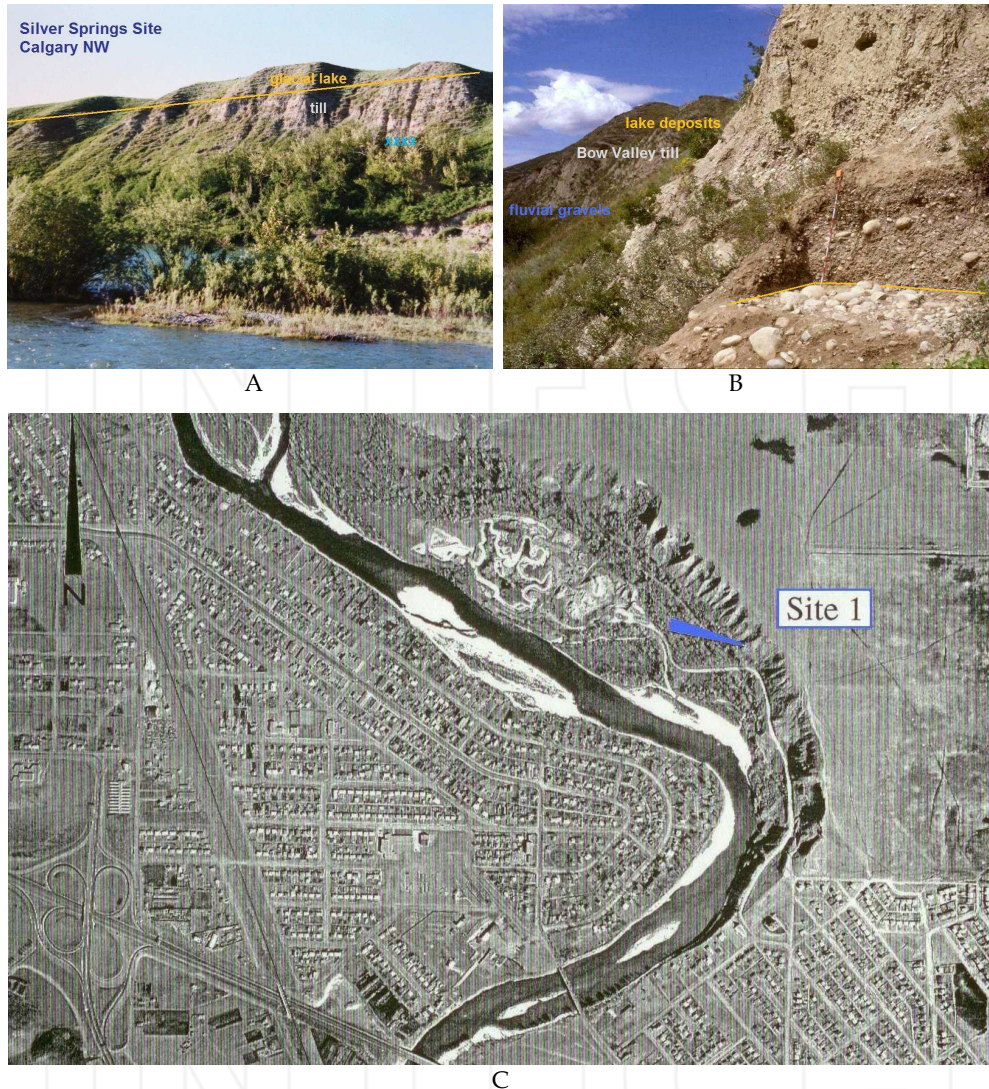


Fig. 8. A. A View of the Silver Springs archaeological site (Calgary Site 2) with the position (xxx) of cultural finds (the section SSW); B. The section stratigraphy and the site excavation with artifacts (ca. 32 ka BP) distributed on top of the mid-last glacial (MIS 3) river gravels and secondarily entrained into the basal part of the overlying till during the Bow Valley ice advance; C. An aerial photograph of the Late Pleistocene sections at the occupation Site 1 (Varsity Estates) exposed above the Bow River valley, Calgary NW, SW Alberta. The flat topography above the slope sections is the bottom of the former Glacial Lake Calgary (dated to ca. 20-13 ka BP) dammed by the Laurentide ice and overlying the Cordilleran Bow Valley till at the Calgary Site 1 (Varsity Estates). More recent (ca. 24-22 ka BP) Palaeolithic artifacts occur at the contact of both geological formation at the depth of -24 m below the top surface.

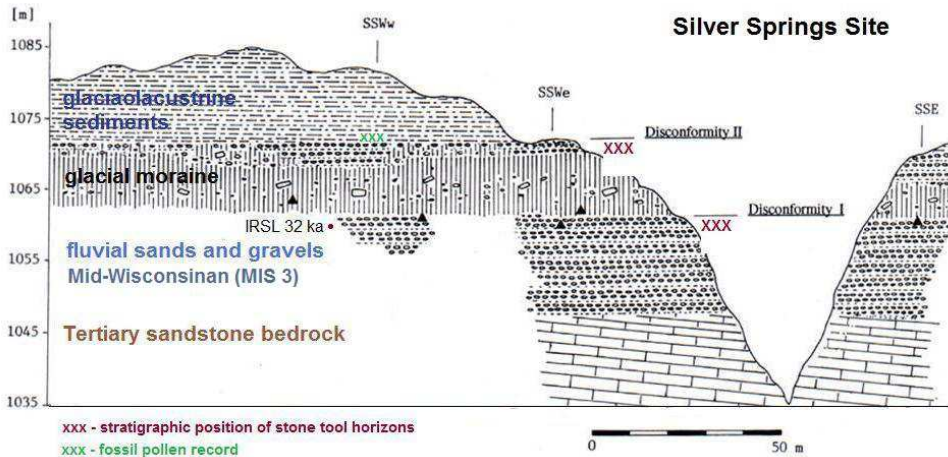


Fig. 9. Stratigraphy of the Late Pleistocene sections at the Silver Springs Site, Calgary NW, with two Palaeolithic occupation horizons – on the top surface of the pre-glacial (MIS 3) gravels and the base of the overlying last glacial Bow valley till (Disconformity I) - *the lower series stone industry*, and on top of the moraine below the Glacial Lake Calgary sediments (Disconformity II) – *the upper series industry*, with fossil pollen of spruce, pine and grasses.

by the Last Glacial / Late Wisconsinan Cordilleran ice advance (23 000 year BP) (Figs 8B, 9). At Site 1, numerous artifacts (100+) with the diagnostic lithic waste resulting from stone-tool manufacturing were found *in situ* (*sensu stricto*) in the 55 m² excavation on the surface of the glacial moraine (till) from an intact and buried context under 24 m of the lacustrine sediments of Glacial Lake Calgary (Figs. 8C, 10C-F)(Chlachula, 1996a, 1996b, 2002, 2003). The best-documented Calgary Site 1, discovered already in 1990, produced the most unique lithic artifacts from an intact place interpreted in view to the lithic assemblage composition as a habitation area – a workshop – delivering stone tools at various stages of their production with the accompanying (micro-) lithic waste / *débitage* retrieved by floating.

In spite of, at the moment of discovery, the very unexpected geological contextual position of undoubted Palaeolithic tools at the top of the Cordilleran Bow Valley till beneath thick glacio-lacustrine sediments of Glacial Lake Calgary (24 m below the present ground and 23 m above the Bow River), this was confirmed by controlled excavations in the places, where the most eloquent find – a bifacial stone tool – reminiscent of typical handaxes, was found (Fig.11A). The original assemblage of 22 artifacts, including 3 finished tools and 2 cores was embedded in the top of the gravely till within a cohesive clayey matrix at the contact with the overlying lake deposits. Most of the lithic assemblage included 17 small flakes, which could have been partly fitted back on to the biface made from a flat quartzite cobble. At the Calgary Site 2, discovered in 1991, similar percussion-flaked artifacts were found in the basal part of the same glacial deposit (Bow Valley till), and in the underlying river gravels. A site-specific geoarchaeology-glacial geology was implemented during the subsequent geoarchaeology investigations in 1993-98 by expanding to final 60 m² of the total excavated area at the Calgary Palaeo-American Palaeolithic locality (a final report in preparation).

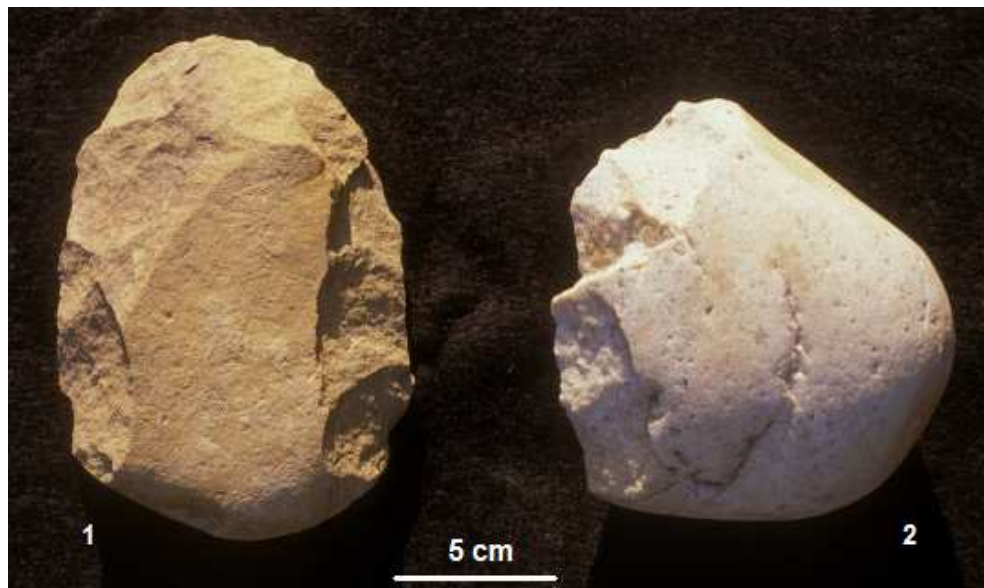


Fig. 10. Calgary Site 1 (Varsity Estates). A. The site location in the western Alberta foothills; B. The Bow valley view from the site top surface (a former bottom of Glacial Lake Calgary); C. The site view above the Bow River; D. The site excavation with the Palaeo-American occupation horizon (>20 000 yr BP) on top of the Late Wisconsin Cordilleran Bow Valley till underneath of 24 m of glacial lake deposits; E. End-scraper on a flaked quartzite cobble on top of the glacial diamicton; F. A quartzite hammer-stone with concentrated percussion marks (indicated by arrow) sealed *in situ* at the contact of the till and the glacial lake clays.

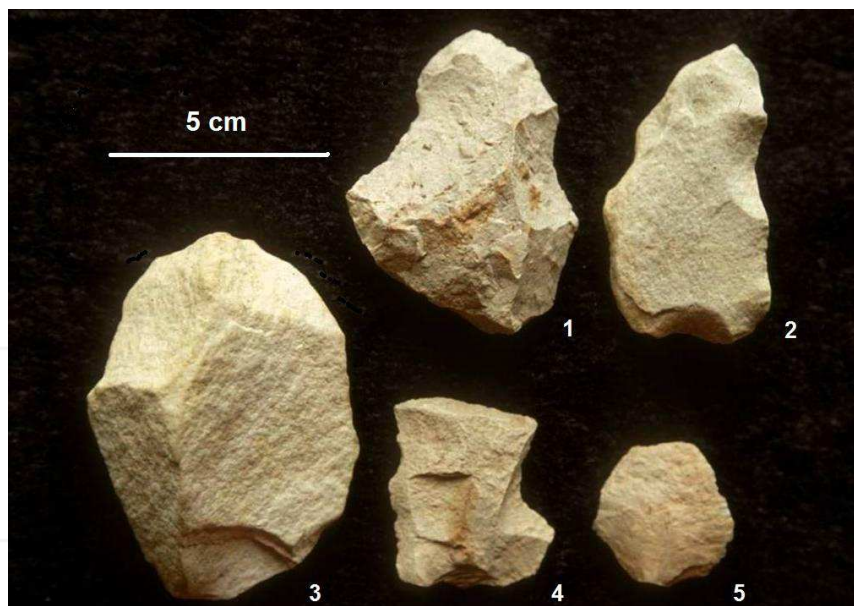
The stratigraphic sequence from the Bow Valley sites, providing a straightforward evidence of the Late Pleistocene peopling of western Canada, documents a model succession of alluvial facies in the lower part of the composite geological site profile into glacial and glaciofluvial facies in the middle sections, as a result of a gradual establishment of full glacial conditions in the former Bow Valley (Fig. 9). The reconstructed general sedimentary facies model illustrates one glacial cycle with an ice advance and retreat. The basal fluvial or proglacial complexes at Site 2 (*Facies Association 1*) were formed during the (Bow valley) ice advance stage; the glacial deposits (*Facies Association 2*) during maximum glaciation, while the overlain proglacial sands and gravels (*Facies Association 3*) document the retreat phase. Two main unconformities, defined as the major chronostratigraphic hiatuses of the regional Late Pleistocene glacial history, were identified. *Disconformity I* relates to the time interval elapsed between the accumulation of the uppermost (glacio)fluvial gravels and their burial by the Cordilleran till during the Bow Valley ice advance. Deposition of the glaciolacustrine sediments in the upper part of the study exposures (*Facies Association 4*) at Site 1 is linked with the subsequent Laurentide glaciation reaching down to the present NE Calgary area. *Disconformity II* then relates to the temporal hiatus elapsed between the two (mountain and continental) glacial events. Both unconformities, associated with past open environments, corroborate with the stratigraphic positions of the cultural horizons, implying two episodes of the Palaeo-American occupation of the upper Bow River valley, with the earlier at Site 2 (Silver Springs and Bowmont), and the later at Site 1 (Varsity Estates). Age assessment of the locality is based on the chronostratigraphic correlation of the stone industry-bearing layers with the regional Quaternary geology scheme (Chlachula, 1996a). An IRSL date of 32 ka BP from a fine sand deposit just above the older Palaeolithic industry-bearing horizon at Site 2 indicates the Mid-Wisconsin timing of the original Bow valley occupation (Chlachula, 2002).

3.3 Palaeolithic cultural evidence

The artifacts at the Calgary sites are made from local quartzite and hard siltstone cobbles collected by early people at both locations from the Mid-Wisconsinan river gravels and from the top surface of a gravelly Bow valley moraine after the ice retreat at the Site 1. The stone flaking technology is not uniform, but repeated in the patterned occurrences on specific tool types, produced and used in the same or a very similar functional manner. A simple, direct, hard-percussion flaking, using a cobble hammer-stone, was the dominant technique (Fig. 5). A bipolar (bi-directional) flaking also was frequently applied. A typical soft-hammer stone percussion technology, using bone or wood and characteristic for the Upper Palaeolithic stone flaking, is documented by few cores with a single flaking platform and unidirectional, parallel blade removals. The formal typology of the artifact assemblages consists of a variety of typical "pebble tools," including unifacial and bifacial choppers (Figs 5A, 11A-2, 12C), bifaces (Fig. 11A-1), as well as specific massive scrapers produced on large cobble fragments fractured by an anvil percussion technique and meticulously edge-retouched (Fig. 12B). Flakes were worked into side-scrapers (Figs 5C, 12A) and end-scrapers (including typical carinate forms analogous to those found in the Upper Palaeolithic in Europe or Siberia) (Figs 5D, 11B-3), and simple burins. A particular stone tool type is represented by small (1-5 cm), edge-retouched pointed tools (Fig. 11B-2). Overall, the Palaeo-American collections from the Bow Valley sites display a very close technological level and a typological repertoire typical of the Late Pleistocene industries of north-eastern Eurasia (Chlachula, 1996a, 1996b, 1997). Analogous stone-working techniques are present at the other Late Pleistocene Alberta sites.



A



B

Fig. 11. Varsity Estate Site. A: bifacial tools from the excavation on top of the Bow moraine. B: a comparative quartzite flake artifact assemblage (2-3 Calgary Site 1 - Varsity Estates; 1, 4-5 Ondratice, an early Upper Palaeolithic site in southern Moravia, central Europe /Svoboda 1980/) displaying identical technological patterns of quartzite working.

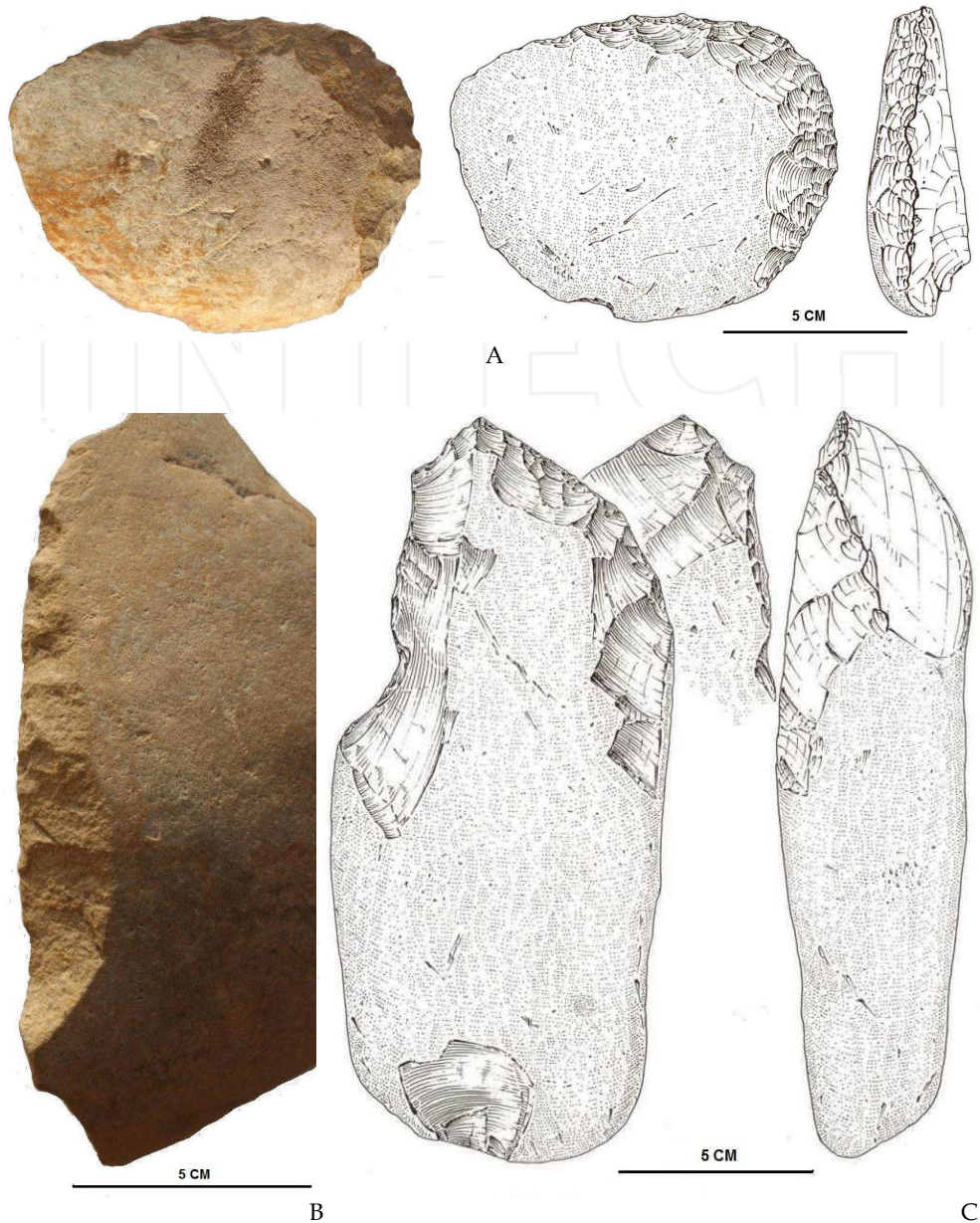


Fig. 12. Silver Springs Site, Calgary (the mid-last glacial alluvial sandy gravel formation). Palaeolithic stone tools made on quartzite flakes (A) and cobbles (B-C). A. a side-scraper on fractured flake; B. a massive uniface scraper on a cobble fractured by an anvil-percussion technique; C. a pointed bifacially worked tool (all photos & drawings by author).

The unequivocal cultural character of the Alberta Palaeolithic stone industries consists of sets of patterned flaking and edge-retouching attributes, which are characteristic of the Old World Palaeolithic stone industries (Fig. 6), but commonly also found in the local Holocene Indian traditions produced on a similar raw material and persisting throughout the prehistory of the western Canadian prairies (Chlachula, 1994b; Chlachula & Le Blanc, 1996). In a detailed comparative study, it was demonstrated that these culture-diagnostic patterns, however, are virtually absent on the lithologically identical rocks naturally found in the area, which were subjected to high-energy fluvial and glacial transport and that could potentially mimic some artifact-like flaking pattern (Chlachula, 1994a) (Fig. 4). Independent SEM analyses of retouched edges of small utilized flakes and tools displaying use-wear utilization marks indicate use for hide, bone and wood processing (Dept. of Anthropology, University of Alberta; Department of Archaeology, Universidad Autónoma Barcelona).

In summary, the defined diagnostic procedures of anthropogenic stone flaking and retouching in association with the distinct tool types produced in patterned technological ways clearly differentiate the local industries from the naturally fractured clastic materials. The west Canadian pre-glacial stone tool assemblages display a variety of applied controlled rock-flaking techniques on different technological levels and a common recurrence of well-classified tool forms. The most characteristic artifactual attributes, recurrent technological procedures, a patterned typological variability, and a variety of the utilization macro- and microscopic traces confirm beyond any doubts the authenticity of the stone tool industries of the Alberta Palaeolithic Complex as also confirmed by many experts in the early lithic technologies of the Old World Palaeolithic as well as the North American Palaeo-Indian archaeology. At this moment it is impossible to draw some definite cultural links to a particular cultural area in East Asia / Siberia since the Alberta's lithic components display a wide range of time-transitional and geographically distributed Palaeolithic stone-tool types.

3.4 Chronology and environments of the pre-glacial sites

The Late Pleistocene age of the mapped Palaeolithic sites in western Alberta is conformed by their "pre-glacial" geological context buried under extensive bodies of glacial till and other glacigenic deposits. The stratigraphic position of the Bow Valley sites separated by the Cordilleran till implies clearly two episodes of the Palaeo-American inhabitation in the area. Reconstructed palaeoenvironments at Site 2 (Silver Springs) indicate a braided river setting during the earlier occupation. Discarded artifacts, subsequently sub-glacially entrained into the glacial deposit document distortion of the earlier human occupation surface by a valley ice emerging from the Rocky Mountain ice-lobe. The Bow Valley glacier is likely to have been confined only to the main valley leaving the surrounding foothills unglaciated. Presumably a temporary terminal ice position, followed by a progressive wastage of the glacier is indicated by the accumulated till deposits that are characteristic of a stagnant and disintegrating ice-front. Although no chronometric control exists for this glacial event, it is most likely (early) Late Wisconsinan (Bobrowsky & Rutter, 1992). This implies the Mid-Wisconsinan (mid-Last Glacial / MIS 3) age for the Palaeo-American occupation. This temporal assessment is corroborated by the IRSL date of 32 000 BP ($\pm 10\%$) on a laminated silty sand unit of the fluvial formation sealing the cultural horizon (Chlachula, 2002).

Following the valley deglaciation caused by climatic warming, people re-occupied the SW Alberta area, presumably after several millennia, as indicated by the analogous stone tools

excavated *in situ* on top of the Bow Valley till at Site 1. This more recent (Late Wisconsinan / late Last Glacial / MIS 2) occupation surface was subsequently buried under 24 m of glaciolacustrine sediments after submergence of the river valley by a proglacial lake (Glacial Lake Calgary) dammed by the Laurentide ice advance from northern Alberta. The chronology of this later (continental) glaciation is extrapolated from the age of fossiliferous fluvial river gravels dated to ca. 40 000-21 000 yr BP in central Alberta near Edmonton ca. 300 km north of Calgary overlain by a till of this continental glaciation (Young et al., 1994). In view to its stratigraphic position beneath the Glacial Lake Calgary sediments, this more recent cultural horizon at Site 1 clearly predates formation of the glacial, ice-marginal basin. Absence of pedogenic weathering of the (till) occupation surface and the fresh appearance of the excavated stone industry suggest that a relatively short time span likely separated the Bow Valley and the later continental glaciation, and that lithic artifacts were discarded not long before the Laurentide ice blocked the Bow River to form the glacial lake. The unique stone tools, recorded in the excavated and spatially limited area with the refitting *débitage* show that the human activity occurred directly at this spot and the archaeological record underwent only minimal disturbances during the site inundation by the glacial lake.

Pollen of sedges (Cyperaceae) and sporadic arboreal taxa (*Pinus* sp. and *Picea* sp.), recorded from the occupation surface at Site 1, indicate a moderately cold, semiarid interstadial climate within a periglacial parkland/steppe tundra setting in a zone of seasonal permafrost. Coniferous forests were distributed throughout Alberta during most of the Mid-Wisconsinan Non-Glacial Interval (65 000-23 000 yr BP). However, pine and spruce were absent in western Alberta during and after the last glacial maximum (Schweger, 1989) and re-colonized the present western Calgary area as late as 10 000 years ago. The temporary Cordilleran glacier advance with the ice front, terminating within the site-location area, seems not to have had a major effect on continuity of the local Palaeolithic inhabitation of the Western Alberta foothills. The glacier evidently disrupted the prehistoric occupation of the valley, but probably did not force people to leave the western Calgary area until the continental ice advance. The two occupation episodes may thus have been separated by only a short time span in a range of several hundred of years or even less.

Despite the absence of fossil remains at the Bow Valley sites, the cultural record shows environmental potential for human colonization of the western Canadian prairies early in the last glacial stage and before that time. The cultural horizon from Site 1 with the palynological evidence does not support the view of an extremely cold, inhospitable glacial environment on the eastern slopes of the Canadian Rocky Mountains throughout the last glacial stage (23 000-12 000 yr BP). Its stratigraphic position also provides an eloquent proof for temporal asynchronicity between the Cordilleran and Laurentide ice during the last glacial maximum in this part of Alberta (Catto & Mandryk, 1990), the area of presumed coalescence of the two ice-masses (Rains et al., 1990). The cultural record from the Calgary sites further suggests that the early prehistoric people were adapted to local periglacial environments. This does not corroborate the idea of an expansive Cordilleran glaciation gradually extending far into the Alberta Foothills and plains or the inability of a Pleistocene American population to survive in an ice-proximal setting. Environmental fluctuations during the early Late Wisconsinan (23 000-21 000 year BP) probably did not affect human occupation in the southern Alberta Foothills until the maximum Laurentide advance over the adjacent southern prairies (ca. 20 000-18 000 year BP). As there are no formal differences

between the lithic assemblages from each site, they are considered to represent one early Palaeo-American tradition with clear links to the Middle and Upper Palaeolithic cultures in Siberia and the Far East. The uniformity of the stone tool assemblages further suggests that the Palaeo-American people maintained more or less the same environmental adaptation.

Because of the explicit and environmentally determinant chronostratigraphy, the Palaeo-American archaeological evidence from the Bow Valley has direct implications for elucidation of the last glacial history and reconstruction of the spatial and temporal configuration of the Cordilleran and the Laurentide ice-sheets in SW Alberta – the loci of the postulated “ice-free” corridor during the last Ice Age. The stratigraphic position of the cultural records shows that the Laurentide ice advance from the north along the continental slope margin damming the Bow River took place when the Cordilleran Bow Valley glacier *had already retreated* farther west towards the Rocky Mountains, outside the present Calgary city limits, opposite to the scenario of an extensive ice-coverage and ice-masse coalescence (Osborn et al., 2000). This ice-free time interval is evidenced explicitly by the *upper series* stone industry excavated *in situ* at the Calgary Site 1. The fresh and unrolled artifacts from the top of the Bow till clearly imply re-occupation of the formerly-settled area in the river valley following wastage of the Cordilleran glacier and preceding the formation of the glacial lake. The stratigraphic and contextual geological positions of the cultural record thus clearly exclude a coalescence of the Cordilleran and Laurentide ice at Calgary during the last glacial maximum, ca. 21 000 yr BP (Moran, 1986), and imply a hiatus between the two glacial events (Fig. 13). The undated time span of 21 000 – 17 000 yr BP allowed time for peopling of SW Alberta even if some parts were covered by ice. In terms of regional conditions during the early last glacial stage, the geo-archaeological evidence suggests more localized glacial advances from the Rocky Mountains in the SW part of the province in the form of piedmont ice-tongues of the Cordilleran ice-cap, restricted to the major valleys cutting the eastern foothill slopes, and a more readily responding to the last glacial climates, instead of a single continental ice-mass covering most of western Alberta. Morphological, textural, and fabric properties of the glacial diamicton facies and the associated proglacial deposits in the mapped sections show intensive mass-wasting processes before and after the terminal position of the Bow Valley ice-front within the area of the palaeogeographic position and the stratigraphic contextual setting of the archaeological locality (Chlachula, 1996a).

3.5 Late Pleistocene ecology of western Canada

The present geoarchaeological evidence from mostly deeply buried sites from pre-glacial and glacigenic geologic formations discovered in a pilot field survey across Alberta (Fig. 1) shows the Palaeolithic inhabitation in the western Canadian prairies at various stages during the Late Pleistocene interstadials and the following the early last glacial (Chlachula & Leslie, 1998; Chlachula, 1997). An alternating pattern of a mosaic parkland-boreal forest expansion during warmer climatic intervals followed by establishment of dry steppe-tundra during glacial stages characterizes the regional environments between 130 000 and 12 000 yr BP. After the early last glacial maximum (ca. 70 000 yr BP), glacial activity was significantly reduced during the mid-last glacial stage (65 000-23 000 yr BP), but a dry land continued to connect for millennia the eastern Chukotka and Alaska because of the low-sea level stands (Hopkins, 1967). During most of that time, a boreal forest cover in the foothills passing into open parkland-steppe in the plains became distributed from Alaska across Yukon, north-

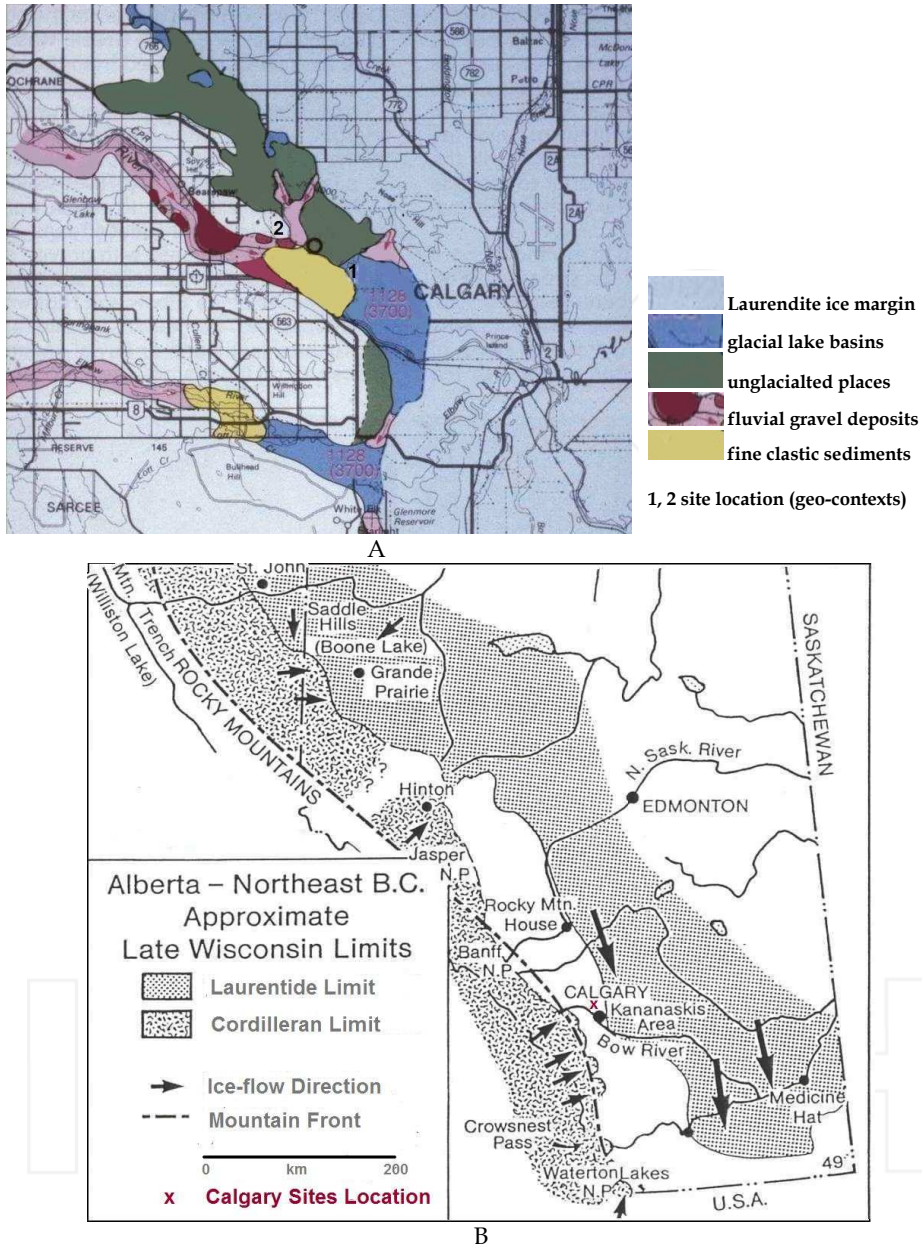


Fig. 13. The last glacial history of the upper Bow River valley. A. Location of the Pleistocene occupation sites at the margin of a glacial lake (Moran, 1986) dammed by the continental ice (ca. 20 000 yr BP) and inundating the former ice-free occupation area; B. The stratigraphic position of the cultural records below the Glacial Lake Calgary beds corroborates the non-coalescence of the Cordilleran and Laurentide ice-masses (cf. Rutter, 1980; Catto et al., 1996).

east British Columbia to western Alberta, providing favorable conditions for movement of Palaeolithic people migrating across the exposed Bering land-bridge and along the eastern side of the Rocky Mountains further south into the interior of North America.

The mid-last glacial (Mid-Wisconsinan) biotic records from the western prairies and the adjoining foothill areas indicate a moderately cool climate with reduced seasonal fluctuations throughout Western Canada. Pollen, fossil plant remains, wood fragments (spruce, pine and birch), molluscs and insect from fossiliferous deposits from the Smoky River ¹⁴C-dated to 43 500-27 400 yr BP show an interstadial setting, similar to the present one, with a mixed coniferous-deciduous forest and average July temperature around 18°C (Liverman et al., 1989). It is possible that spruce and pine, indicative of a moderately cold climate and distributed across western Alberta during most of the long interstadial interval, survived in protected southern locations in the foothills for some time into the early Last Glacial /Late Wisconsinan prior to the Laurentide glaciation of the nearby prairies. The absence of pollen zonation from January Cave in the Livingston Valley, 60 km south-west of Calgary, with a low arboreal pollen component (less than 7 %, and dominated by spruce, pine and some alder, birch and willow), representing a habitat of semi-arid parkland-steppe, indicates environmental stability from ca. 33 000 until 23 000 yr BP (Burns, 1991), temporarily corresponding to the earlier Palaeo-American occupation in the Bow Valley (Calgary Site 2).

The Western Prairies and the adjacent Rocky Mountains were inhabited by a large Rancholabrean fauna, including mammoth, caribou, bison, horse and camel, distributed as fossils in the Middle and Late Wisconsinan deposits from the north-western Yukon across the Rocky Mountain Interior to south-central British Columbia. Faunal exchanges between the northern and southern prairie areas are evidenced by the similar composition of the Late Pleistocene grassland animals from the most prolific fossiliferous sites at Old Crow flats in northern Yukon Territory and at Medicine Hat in southern Alberta (dated by radiocarbon to 28 600-24 500 yr BP), indicating a relatively mild and dry climate (Schweger, 1989). Some species (such as mammoth, giant bison and the Mexican ass) survived in SW Alberta until the very end of the Pleistocene (13 000-12 000 yr BP).

With progressive cooling towards the late Last Glacial stage, mixed boreal forests, discontinuously distributed over the Western Prairies, were replaced by periglacial semiarid herbaceous forest-tundra and steppe-tundra that undoubtedly provided a suitable natural habitat for human occupation, especially in the less densely vegetated mosaic areas and in the river valleys. From Alaska to Alberta, pollen records show sparse tundra vegetation dominated by Cyperaceae, Gramineae and *Artemisia* until about 14 000 yr BP (Clague & MacDonald, 1989; Schweger, 1985). It is evident that the Late Wisconsinan sub-stage cannot be correlated with a single glacial episode, but likely includes several stadial and interstadial intervals witnessed in biotic data. The presence of mammoth and muskox indicates opened parklands over most of western Alberta. Accordingly, the necessary biomass was available at least until about 23 000-21 000 yr BP to sustain the local Palaeolithic groups on the upland prairie east of the Rocky Mountains, especially in more protected settings in the ice-free river valleys in the Foothills. An analogous survival of prehistoric people is assumed in the northern Altay foothills, SW Siberia, because of micro-climate conditions (Chlachula, 2001). The incipient glaciation in SW Alberta, including the Bow Valley, most likely started not earlier as about 21 000 BP, and the extent of the glaciated area was apparently rather limited. Also, is evident that the Late Wisconsinan cannot be correlated with a single glacial episode,

but likely includes several very cold as well as moderate climatic intervals. Independently of the biotic evidence, the geoarchaeological record from Calgary suggests a relatively limited environmental impact of the valley ice on the Palaeo-American occupation and ecological viability of the area prior to the Last Glacial Maximum around ca. 20 000 yr BP. The climate and the mean annual temperature were evidently cooler than at present, although the seasonal climatic shifts were less pronounced. Dry atmospheric streams from the Pacific coast leaving most precipitation in the Cordillera Range analogous to present-day Chinook may have caused significant short-term but regular warming during winters. If and for how a long period of time people could have survived in an inhospitable, harsh, ice-marginal environment under full glacial conditions with sparse tundra vegetation dominated by Cyperaceae, Gramineae and *Artemisia*, lasting until about 14 000 yr BP, is unclear. At that time, they are likely to have moved to more southern areas of the North American plains.

Following the pioneering research at the Calgary locality, a systematic survey for other pre-glacial cultural evidence was conducted covering ca. 10 000 km of surveyed area. Active and up to over 100 m high slope erosions in the major river valley flowing W-E across Alberta, and their main tributaries were surveyed to test the hypothesis that other early sites can be recorded in similar pre-glacial contexts (Fig. 4). The field investigations, locating intact Quaternary sections by using maps and air-photographs, focused on the fine alluvial (presumably mid-last glacial or last interglacial) deposits, some also fossiliferous, beneath the last glacial tills in order to secure *a priori* the relative age of the potentially incorporated archaeological finds. These field investigations resulted in discovery of other Palaeo-American sites across the western part of the province - in the middle Peace River area in the north, the North Saskatchewan River valley in central Alberta, as well as the South Saskatchewan River basin in the south, all in the same stratigraphic position beneath the last glacial Laurentide till related to the continental glaciation, and deeply buried (up to 50 m!) below the present surface (Chlachula & Leslie, 1998; Chlachula, 1997). Together with the Bow Valley sites, this patterned occurrence of the early cultural records clearly shows a geographically broader inhabitation of western Canada prior to the Last Glacial.

Except for the protected river valleys with sites established on south-facing slopes, some cave sites in unglaciated valleys close to the Rocky Mountain front were probably also occupied. A small artifact assemblage on hard limestone cobbles, including a massive side scraper on a large cobble fragment identical with the typical Calgary specimens and several utilized flakes, was found in Eagle Cave in Crowsnest Pass, dated by small mammal bones from the cave filling to 22 700 years BP (Kigoshi et al., 1973; excavation A. Bryan) (Fig. 14).

3.6 The Palaeolithic peopling of North America: A pre-glacial perspective

The evidence from western Alberta shows that Palaeo-American people inhabited parts of Western Canada at latest from the second half of the Mid-Wisconsinan (35 000-24 000 yr BP) and were able to cope with the periglacial environments *prior* to the Last Glacial Maximum. However, a possibility of an earlier occupation during ice-free conditions cannot be ruled out. As an alternative to the former "Clovis-first" model, it is assumed that people arrived to North America much earlier, likely within a natural process of faunal exchanges between the Eurasian and American continents. The new species coming from Eastern Asia in the last large wave during the early Late Pleistocene included, among other, deer, wapiti, caribou, Neogene horse, musk-ox, mountain sheep, pronghorn, porcupine, hare and raccoon.



Fig. 14. A. Eagle Cave - an early occupation site the south-west Alberta Rocky Mountains. B. a bifacially-flaked limestone cobble found with fossil fauna beneath the last glacial till.

Nevertheless, it is unlikely that the prehistoric people were exclusively dependent of the large-game (e.g., mammoth, mastodon, bison) hunting, but practiced more general foraging subsistence activities. The “pre-glacial” cultural discoveries in western Canada imply that the ‘ice-free’ corridor along the eastern Rocky Mountains existed more than once, and, therefore, human and animal migrations, besides non-glacial vegetation cover expansions, happened before the Last Glacial Maximum, and quite conceivably, even earlier than during the Mid-Wisconsinan interstadial interval during the Last Interglacial - sub-stages MIS 5a-d (120 000-74 000 yr BP) not taking into consideration the interglacial climate optimum (MIS 5e; 130 000-120 000 yr BP) with raised sea-water above the present level.

The initial prehistoric colonization of the Americas is seen as a gradual process in the broader ecological context of the Pleistocene Beringia, presumably as an opportunistic infiltration of small hunting and foraging groups from NE Siberia into the new territories. The expanded land bridge, connecting Alaska and Chukotka (Fig. 1A), was available during most of the Late Pleistocene and maintained repeatedly for thousand of years before the Last Glacial Maximum (Frison & Walker, 1988). The presence of Palaeo-American people in the unglaciated area of the Yukon Territory is indicated by flaked lithics and worked bones from Bluefish Caves and possibly by humanly fractured and modified bones from the Old Crow flats (Morlan, 1986; Cinq-Mars, 1990). After entering the New World, physically, it was possible for the Middle-Upper Palaeolithic hunter-gatherers to penetrate further south either along the western coast (Gruhn, 1989) or the eastern flanks of the Rocky Mountains during most of the Middle Wisconsinan interstadial interval (65 000-24 000 yr BP) (Fig. 1C).

Mixed boreal forests, discontinuously distributed over the western prairies during the mid-glacial interstadial interval and herbaceous forest-tundra and steppe-tundra during the early last glacial stage undoubtedly provided a suitable habitat for human occupation, especially in the less densely vegetated mosaic plain settings and in the river valleys. Fossil remains of mammoth and musk-ox point to opened parklands over large parts of western Alberta in corroboration with pollen records until the early Last Glacial. The cultural finds from the Bow Valley themselves precondition inhabitability of the area prior to the LGM with necessary biotic resources. Periglacial steppe was one of most productive Pleistocene biotopes. Naturally protected settings in the ice-free mountain

valleys in the foothills would host favorable ecosystems for the Upper Palaeolithic occupation. The climate and the mean annual temperature were evidently cooler than at present, although the seasonal climatic shifts were probably less pronounced. Periglacial adaptations are evidenced by the cultural records from the polar regions of Siberia as far as 70° N during the later part of the mid-last glacial interstadial dated to 28 000 - 26 000 yr BP (Pitulko et al., 2004). If people could have survived in a marginal environment under full glacial conditions is a matter of discussion.

It is illogical and by any reasoning unfounded to assume just a rather late (Final) Pleistocene peopling of the Americas (Lynch, 1990; Hoffecker et al., 1994; Goebel et al., 2008, etc.), when the Early and Middle Palaeolithic people clearly colonized the vast regions of the adjacent Siberia and the Far East along the Pacific rim long before that time. The Palaeolithic oikumene persisted for hundreds of thousand years on the western side of Beringia, dating back to at least the Middle Pleistocene (730 000-130 000 yr BP) and possibly even earlier (e.g., Medvedev et al., 1990; Mochanov, 1992; Derevianko & Shunkov, 2009; Vasilevskiy, 2008), and concomitantly with the periodic exposures of the land-bridge connecting both continents (Hopkins, 1973). The mapped presence of the Middle and the Upper Palaeolithic occupation sites in the polar regions of Eurasia and along the Arctic coast (Pavlov et al., 2004; Pitulko et al., 2004; Vereschagin, 1977; Mochanov & Fedoseeva, 1996), just demonstrates human adaptation to periglacial environments for at least 40 000 years.

The Late Pleistocene glaciations of the northern Cordilleras had very likely only a temporary effect slowing down the human dispersal into the southern latitudes of the continent. The regional geographic configuration of the mapped Cordilleran, Laurentide and montane glaciers indicates the absence of any obstacle in the form of a major ice body (Catto et al., 1996) that would have prevented dispersal of the Palaeolithic people to North America. By coupling the existence of the land-bridge and the penetrability of the western Canadian prairies alongside the Rocky Mountains during the Late Pleistocene, then people could have freely passed from the western side of Beringia into the interior America without major natural constrains at many times and for many millennia during the Late Pleistocene especially during the climatically moderate interstadial intervals (65 000-24 000 yr BP). The only documented coalescence of the Cordilleran glacier and Laurentide ice sheet during the Last Glacial Maximum in the Athabasca Valley, northwestern Alberta (Bobrowsky & Rutter, 1992) must not have had any direct implication for the occupation of the southern portion of the province and constituted only a major temporal barrier for a southern movement of *later* (Palaeoindian) groups. Re-opening of the "ice-free corridor" in west-central Alberta along the eastern slopes of the Canadian Rocky Mountains at the end of the Last Glacial, sometime between 14 000 and 12 000 yr ago (Rutter, 1980; Liverman et al., 1989), thus should not be considered as a major natural precondition for the "initial" peopling of North America south of Beringia. Evidently, people already occupied this vast area well before that time.

4. Discussion

Although the archaeological studies during the last decade disproved the Clovis tradition as the cultural entity associated with the initial peopling of North America, question about chronology of the initial Palaeo-American migration(s) and the level of technology the early Americans brought with them is still from fat to be resolved. The recent discoveries in the SW United States (Waters et al., 2011) have demonstrated that the Clovis Culture (¹⁴C-dated

to ca. 13 100-12 800 yr BP) is a result of an entirely autochthonous New World culture-historical development analogously as the Dyuktai Culture in the Russian Far East dated to ca. 14 100-13 000 yr BP (Mochanov, 1969). Although the antiquity of presently the earliest in the U.S. - accepted Buttermilk Creek Complex at the Debra site, Texas, has been extended by some two thousand years (to 15 300-13 200 yr BP), the research focus on shallow-subsurface geological contexts of investigations remained (the cultural horizon at the Debra sites lies just at -1 m!). This situation with early sites' visibility is unlikely to change unless adequate geology and geoarchaeology approaches and analytical methods will be implemented in the field survey aimed at the *deeply-buried* Pleistocene occupation sites in the high depositional-rate geographical areas. Also, there is still an unfounded resistance to the notion that there could be anything on the Upper - Middle (or earlier) Palaeolithic technological stage level.

It may be this unwillingness to take seriously into consideration any lithic record from the Pleistocene-age deposits that differs from generally recognized industries, and/or an inadequate professional knowledge and capability to evaluate objectively rudimentarily modified stone artifacts which may altogether be largely responsible for the "controversy" surrounding the earliest American prehistory. This directly reflects the fact that most North American archaeologists lack training in Quaternary geology. What is most important, they do or may not look for the ancient sites in the right, including the deeply-buried Pleistocene geological settings. Not necessarily visibility, but primarily recognition of simply worked lithic records is the main factor which can significantly contribute to new discoveries of very old Palaeo-American sites. Especially the formerly glaciated as well as the extraglacial areas of a high sedimentation input have a major potential and should be systematically surveyed. Recurrent patterns of the "Palaeolithic" stone flaking with knowledge of the diagnostic artifactual attributes and their associations in a particular lithic assemblage is one of the fundamental study criteria, apart of the geological context. On the other hand, the cultural material recorded in its original geological context may provide a significant source of proxy data on the past climates and climate change in some areas of the Northern Hemisphere that experienced the Pleistocene glaciations, in terms of their timing and the geographical extent corresponding to the general concept of paleontological "trace fossils" in historical geology. This approach is routinely practiced in Africa or Eurasia, and search for 10 or 100 m-deep geoarchaeological locations, some of a very high age, may be standard and nothing unusual (e.g. Medvedev et al., 1990; Mochanov, 1992; Chlachula, 2001b). Because of the close ties of archaeology and Quaternary geology, many of the ancient Early or Middle Palaeolithic sites are found during a geological (loess-palaeosol), stratigraphic and/or geophysical mapping.

The dissention about the archaeological expressions and the contextual associations of the Pleistocene New World early prehistoric evidence reflects the absence of an uniform and internationally accepted methodological framework used as a model procedure for evaluating the summary data of the potential pre-Clovis (or "pre-Buttermilk") complexes. This should involve both the field geoarchaeological studies as well as laboratory analyses. Particularly the identification of an early "non-diagnostic" lithic industry in an unusual or unexpected deep stratigraphic geological context may be a complex problem. This, however, cannot be approached only "intellectually," as it has been a common practice, by simply refusing evidence as this does not fit the established historical model or paradigm without providing supporting, own hard data-based scientific arguments. All

the more so if the opponent(s) lack the necessary professional background in the lithic and the contextual geology studies.

The cultural nature of rudimentarily modified artifacts can be established by a set of criteria applied in a simple, but logical sequence. This includes discrimination on lithic specimens of unambiguous modification traits which do not occur in analogous deposits at other places with identical raw materials, and which possess clear attributes encountered on definite stone industries easily replicated by experimental flaking. It must be kept in mind that nature can under certain circumstances also produce some recurrent patterning of rock modification, and any simplistic generalization should be avoided. Rock flaking criteria should, therefore, comply exclusively with the local geo-contextual and sedimentary conditions. Accordingly, correct interpretation of the geological context, and a sufficient knowledge of physical properties of raw material and potential sources of natural edge-wear are of utmost significance. An exclusive reliance on formal morphological resemblances with Palaeolithic tool types, or a presumed lithic technology should be avoided. Nevertheless, the diverse Old World Palaeolithic collections can be used only as proxy data. Finally, the overall quality of presentation with clear description and detailed documentation of (archaeological) material, completely assembled contextual data, and their critical evaluation are equally important.

As the fundamental issue in the early American prehistoric geoarchaeology field research concerns the recognition of artifactually flaked lithics in deep geological contexts, implementation of adequate techniques of study is prerequisite. These should not be limited just to (at best statistical) determining the degree of probability of the cultural status of a particular lithic assemblage, but its authenticity should be explicitly qualitatively assessed. Geomorphological, sedimentological, petrographical and rock-mechanical investigations, combining both field observations and analytical laboratory expertise play a crucial role. Dynamics of a depositional environment should be studied in order to determine the actual potential for natural modification of a particular lithic material. Easily accessible deposits with naturally fractured rocks of old geological ages can be used for a control testing. All these and other study aspects are especially vital for the possible Palaeolithic assemblages found without association with any other archaeological record or cultural features. This, however, is not possible without a broad multidisciplinary approach following more than one line of supporting evidence. It is very important to pursue such approach, not only for elucidation of the earliest American (as well as Siberian) prehistory, but also for a further development of field as well as analytical methods, which can also be applied in other parts of the World in similar study contexts and for the same ultimate research goals (Fig. 15).

Although the principal above-discussed „pre-glacial” sites near Calgary are unique among all the early American sites in view of the unusual glacialigenic geological contexts, antiquity as well as the archaeological manifestations, there is a striking parallel from western Europe -- the Lower Palaeolithic site at High Lodge, England, with flaked flint artifacts distributed in the Anglian till as a result of glacial transport (Ashton et al., 1992). This Middle Pleistocene occupation locality, stratigraphically estimated to date to ca. 0.5 Ma and formerly established in a riverine setting, was subsequently overridden by the Anglian ice, causing a subglacial entrainment of the flint artifacts secondarily distributed in the till, i.e., experiencing the identical post-depositional geological process as the Bow Valley sites.



Fig. 15. The Calgary prehistory: A: The Late Pleistocene site (Varsity Estates) with the exposed occupation horizon on top of the Bow Valley till stratigraphically - 24 m below the present top surface (B). B: A Holocene-age Indian site (Calgary Bowmont) with tepee rings and stone tools excavated in shallow (-30 cm) cultural layers on top of the Bow valley cliff. An illustrative example of *different* field investigation approaches in *different* geological and geoarchaeological contexts delivering the chronologically *different* cultural evidence on early inhabitation of a particular study area. For the early sites, it must be searched in the deeply buried geological formations that are extensively distributed across the province of Alberta.

5. Conclusion

Glacial and glacial deposits of diverse geological genesis of the Pleistocene glacial stages are extensively distributed over vast areas of the mid- and high latitudes of Eurasia as well as North and South America. These deposits and the underlying non-glacial interstadial and interglacial formations have proven to incorporate cultural materials that would normally be unexpected by most archaeologists. Particularly in North America, where archaeology has developed in frame of cultural anthropology based on Indian or other recent aboriginal ethnological studies, the ties to Quaternary geology have been historically rather marginal contrary to the Old World and the Siberian archaeology (Chlachula, 2011). Accordingly, the overwhelming survey approaches and the associated field prospection techniques focus more or less just on the Holocene cultural manifestations visible on the present surface (such as tepee stone rings or scatters of lithics or ceramic fragments) (Fig. 15B), and sealed in the shallow-buried geological contexts. This fact is rather absurd, since very massive and deeply stratified Quaternary formations, the Late Pleistocene in particular where the earliest human traces in North America would be logically most anticipated, are distributed in the very area of the presumed continental passage of prehistoric immigrants on their way from NE Asia.

Until the early 1990's, these Quaternary formations, exposed in many and easily accessible and geologically readable sections, some of them fossiliferous, were totally out of any geoarchaeological survey and research interest until the discovery of the "pre-glacial" cultural horizons at the Calgary / Bow Valley locality. The following pilot geoarchaeological investigations in western Alberta resulted in the locating several other anthropogenic sites in the same geological / palaeoenvironmental settings, thus providing definite, unequivocal evidence of the existence of the Palaeo-American peopling of western interior Canada long before the emergence of the Final Pleistocene (Palaeoindian) cultures. Based on a critical multidisciplinary examination of the archaeological as well as geological data, the Bow Valley with other Alberta localities are contextually the first Pleistocene - Palaeolithic sites in America discovered below glacial deposits, although close parallels come from Europe as well as the North Russian Arctic (Ashton et al., 1992, Laukhin, 1991, Pitulko et al. 2004).

The term "Palaeolithic," applied for the "pre-glacial" stone tool assemblages from western Canada, is used to refer to the particular technological stone flaking stage as well as the time period corresponding to the traditional Old World culture-historical concept. These early cultural records, representing *de facto* "trace fossils", may also significantly contribute as palaeoenvironmental proxy data to mapping of past climatic events and reconstructions of Quaternary environments. Even if obtained from a concise geographic area, but a clear geological context, such early cultural records may have definite local as well as regional implications. Realization that the American *Palaeolithic* sites, potentially of considerable antiquity, can be found in similar (pre-)glacial geological settings and introduction of the adequate geoarchaeological site-survey techniques, have crucial relevance for elucidation of the earliest New World prehistory. Geographically extensive river valley exposures along the eastern slopes of the Canadian Rocky Mountains and the adjacent western plains have an excellent potential for preservation and recovery of such buried early cultural archives.

For *early* sites must be searched in *early* deposits! The pioneering geoarchaeological investigations in Alberta, opening a completely new niche of research in the areas formerly affected by glaciations, show the necessity of implementing the corresponding geological

methodological approaches and research techniques into the earliest prehistoric studies in the formerly glaciated parts of the Americas as well as other regions of Pleistocene Beringia.

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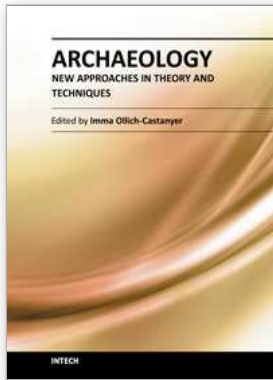
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The contents of this book show the implementation of new methodologies applied to archaeological sites. Chapters have been grouped in four sections: New Approaches About Archaeological Theory and Methodology; The Use of Geophysics on Archaeological Fieldwork; New Applied Techniques - Improving Material Culture and Experimentation; and Sharing Knowledge - Some Proposals Concerning Heritage and Education. Many different research projects, many different scientists and authors from different countries, many different historical times and periods, but only one objective: working together to increase our knowledge of ancient populations through archaeological work. The proposal of this book is to diffuse new methods and techniques developed by scientists to be used in archaeological works. That is the reason why we have thought that a publication on line is the best way of using new technology for sharing knowledge everywhere. Discovering, sharing knowledge, asking questions about our remote past and origins, are in the basis of humanity, and also are in the basis of archaeology as a science.

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