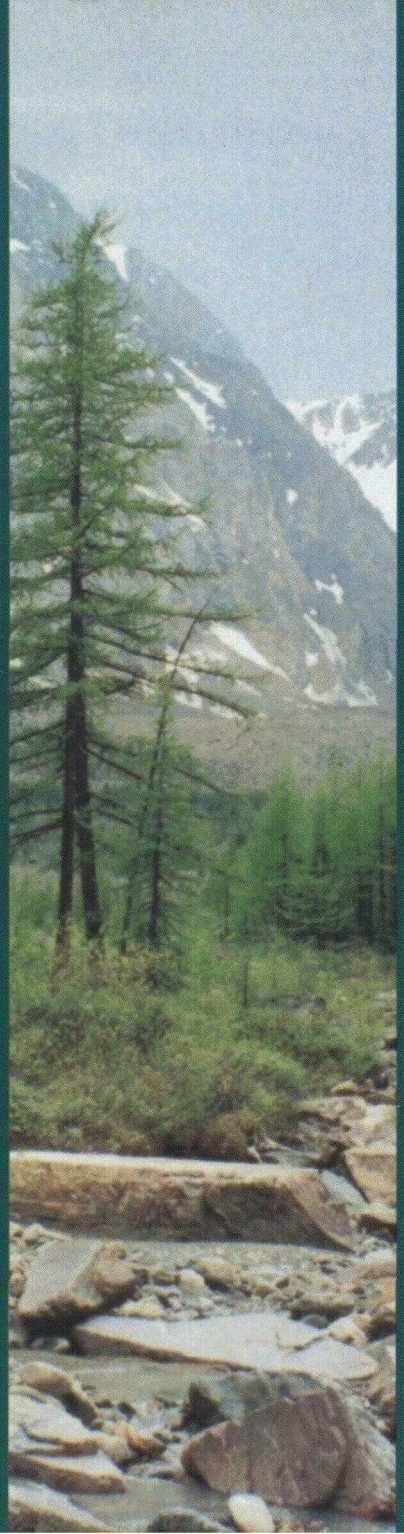

Lectures for Geography Students on the Altai Region Held at the International Summer Field School August 8-12, 2005

Barnaul 2005

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Depending on the depth and occurrence of stratum, underground waters are often salted. Fresh waters constitute about 86% from the common stock. Artesian wells and bore-holes used to access the waters. Subterranean waters which lie 0,5 m - 4 m deep are widely used for water-supply. The level of subterranean waters in lowlands is high; which often leads to the swamping.

Underground waters are distributed irregularly. The largest stocks are in the right-bank part of the Ob valley, in the south-west part of the Priob plateau. Water supply for agriculture has no difficulties, but the center of the Priob plateau and in the foothills waters are of unsatisfactory quality. Water pipes in the region are built not to use water-distillers. Not more than 20% of underground water stocks are used in the Altai territory. 60 reservoirs with a total volume 635 million m^3 may be found in the region, including Gilevskoye (471 million m^3). The Kulundinsky Canal (182 km) and the Aleysk irrigation canal system (90 km) continue to function. The Burlinskaya irrigating system is being built. There are 12,000 bore-holes in the Altai territory, using 800 - 850 m^3 annually; half of them are from underground water stocks. Each Barnaul citizen uses 550 liters daily; Biysk citizens use 118 liters, Rubtsovsk citizens use 294 liters, and in the country 126 liters is the norm.

Lecture 5

Glacial and Interglacial Periods in Altai

Despite certain debates concerning the correspondence of some Neopleistocene events in Siberia to global paleoclimatic records, it is obvious that nature underwent numerous climate changes during that period of time which caused changing of cold (glacial) and warm (interglacial) epochs. In the north of Western Siberia during the period, Brunes paleomagnetic epoch glaciers spread to the south at

least seven times, creating large glacial-subpond reservoirs. Meanwhile, in the south in the extraglacial zone less mass was formed.

In the mountain areas of southern Siberia these global events also influenced the development of nature, especially glaciation. Problems concerning sizes, repeatability and age of ancient glaciations, stadial motions traces and the last glaciation peculiarities are either poorly decided or still far from the decision. L. N. Ivanovsky has recently done careful and detailed analysis of these problems. Similar problems found in other mountain countries are also far from the decision and, obviously, have the same general character. As L. N. Ivanovsky has noted, the question connected with the recurrence of glacial epochs and their age raises the possibility of proving the existence of Midpleistocene glaciation traces in particular and remained uncertain as recently as tens of years ago. Meanwhile this problem is of significant importance and its decision greatly depends on answering other questions of evolutionary geography in mountain countries.

Many questions connected with ancient glacial periods of mountain territories are debatable because of insufficient diagnostics of the forms of relief and deposits. Frequently the same forms of relief or deposits are considered to be both glacial and inglacial from the point of view of different researchers.

The situation is especially difficult in the mountains of Central Asia. Numerous conditions of ancient glaciation development complicate systematization and diagnostics of the old glaciation relief forms. Moreover, chances to study the newest unconsolidated deposits are rather limited. All these facts have greatly influenced the formation of the various points of view on the history of the development of glacial and interglacial natural conditions in the mountains.

According to W. W. Zamoruev's opinion, there are currently two scientific schools dealing with the glacial history of mountain countries—traditional and alternative. The traditional paleoglaciology school distinguishes traces of several independent glacial epochs in the mountain relief, while the alternative school criti-

cizes this traditional concept and proves glacial traces to be the result of the late Pleistocene glaciation only (or both: mid- and late Pleistocene).

The researchers' aim to "mark" traces of several glacial epochs in mountain countries is encouraged by their effort to find equivalents of morainic horizons in the mountains like those already found in the plains. This wish can now be strengthened by the occurrence of numerous materials on paleoclimatic records of the oceans, glacial covers and ground deposits of lakes demonstrating the existence of several warm and cold epochs in Pleistocene. For example, the authors of the Baikal paleoclimatic record speak about 10 glaciations in the Baikal region.

A review of the literature on various mountain countries shows the situation is similar to that analyzed by L. N. Ivanovsky for Baikal that practically everywhere else. Most publications reflect the traditional opinion, however there are numerous works whose authors are of a different opinion.

To characterize glacial and interglacial periods in Altai it is necessary to define their manifestation traces on the area and in the profiles of Pleistocene unconsolidated deposits. There are several points of view on this problem, and it is solving this in the first place that makes the main skeleton of paleographic reconstruction.

It is hardly considered that all global Pleistocene tectonic and climatic changes of natural conditions did not occur in this or that way in Altai. However, it does not mean that all of them should be fixed in the relief or sediment strata (mass); especially in certain sediment profiles of that time which are placed, as a rule, in the regions of active weathering and washout.

Nowadays there are efficient lithological criteria of Neopleistocene deposits in Altai which are mainly characterized by grey (pale-yellow) color and better safety of fragmental material in comparison with more ancient (for example, Pleiocene) ones. At the same time, some researchers prove the existence of brown deposits in Neopleistocene strata.

Common features of Neopleistocene glaciations in Altai had been thoroughly investigated already by the first half of the 20th century, and on this basis

various units of glacial cycles were built. As a whole, P. A. Okishev analyzed problems of ancient Altai glaciation in the last century.

The history of Altai paleoglaciological research proves frequent use of chronostratigraphical schemes in better-investigated regions. In the 1920s through the 1950s the Alpine four-multiplied circuit of Pleistocene glaciation was widely used. In the 1980s the stratigraphical scheme, which had horizons of eight glacial epochs, correlated to the stratigraphical succession of Ch.Emiliany's isotope curve reflecting sedimentogenesis of deep-sea oceanic sediments, was adopted. From the 1960s through the 1980s researchers began to think about 2-3 glaciations in Altai, sometimes subdivided into phases or megastadials. Mostly due to research of Y. W. Devyatkin, P. A. Okishev and Y. P. Seliverstov, paleoglaciology was developed in Altai in the second half of the last century. L. N. Ivanovsky's role in studying ancient glacial processes is of great importance.

The basic point of view, dominant in research on glacial events in Altai in the 19^{th} and 20^{th} centuries, is connected with the existence of several glacial and interglacial epochs. Many scientists discovered some grey layers in profiles. Each layer corresponds to a definite epoch. Other scientists believed that it was impossible to correlate layers and epochs according to lithological and facial sediments, because the number of later glaciations constantly reduced. They also discussed the morphostratigraphic differences of glaciations. Both concepts have contributed to the study of Altai glaciations in the Pleistocene period. However, none of these concepts has had enough factual grounding, although it is obvious that complicated glacial complexes of consecutive glacial reduction existed during the period of glaciation degradation (morpholithocomplexes, according to W. W. Butvilovsky, or limno-glacial complexes, according to Y .P. Seliverstov and D. W. Sevastyanov).

However, new points of view appeared between the 1970s and the 1980s:

1. There were several Pleistocene glaciations in Altai, the largest of them – in Midpleistocene (with more than 1300 m of snow-line depression). The largest glaciers reached the bottom of mountains.

2. Scientists point to two chief glacial cycles – megastadials - in the late Pleistocene period. The snow-line depressions of the oldest one was less than 850m. Regressive steps of megastadials were characterized by phasic glacial motions: 2- in the first, 7 – in the second.
3. The last regressive stage of the 17th through the 19th centuries is still occuring, so modern glaciers are relicts of the second late Pleistocene megastadial (N. M.).
4. Mountain glaciation in Altai and cover glaciers in the north of Western Siberia developed metachronically.

Intramontane and intermontane basin (Chuiskaya, Kuraiskaya, Uimonskaya, Bertekskaya etc.) deposits are the most perspective for paleographic reconstruction in Altai. For example, in Chuya basin (by the way, one of the most investigated in Altai) W. W. Butvilovsky defines 5-6 sediment cycles. It is difficult to find out their climatochronological rank and origin. Taking into account modern and late Plistocene situations and rhythmostratigraphy methodology, W. W. Butvilovsky hypothesized that rudaceous deposits accumulated in subaerial conditions, similar to modern ones, while thin-laminated clayey deposits accumulated in subaqueous ones when vast lake reservoirs appeared, perhaps created by glacial sub-ponds.

Still fragmentary information on Altai Neopleistocene allows discussion of five sedimentation cycles. However, there is practically no opportunity to break down uncovered mass into two or some horizons having status of independent glacial or interglacial epochs. Today there is no way to be sure of some glacial and interglacial complexes in Altai profiles.

In other known Pleistocene sections, deposits of the only glacial epoch have been fixed (for example, Chagan section).

The most widely used radiocarbon method for dating glacial and interglacial sediments is not perfect because of its short time range. On the other hand thermoluminescence (TL) dating, which was widely used for creation of stratigraphic

scales, raises doubts connected to the debatable physical bases of this method and its unreliability.

According to paleomagnetic, thermolumeniscence and radiocarbon dating of deposits, the Midpleistocene glaciation in Altai is considered to be the largest, while the following late Pleistocene glaciations are much smaller in size. Other researchers, together with W. S. Sheinkman who used the new TL-method of dating, think the late Pleistocene glaciation was the largest in Altai. This raises a question of other periods of glaciation in Altai. If all previous glaciations had similar sizes, or the last one was the largest, it is necessary to search for their traces basically in sections of friable sediments, which are not enough.

At the same time, investigations of this area confirm that it is necessary to conduct such work in Altai with the help of TL-method, which offers the best available data. The use of previous dating methods requires certain care, though they are a basis of chronostratigraphical constructions in Siberia.

U. P. Seliverstov continued his paleoglaciological research in Altai in the 1990s. The author also took part in this research. U. P. Seliverstov supported the idea of plural glaciations in mountains of Internal Asia. He picked out traces of two young glaciations and marked the rest of the leveled platforms above them, carrying to more ancient glaciation. They belonged to young constructions of the Ice Age period of time, and more ancient constructions - to Risskiy period. U. P. Seliverstov analyzed the character of relations between glacial constructions of the Ice Age period in connection with the ridges of the Russian and Mongolian Altai, as well as the Tzagan-Shibetu and Tannu-Ola ridges. He discovered triple ice motions far off the limits of mountain slopes from the early Ice Age period, and each time ice returned to mountains again. According to him, glacial constructions of the late Ice Age period are located in valleys or are enclosed in constructions of the early Ice Age period.

Thus, U. P. Seliverstov supported the idea of the maximal development of glaciation in Altai in the late Neopleistocene, although he supposed large glaciation in some areas of Mid- Neopleistocene as well.

So, paleoglaciological research in Altai conducted during the last two decades showed that glacial deposits and forms of relief could be divided into four time intervals. Sediments and moraines are the most ancient of the late Neopleistocene glaciation, which was maximal in Altai (except for larger glaciation in Mid-Neopleistocene). Glaciers of that time formed large intermontane-valley complexes, joined to intramontane basins. Sometimes they formed glacial basins (Dyulukulskaya, Bertekskaya, Karakabinskaya, Verhnekobdosskaya). They also created glacial-pond reservoirs locking neighbor narrow valleys between basins or below nonglacial valleys (Chuiskaya, Kuraiskaya, Uymonskaya, Tuzharskaya, Kunduktukulskaya).

The reduction of this glaciation (or megastadial) has passed through three large shifts, which left limno-glacial complexes in wide valleys and basins, while in narrower ones it separated mountain valleys moraine-colluvial complexes strongly broken by processes of megastradial and the second megastadial. Frequently such complexes are settled down in narrower troughs, which we sometimes call "raviney" troughs.

There is still a problem of absolute chronology of late Pleistocene events in Altai. Now it is popular to compare the received new materials of Altay paleogeography with the data of global paleoclimatic records and on this basis to give age ratings to Late Pleistocene events.

So, practically the whole area of glacial development traces expressed in relief and discovered in deposits belongs to the last (late Pleistocene) glaciation. W. W. Butvilovsky confines them to the period of 10,000-25,000 years; whereas P. A. Okishev and Y. P. Seliverstov focus on Late Pleistocene as a whole, i.e. to the first and the second megastadials (early and late Ice Age periods). At the same time this conclusion shows that glaciation development area of Late Neopleistocene covers the territory larger than it was considered earlier.