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BASIC PROFILES OF NEOGENE-PLEISTOCENE DEPOSITS

INTRODUCTION

The studies of basic profiles of the Neogene-Pleistocene deposits supply the principal stratigraphic data, that are necessary to the recognition of individual physical elements as well as complex of elements which create the integrity of nature. However, there arises the question how the essential stratigraphic data can be distinguished from the secondary ones. The most useful is the paleogeographic criterion because it is the basis of appreciation of individual elements in the development of nature. Hence, the significance of stratigraphic data can be properly estimated only by means of paleogeography.

It is evident that stratigraphy and paleogeography are strictly connected with each other since the significance of stratigraphic data becomes comprehensible solely due to the paleogeographic analysis.

I appologize for my long introduction, but it is necessary as the report is devoted to the stratigraphy and paleogeography of the Pleistocene. I think that the investigators of the Pleistocene will agree with me that there are too many inconclusive discussions on the subject. Some of us may be inclined to see the cause of these endless discussions in the habits of debaters, but it is more sensible to seek for the objective causes of differences of the opinions, which would certainly express an optimistic attitude. If the causes of different points of view are objective, an effort could be made to eliminate them since they consist in the variety of competing methods which are rather contrasted than compared with one another.

It may seem that differences of opinions on stratigraphy provide a lot of pleasure for some of us and that we are satisfied with the *status quo*, i.e. with the differences of opinions (which constitutes the subjective and not the objective aspect of the problem).

Let us come back to the objective sources of the discrepant views and to

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great number of various groups of methods. Different methods applied in the investigations of various profiles can never produce consistent results. The only constructive suggestion can be a change of the general methods applied in the investigations of the Neogene deposits; instead of nonconsistent detailed methods applied here and there, a generally accepted method should be used for every basic profile.

The staff of the Department of General Physical Geography and Paleogeography of the Moscow State University, in the sixties of this century introduced a coordinated, complex method of investigations of basic profiles.

I suggest that the conjugate—complex method should be accepted as a general method applied in the investigations of basic profiles. The essence of the conjugate method lies in applying to all profiles the combination of individual methods.

Let me present the examples:

My colleagues carried out the investigations of 4 basic profiles: at Mamontova Gora (Central Yakutia) – T. D. Boyarskaya; Rostov Yaroslavsky (Čeremošnik) – N. G. Sudakova; Priazovie (Livenčovka–Margasitovka––Viesioloye–Vozniesenskoye) – V. P. Dobrodieev; Issyk-Kul (Tian-Shan) – Z. V. Alošinskaya. Each profile was examined by more than 20 comparative detailed methods, which embrace groups of basic methods: lithological, geochemical, paleontological, archeological, geophysical and geomorphological.

Up to now, however, only the group of paleontological methods is applied in a systematic way, with supply of other methods used here and there. So, it is obvious that the investigations of profiles are incomplete. Particulary surprising is the fact that the main part of deposits – their mineral part – is examined casually. In my opinion, the mineral part should be always studied by means of lithological and geochemical methods. It must be pointed out that in our country the application of geophysical method of estimation of the absolute-, paleotemperature-, and paleomagnetic age is limited too. It applies equally to the research work carried out by our Department. It was only quite recently that we have introduced additional paleomagnetic investigations for the profiles in question and the absolute dating. The diagrams, however, can be obtained not earlier than after 1–2 years. The investigations cannot be universal either because of objective reasons. Often, some sections are hardly available – obliterated or destroyed – when the full examination has been completed. The archeological findings and remains of big mammals are also encountered only occasionally.

Despite all the deficiences mentioned above, the main goal of investigations is attained. The complex method is (1) multiple, (2) groups of particular methods included into the complex method are compared and controlled, (3) comparison and control are presented graphically and mathematically,

(4) every method yields results of its best and on the other hand, the weak points of a method are complemented by strong points of others. We assume that "every method is at the same time the best and the worst".

COMPLEX METHOD

Let us give some examples of the co-operation of particular groups of methods. Because of shortage of time and place I cannot present the full "statistics" of comparisons, so I shall limit myself to some examples.

Comparison of the results of application of individual groups of methods is necessary for the ascertainment of main regularities occurring in: (1) directed – unique – development of nature from the Neogene up till the present time, and (2) rhythmical changes of nature in the Pleistocene. The examples will show us what has been stated in each of the four profiles mentioned above.

MAMONTOVA GORA

The Neogene–the present time. The amount of gravels and calcium content increases, whereas the content of kaolin, montmorillonite and mat grains decreases; phylogenetic development lines of fauna are fixed; exotic floristic elements either subtropical or others are on the wane; the role of tundra communities and of grasses and dwarf-shrubs increases.

The Pleistocene, warmer phases: high resistance coefficients of minerals, predominance of kaolinite in the composition of clayey minerals, high percentage of secondary minerals, high degree of hypergenic changes, prevailance of forest complexes and forest rodents, lowering of continentality of climate and degradation of permafrost in its extention. The mean annual temperatures and precipitation higher than at the present time.

The Pleistocene – colder phases: considerable admixture of aleurites, low resistance coefficients of minerals, slight chemical alteration, considerable content of hydromica within clayey minerals, diminishing of forested areas and increase of forest-tundra and tundra-steppe extents, predominance of the fauna of lemmings, stronger continentality of climate and intensive development of permafrost phenomena, lower mean annual temperatures and precipitation as compared with the present time.

Complex analysis made by means of detailed methods leads to the following conclusions – for the warm phases of the Pleistocene:

	mean annual temperature (C°)	precipitation mm/year	coefficient of continentality
warm phase:	–10*	300–400	20
cold phase:	–16	100–200	30

which proves that deterioration and aridity of climate occurred simultaneously.

The mathematical control revealed a very remarkable fact that for the mineralogical and chemical data the exactness of relation ranges to 0.8 and for the paleobotanical and paleofaunistical data – even 0.9. Some improbable combination can also be selected such as calcium content of deposits–afforestation: the inverse relation is obtained.

A part of regularity may be explained by tectonic processes: in the course of the development of landscape the Verkhoyansk province of alimentation was replaced by the Aldanian province.

The same results can be obtained due to the complex method also for other profiles. Because of necessity I will try to present them even in a shorter way.

ROSTOV YAROSLAVSKY

The section in Rostov Yaroslavsky which was demonstrated to the participants of the Symposium presents the sediments of the second half of the Pleistocene (precisely: the middle, the younger and the late Pleistocene). Hence, the conclusions deal with comparison of the warm (Mgin) and cold (Moscow and Valday) phases of the Pleistocene.

Cold phases: increased weighted mean diameters of rock particles of 2 mm, great variety of grain-size gradation, large content of calcium, compactness of sediments, big volume weight and small porosity of the (Moscow) moraine, slightly rounded rock debris whose longer axes are oriented N–S and NW–SE. Upper "cold" horizon (synchronuous with the Valday glaciation) contains remains of the tundra fauna (lemmings).

The warm period (Mgin): uniformity of grain-size gradation, low compactness of deposits, forest forms of rodents, mixed forests characteristic of the Mgin period.

All the data are in full accordance. They constitute the basis for the comparison of the Mgin and present-day climate:

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* present-day: –12°C.

	mean annual temperature (°C)	annual precipitation mm/year	coefficient of continentality
present time:	3.1	575	150
Mgin period:	11.0 (!)	750	114

PRIAZOVE

The profile has been well known for a long time. Like in Mamontova Gora there are exposed here the deposits from the Pliocene till the present time. It gives opportunity to examine the general regularity in the development of nature since the Neogene till now and the rhythms of this development in Pleistocene time.

The Neogene – the present time. Directed development of nature: increase of the content of dusty fraction (product of mechanical weathering), decrease of the contents of koalinite and montmorillonite, increase of the content of hydromica, decreasing resistance coefficient of minerals, etc. Transition of the red soils into loess, phylogenic development of fauna, vanishing of exotic floristic elements, diminishing of the forest cover, growth of the role of steppe communities, etc.

The Pleistocene. Phases of amelioration and deterioration. The resistance coefficient of minerals, kaolinite and clayey fraction increase significantly in the fossil soils (amelioration) and decreases in the loess; loesses are more porous than fossil soils. Humus of the steppe and desert type predominates in fossil soils, whereas in loess – humus of the forest and forest-steppe type. Pollens of forest communities prevail in soils, in loess – pollens of steppe vegetation, etc.

The above examples show the possibility of the confrontation of results obtained on the basis of application of different detailed methods.

ISSYK-KUL

The depression of the mountain lake (1600 m) is filled up by Neogene and Pleistocene deposits, about 1000 m in thickness. Examination of individual horizons in the section reveals the following development of landscape:

The Neogene – the present time. Direction of changes: increase of the average grain sizes, of resistance coefficient of heavy minerals, of content of epidote and calcium according to CO_2; ilmenite appears but montmorillonite disappears; glaciers come into being; floristic exotics vanish, the content of tree pollens is reduced, phylogenic development of elephants, horses and rhinoceroses takes place, etc.; appearance and evolution of the man (Musterian).

The Pleistocene, phases of amelioration and deterioration. The general salinity of deposits, the resistance coefficient of minerals and content of calcium increase in the warm periods and decrease in the cold ones. In the warm periods there was a decrease of the content of pollens of tree species and differentiations of floristic communities: from desert to the open birch forests. Glaciers shrinked and the lake size diminished (interpluvials). On the other hand, during the cold periods the forests expanded (steppes, birch and spruce forests), as well as the extent of glaciers and lake (pluvials).

The above examples show that the application of the complex method has proved to be efficient in the four profiles situated under quite different conditions; in the next four sites (Altay, Likhvin, Don, Carpathian foreland) similar investigations have been carried on and some valuable preliminary results have been obtained.

The simultaneous application of 20 methods is sure to require more time than one single method. Are our suggestions feasible then? The results obtained through a series of experiments prove that such an examination of one basic profile takes about 5 years if performed by 5–10 workers. Is this a long and expensive process? On the contrary, it appears to be much shorter and cheaper than the incoordinate investigations being carried out by different groups of workers for several years and giving rise to new discussions too frequently.

In particular such institutions as the Ministry of Geology of the USSR and the Academy of Sciences (of the USSR and of individual Republics) should make use of the complex method which secures reliable results. The following explanation is necessary: the investigations of the youngest deposits must be based on the field and laboratory works. The latter becomes particularly important, being characteristic of our times. Every research centre should possess a well organized and well equipped laboratory. The Laboratory of Young Deposits and Paleogeography (of the Departament of Physical and General Geography and Paleogeography of the Pleistocene) disposes of the equipment which permits to carry the investigations in six directions by means of 20 different laboratory methods.

DISTRIBUTION OF SECTIONS

The distance between the particular sections investigated reaches up to 7,000 km. They are scattered in the area of 22 million km sq. However, the problem of the distribution of profiles cannot be resolved by determination of the relationaship between the size of an area and number of profiles. The rule "the more the better" is also naive. It is said that a discussion should not

be based on figures but on competence. And scientific competence consists in the sensible sub-division of the area in question into space and time regions with at least one profile in each of them.

The question is whether the various areas underwent different processes of development in Pleistocene time. For many years I have been trying to prove this hypothesis to be true and – I dare to say – not without a success. This hypothesis, however, has found its opponents. It is much easier indeed, to assume that all regions developed in the same way. Such an assumption, though completely meaningless (how the contemporary diversity of nature originated?) – is widespread and constitutes the basis of some standarized stratigraphical schemes accepted by competent scientific organizations, who entirely disregard the real regularities in the development of nature, I suppose that I shall not be eccentric if I refer to the scientifically proved opinions according to which behind the zone of arid climate in the forefield of ice-sheets there was also a zone of more humid climate (pluvial). The two zones occurred simultaneously. Which of the two ideas has been confirmed by the investigations of the profiles in question: the orthodoxally stated uniform development of nature or that of locally differentiated character, which had already been proved on the basis of many factors?

The latter point of view gains a full support. In general meaning it is testified by the comparison of the complex diagrams from Mamontowa Gora and Issyk-Kul. Regarding the periods of cooling (not glaciations) as synchronous, one comes to the conclusion that the increase of climatic humidity in North-Eastern Siberia corresponded with the time of growing aridity (interpluvial) in Tian-Shan, and *vice versa* – the arid period in North-Eastern Siberia corresponded with the humid period in Tian-Shan. Still more striking are the differences in the development of vegetation in the individual regions. The differentiated development of vegetation has been recorded many a time and is generally accepted by paleobotanists. The vegetal cover constituted a component of the environment associated most closely with faunal species (graminivorous and then carnivorous mammals); hence, the differentiated development of vegetation determined the development of fauna to a high degree.

In this manner, the examination of basic profiles by means of the complex method confirms different directions and different intensity of the development of nature for every region and period.

I am not going to describe specific local features characteristic of the development of nature because it has been done already for the USSR and for the whole world in our monography[1] and in individual articles. I will only

[1] K. K. Markov, A. A. Veličko, G. I. Lazukov, N. N. Nikolaev – The Quaternary Era; 3 vols. Moscow, 1969.

mention the map of the world in which the differentation of development of the Earth surface is presented. It depends on tectonics and solar radiation. In the area of the USSR the both agents determine not less than 11 regions (strato-regions) of a remarkably different development in the Pleistocene[2].

It is obvious that such estimative appreciations are not void of convention, but they may give a general idea of the rank of investigations: at least 11 basic profiles should be examined by the complex method – that is an immense but feasible programme of the research work (so far there have been examined only 4 profiles).

I repeat once more that the reliability of conclusions and relatively low expences are assured.

Translated by Z. Apanańska

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[2] K. K. Markov – Stratigraphy and chronology of the Pleistocene. *In*: Young tectonics, sediments and man. Ed. Moscow Univ. 1969, p. 3–8.