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PALAEOCLIMATIC EVENTS AND HUMAN PALAEOENVIRONMENT OF WESTERN SIBERIA IN THE LATE PLEISTOCENE

ABSTRACT: The paper illustrates the application of the combined use of a palaeoenvironmental Database and GIS technology for analysis of the environmental components and ancient sites in Western Siberia for the time interval from 50,000 to 10,000 radiocarbon years ago. Both geological and archaeological information were used to generate the palaeolandscape maps and to establish the features of the spatial-temporal distribution of Palaeolithic sites.

KEY WORDS: Geoarchaeology – Late Pleistocene palaeoenvironment – Mousterian – Upper Palaeolithic – Western Siberia

INTRODUCTION

The aim of the paper is to examine inter-relations between the natural environment and ancient people on the territory of Western Siberia over the time interval from *ca* 50,000 to 10,000 radiocarbon years ago (BP), a period of rapid and severe environmental changes throughout the Northern hemisphere (*e. g.* Velichko 1984, 1993). Because Late Pleistocene and Early Holocene humans were hunters – gatherers, environmental conditions affected very strongly the people's lifestyle, economy and cultural development. Western Siberia, which incorporates the territory between the Ural Mountains and the Yenisei River including the West Siberian Lowland and the Altai and Sayany Mountains, is a promising area for the study of human-environment interaction because a large body of data is available for both Quaternary geology and archaeology. The palaeoenvironmental Database and Geographic Information System (GIS) technology for data processing and maps generation have been used in order to establish the computer-based approach for geoarchaeological research in Siberia. Also the possible impact of rapid and catastrophic environmental phenomena on human existence has been studied, particularly the settlement distribution patterns.

MATERIAL AND METHODS

As sources of information, both the authors' own data have been used (Panychev 1979, Firsov *et al.* 1985, Orlova, Panychev 1993, Orlova 1995, in print, Levina, Orlova 1993, Zolnikov 1996), and the results published previously by other investigators (Tseitlin 1979, Arkhipov *et al.* 1977, 1980, 1986, 1994, Arkhipov, Volkova 1994, Derevianko *et al.* 1990, Derevianko, Markin 1992, Drozdov *et al.* 1990, Abramova *et al.* 1991, Vasiliev 1992, Goebel 1993, Goebel, Derevianko, Petrin 1993). The Western Siberian Radiocarbon Database, developed in 1995–97 (Orlova *et al.* 1996, in print) has been used for computer processing of the palaeoenvironmental data.

To analyze the Late Pleistocene biotic and non-biotic environmental components and their influences on the spatial and temporal distribution of ancient sites, a Regional

GIS Atlas has been compiled. This Atlas is supported by several software packages, including the GIS "ARC/INFO-ARC/VIEW", the GIS "SOCRAT-GEO" (created at the Novossibirsk Regional Center for GIS Technologies, Siberian Branch of the Russian Academy of Sciences), and the "PARADOX" Database Management System (DBMS). The analytical functions of the GIS Atlas were executed through different types of requests to the "PARADOX" DBMS, and the data processing results are output on worksheets (Zabadaev, Zolnikov 1996). The maps created *(Figures 1–5)* have been used as a basic source for data analysis and interpretation.

RESULTS

Climatostratigraphic periodization of the environmental conditions in the Late Pleistocene of Western Siberia, *ca* 50,000–10,000 BP

To understand the peculiar features of both climatic and environmental changes in the Late Pleistocene, *ca* 50,000–10,000 BP, it is necessary to increase the time scale up to the Middle Holocene (*ca* 5000 BP). This allows to use some palaeoenvironmental situations as analogues. According to the modern conception (Arkhipov, Volkova 1994), the second half of the Late Pleistocene in Western Siberia comprises two main climatic stages, the Karginian Interglacial (*ca* 50,000–23,000 BP) and the Sartan Glaciation (*ca* 23,000–10,000 BP).

The Karginian Interglacial, ca 50,000 – 23,000 BP

For the Early Karginian warming, *ca* 50,000–45,000 BP, palaeoenvironmental conditions are not completely clear. A provisional palaeolandscape reconstruction is presented in *Figure 1*. According to pollen data (*e. g.* Arkhipov, Volkova 1994), the climate was warmer than now or close to the modern one. This may be confirmed by the existence of taiga-like forests in the modern tundra area of the Ob River mouth and Taymyr Peninsula (Arkhipov *et al.* 1977, Kind, Leonov 1982). At *ca* 50,000–45,000 BP, several significant environmental changes had been taking place. They included such phenomena as the degradation of continental glaciers and the exposure of land; the cut-off of glacial lakes; and the formation of fluvial systems. Thus, this period was characterised by rapid geomorphic processes which caused changes of the surface of the northern and central parts of Western Siberia. Evidently, during the only 5000 years it is unlikely to expect the formation of vegetation zones in the northern Western Siberia under such unstable environmental conditions. More probably, the landscapes were quite mosaic-like at that time, and they reflected the dissimilar geological, geomorphic, and cryolithological features.

The Early Karginian cooling, *ca* 45,000–43,000 BP, was characterised by active solifluction processes, the burying of the remains of continental glaciers by colluvial and solifluction deposits, and the conservation of glacier

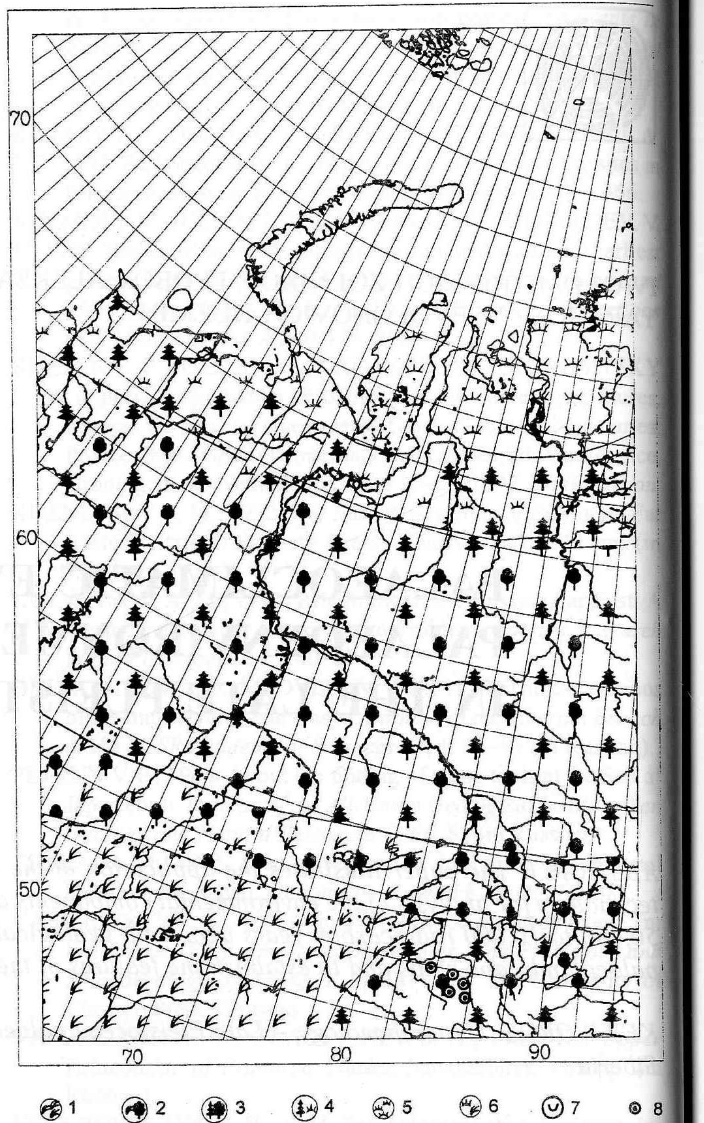

FIGURE 1. The scheme of palaeoenvironment of the Early Karginian (*ca* 50,000–45,000 BP) and the Malaya Kheta (*ca* 43,000–33,000 BP) warmings. 1 – steppe; 2 – forest steppe; 3 – taiga; 4 – forest tundra; 5 – tundra; 6 – "tundra steppe" (periglacial vegetation); 7 – continental and mountain glaciers; 8 – Palaeolithic sites.

remains in underground position under permafrost conditions. The activity of erosional and other geomorphic processes was comparatively low. Because of quite stable conditions of the earth surface in the northern part of Western Siberia, the formation of soils and vegetation cover of tundra and forest tundra had been taking place during *ca* 45,000–43,000 BP.

The climate and vegetation during the Malaya Kheta warming, 43,000–33,000 BP, were similar to the Early Karginian warming *(Figure 1)*. According to the pollen data, it was slightly cooler than now, and the boundaries between principal vegetation zones were little more northwards than today.

The climate during the Konoschelye cooling, 33,000–30,000 BP, was quite severe, of arctic type (Kind 1974).

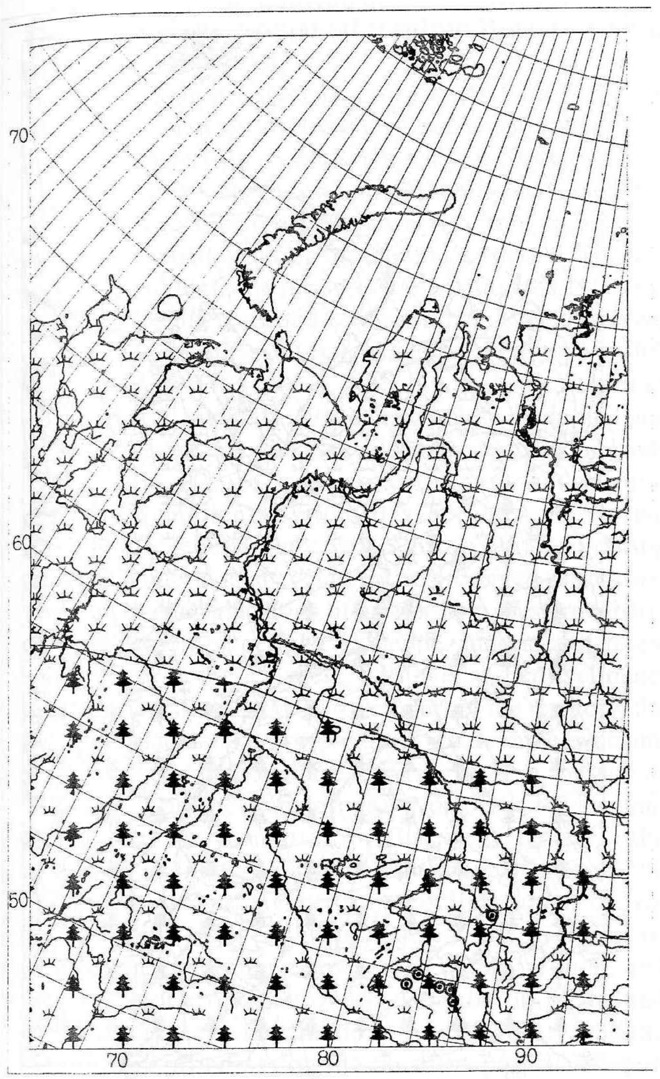

FIGURE 2. The scheme of palaeoenvironment of the Konoschelye cooling (*ca* 33,000–30,000 BP).

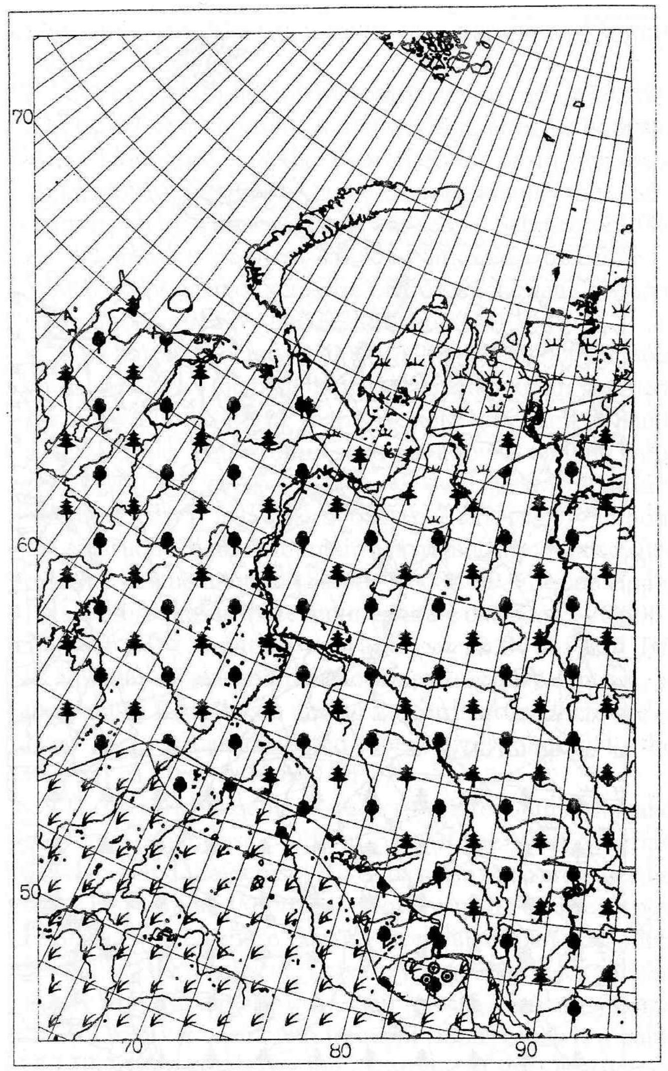

FIGURE 3. The scheme of palaeoenvironment of the Lipovka-Novoselovo warming (*ca* 30,000–23,000 BP).

On the whole territory of Western Siberia, vegetation was represented by two types, 1) tundra – north of 58° northern latitude (N), and 2) forest tundra – south of 58° N (Arkhipov *et al.* 1980) *(Figure 2)*. According to S. A. Arkhipov *et al.* (1977), that period corresponds to the formation of mountain-and-valley glaciers in the northern Ural Mountains, with several bigger glaciers of piedmont type which dammed the Ob River valley near the latitude of Arctic Circle (*ca* 65–66° N).

The vegetation and climate of the Lipovka-Novoselovo warming, *ca* 30,000–23,000 BP *(Figure 3)*, were very close to the Holocene Climatic Optimum.

The Sartan Glaciation, ca 23,000–10,000 BP

The vegetation during that period was represented by three zones, very different from both the interglacial and recent ones *(Figure 4)*. The first type, the periglacial vegetation, occupied the territory south of the continental ice sheet down to the 63° N, and covered almost all the modern forest (taiga) zone. The most typical plants for that zone were wormwood (*Artemisia* sp.) and dwarf birch, along with different cereals (*Poaceae), Licopodium alpinum,* and *Selaginella selaginoides*. The second type of vegetation represented different kinds of arctic tundra. The southern boundary of the tundra zone has been located on 56° N, *ca* 1100 km more southwards than it is today. The third type of vegetation, forest tundra, has been located south of 56° N, on the modern territory of the forest steppe and steppe. Spruce and larch forest occupied the river valleys which drain into the glacial lakes. The southern boundary of the forest tundra zone had been located beyond the Western Siberian Lowland. The climate was cold and dry. The annual mean temperature was approximately by 10° C lower than it is today (Arkhipov, Volkova 1994, Velichko 1993).

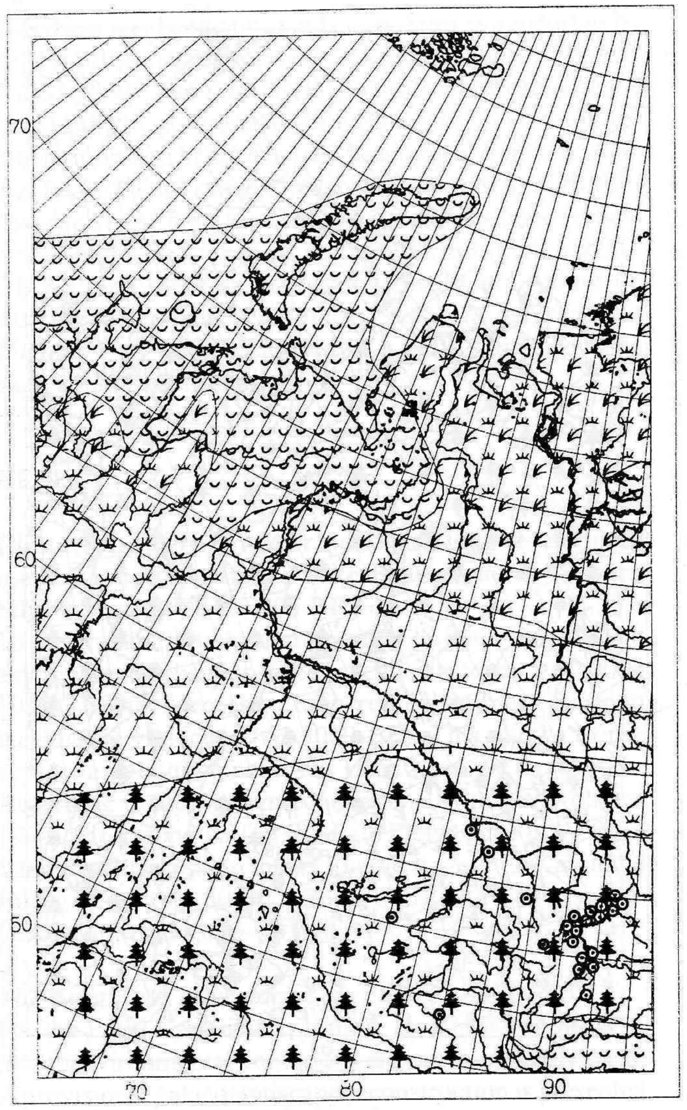

FIGURE 4. The scheme of palaeoenvironment of the Sartan Glaciation (*ca* 22,000–10,000 BP).

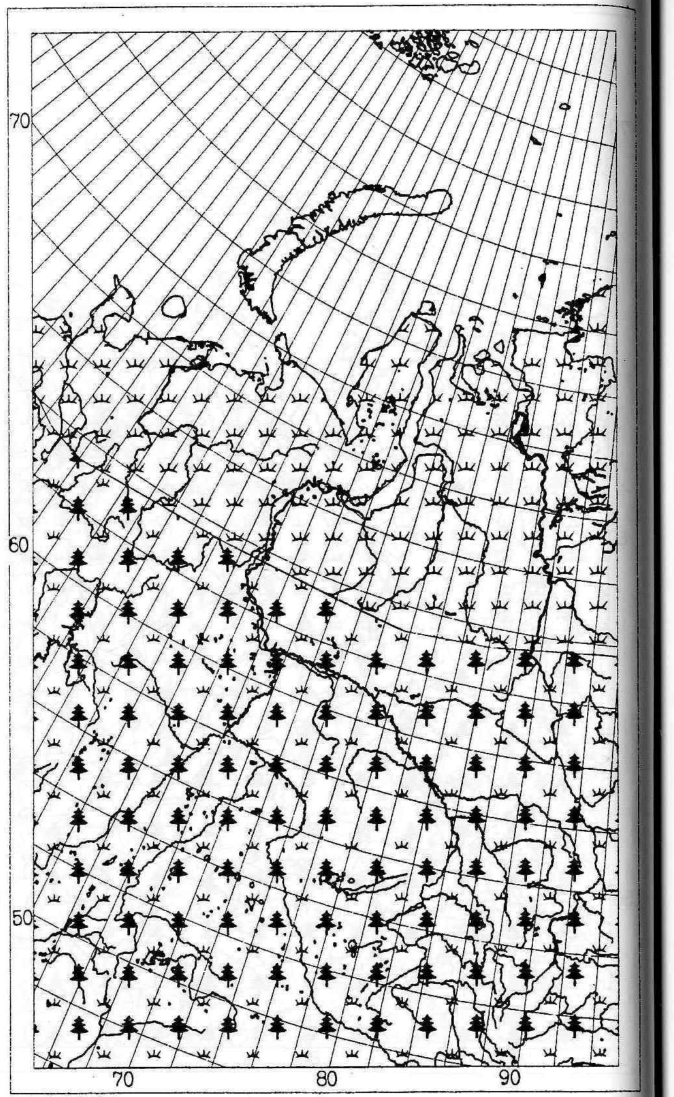

FIGURE 5. The scheme of palaeoenvironment of the Preboreal period (*ca* 10,000–9000 BP).

The Early and Middle Holocene, ca 10,000–5000 BP

During the Preboreal time in the Early Holocene, *ca* 10,000–9000 BP, the vegetation *(Figure 5)* was quite different from the modern one. It was represented by two major types, tundra and forest tundra. Numerous pollen and radiocarbon data reflect the vegetation of the light birch-larch forests on the territory of the modern forest and forest steppe zones (Levina, Orlova 1993, Bukreeva *et al.* 1995). The tundra belt occupied the area down to 64° N. South of that point, the forest tundra zone had been located. The expansion of the forest tundra zone was estimated to *ca* 400 km toward the south. The climate was mild and cold. The average January and July temperatures were lower than today by 7° C and 13° C, respectively (Levina, Orlova 1993).

The Holocene Climatic Optimum, *ca* 8000–5000 BP, was characterised by the expansion of forest vegetation toward the north by 300–400 km when compared with the Early Holocene. In the western part of the territory, forests consisted mostly of pine and fir. In the south-western part of Western Siberian Lowland, the main vegetation type was pine-birch forests with considerable amount of broad-leaved species such as oak, linden, and elm. Today, boundaries of the habitat of both elm and oak lie beyond Western Siberia, and the linden habitat is restricted to the extreme south-western part of the territory. Both linden and elm were represented in the modern forest steppe zone between *ca* 6650 BP and 5480 BP (Levina, Orlova 1993). The mean annual temperature in the Holocene Climatic Optimum on the latitude of Omsk (55° N) was higher than today by 1° C; on the latitude of northern taiga area (*ca* 65° N) it was higher by 3° C; and in the tundra area (*ca* 70° N) it was higher by 9° C (Arkhipov, Volkova 1994, Arkhipov *et al.* 1994).

The model of environmental events in Western Siberia in the Late Pleistocene

During the Late Pleistocene, *ca* 130,000–10,000 BP, the Western Siberian environment changed several times. Two extreme types of palaeoenvironment can be determined: 1) the significant cooling along with continental glaciation of the northern part of Western Siberia, and 2) the significant warming during the interglacial period. The first type corresponds to the Ermakovo Glaciation (*ca* 100,000–55,000 BP), and the second type corresponds to the optimal phase of the Kazantsevo Interglacial (*ca* 130,000–100,000 BP) (Zolnikov 1996). Most probably, these two types of environmental situations correlate with the beginning and the end of glacial-interglacial cycle in the northern lowlands of Siberia. There are some other transitional palaeoenvironmental situations between those two extremes. In general, the changes of environment during the glacial-interglacial cycle may be presented as follows: 1) the continental glaciation of the northern Western Siberia with vegetation of periglacial steppe, tundra, and forest tundra south of the ice sheet; with wet and cold climate; 2) the deglaciation of the northern part of the territory, the cut-off of glacial lakes toward the north, and the exposure of the bottom of glacial lakes; the creation of massifs of "dead ice" and the transformation of part of them into ground ice; the formation of fluvial systems; 3) the formation of interglacial-type landscapes, close to the modern ones; 4) the short-time cooling which causes the mountain-and-valley glaciation, the creation of glacial lakes and their catastrophic break-through; and 5) the climatic optimum with degradation of ground ice; the increase of solifluction, fluvial activity, and the thermocarst processes on the northern part of Western Siberia; the expansion of taiga landscapes toward the south.

This model may be used to examine the features of spatial-temporal distribution of palaeolithic sites in the glaciated areas such as the Western and Central Europe, northern North America, and Western Siberia. Some rapid environmental events could create harsh conditions for human existence, and this may have caused the migrations of ancient people.

The conditions of human existence in Western Siberia during 50,000–10,000 BP

The initial peopling of Western Siberia happened probably *ca* 46,000–43,000 BP, mostly during the Malaya Kheta warming (43,000–33,000 BP), based on firmly documented Mousterian and Early Upper Palaeolithic sites in the Altai Mountain foothills (Derevianko *et al.* 1990, Derevianko, Markin 1992, Goebel 1993, Goebel, Derevianko, Petrin 1993) *(Figure 1)*. The landscape zones during the Malaya Kheta warming were quite stable, of typical interglacial type. During the Konoschelye cooling, *ca* 33,000–30,000 BP, the amount of Palaeolithic sites remained very small, only about six settlements *(Figure 2)*. Probably, that period with quite severe environment was unfavourable for human occupation of Western Siberia.

During the Lipovka-Novoselovo warming, *ca* 30,000–23,000 BP, the amount of Palaeolithic sites in both the Altai Mountains and the Yenisei River basin increased significantly *(Figure 3)*. On the other hand, only the south-eastern part of Western Siberia was settled before *ca* 23,000 BP by ancient people. All the remaining territory of Western Siberia, including the vast West Siberian Lowland, was not occupied by Palaeolithic hunters.

The Sartan Glaciation time, *ca* 23,000–10,000 BP, was characterised by the final human occupation of the southern part of Western Siberia. In the Western Siberian Lowland, several Upper Palaeolithic sites are known, ranging from *ca* 20,000 BP to *ca* 14,500 BP such as Mogochino, Volchiya Griva, and Chernoozerye 2 *(Figure 4)*. In both the Altai and Sayany Mountains, no radiocarbon-dated sites exist within the interval 18,000–12,000 BP. The late Upper Palaeolithic sites in these mountains are dated to *ca* 20,800–18,000 BP (Shestakovo) and *ca* 12,000–9000 BP (Kaminnaya Cave and Bolshoi Kemchug). By contrast, in the Yenisei River basin during the Sartan time there are at least 18 radiocarbon-dated sites corresponding to the interval *ca* 20,000–10,000 BP *(Figure 4)*.

The general palaeolandscape structure for the Altai and Sayany Monutains, southern part of the West Siberian Lowland, and the Yenisei River basin in the Sartan period was very similar *(Figure 4)*. However, the Yenisei River basin was much more densely populated than any other part of Western Siberia. This may probably be explained by the impulse stream-flow regime of the fluvial systems in the Ob River basin with frequent floods of the low parts of valleys, as well as by the damming of the Ob River in the lower stream by the continental ice sheet. This could have caused the flooding of the vast territory within the Western Siberian Lowland, and made this area uncomfortable for human occupation. In the Yenisei River basin with well-developed incised valleys, the floods and other dangerous natural phenomena happened much more rarely than in the Western Siberian Lowland.

In the Late Glacial, *ca* 12,000 BP, the human populations returned to the Altai and Sayany Mountains. In the Early Holocene, *ca* 10,000–8000 BP, due to the climatic amelioration, an abundant deglaciation started in the northern part of Western Siberia. This process was accompanied by the thermocarst and the denudation of the territory with shallow massifs of the ground ice; the formation of peatbogs; the emergence of lakes and the flooding of the valleys of small rivers; and the formation of riverine network (Zolnikov 1996). These significant changes in the landscape structure could cause the destroying of the Palaeolithic sites that had existed on this territory prior to the Early Holocene, *ca* 10,000 BP. This might explain why there is not any evidence of human occupation of the northern part of Western Siberia in the Pleistocene and the Early Holocene, prior to *ca* 6000 BP.

CONCLUSION

This paper illustrates the application of a palaeoenvironmental database and GIS technology for the analysis of both natural environments and ancient site spatial and contextual distributions. The use of a GIS Atlas has allowed to create maps of paleoenvironment for different time intervals. Data on the spatial-temporal distribution of Palaeolithic sites could then be superimposed on the palaeoenvironmental maps. The simultaneous analysis of both kinds of information helps to reveal the peculiarities of human existence in the natural environments of Pleistocene Western Siberia. Also information about the natural environmental hazards has been used to show the influence of rapid environmental events on the existence of ancient people in the Palaeolithic.

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