ABOUT PROBLEMS AND TASKS OF CAVE ICE INVESTIGATIONS

(instead of the foreword)

Ice in caves long since drew rather steadfast attention of scientists. There was surprising its unique arrangement under a ground surface, it was frequently in districts with climatic conditions which are considered completely adverse for preservation of ice within all year. Clearly, that features of cave ice existence are connected both with global and with local (at a level of cavity) the climatic reasons. It is intuitively felt, that cave ice can contain unique climatic information, which is probably capable to throw light on a climatic history of the near past. There were some repeatedly attempts to decipher this climatic history. But while these attempts were finished by failure. The new wave of research interest to ice in caves now rises. This interest can be welcomed only. But it would be desirable to warn of early conclusions as existence and evolution of ice formations in caves are very ambiguously connected to an external climate.

Here it would be desirable to pay attention on some problems and prospects of speleoglaciology.

At the present studying of temporal and spatial features of snow and ice accumulation and ablation in caves is represented to us as very important. First of all, it is necessary to make for separate caves. As, only knowing morphology of a concrete cave, it is possible to understand the reasons, influencing on elements of ice mass balance in them (accumulation and ablation). Studying of accumulation may be under construction on detailed studying of features of snow income and its redistribution inside a cavity (if snow come to cavity) and features of other types of ice formation. For finding out of icing ice accumulation in cavities it is necessary not only to understand features and a dynamic of water inflow in cavity, but also specificity of cavity cooling, its thermal balance and every season temperature distribution inside a cavity. It needs to know for understanding of favorable and adverse conditions of ice existence (thermal anomalies) in concrete cavities and their influence on icings accumulation and evolution. Also it is impossible to dismiss an opportunity of icings movement that essentially may change character of indications on ablation sticks and walls marks. For finding out of features of sublimation ice accumulation in caves there are important knowledge of a climatic components and morphology of a cavity, features of moisture input inside cavities, its quantitative characteristics and their regime. For understanding and an estimation of cave ice accumulation in lakes and rivers it is useful to know the areas of these objects, depths, through flow and features of cooling of cavities sites where water reservoirs are located. Ice distribution in rocks (permafrost) is very difficult to study. It is impossible to make quantitative estimations of neither potential opportunities of its accumulation, nor volume of ice formations without realization of special works (digging of special pits, rock drilling etc.). Rather easily it is possible only to estimate the areas of distribution of a frozen ground in cavities (approximately it can be made by extent of a zone of negative temperature anomaly in caves). But only drilling of boreholes in bottom and walls of the cave channel can help to estimate depths of permafrost penetration inside of rock massifs.

Regular and regime observations of ice accumulation and ablation in caves are one of the major directions of research in speleoglaciology. Only knowing these components of ice mass balance, it is possible to understand and quantitatively estimate conditions of a glaciation in each concrete cavity and the reasons, which cause tendencies of these changes (morphological, cyclic, climatic, etc.). As an example, it is possible to consider the results of icings areas reduction in caves of one region. This phenomenon may be connected to the several reasons: warming of a climate in caves (as consequence of warming of an external climate or anthropogenous influence), reduction of quantity of the water percolating in a cavity (because of reduction of precipitation, change of cavities morphology or a structure of their climatic systems, freezing of rocks around cave channel, cyclic processes connected with a ratio of the cavities dimensions and quantity of ice collecting in caves etc. Only if we understand the reasons of change of the sizes of icing formations in concrete caves, it is possible to search for the incentive reasons of these phenomena outside of caves, such as, for example climate warming.

Important component of cave glaciation dynamics is studying of ice ablation. It is mainly melting and evaporation of ice as mechanical ablation in caves is insignificant. Sometimes it is possible to observe in caves flowstone ice collapse from vaults and walls and it's removing to other places that quite often may mark changes in ice melting conditions. That often leads to acceleration or delay of this process. Conditions of ice melting are directly connected to heat arrival into cavities (with water or air). The thermal and water regime of a concrete cavity is important for understanding of this process. For studying process of ice evaporation are important knowledges not only of air temperatures but also of air humidity because of air moisture deficit plays a determining role in ice evaporation in caves.

Undoubtedly, very important help in studying of snow-ice formations in caves give residial sediments and spore-pollen accumulated in them, and also snow-ice formations age definition by different methods. Sometimes distribution of inclusions in ice allows to understand ice layering in caves which formed by additions of several processes and influences: an external climate and the form of cavity. They determine not only specificity of accumulation of snow-ice formations in a cave, but also type of caves climatic systems. When we determine age in caves, practically always we determine age not of ice but inclusions in it. And the age of inclusions may significant differ from ice age. Such processes: melting out, removing and redeposition of

mud layers from ice are very often in caves; they are especially significant if the age of ice is large. It concerns as well age of the wooden particles, which quite often possible to find in ice.

One of the least investigated directions of speleoglaciology is studying a chemical compound of cave ice. First of all, it is connected with full absence of special methodical and regime works for seasonal (and long-term) changes of ice chemical composition in concrete cavities. Only realization of regime works is capable to characterize change dynamics of ice chemical composition in cavities and its dependence from compound of water entering in a cavity during all period of ice formation. It is connected with dependents ice chemical compound in caves both with compound of initial waters and from morphology of ice formations. It means that it depend from cavities morphology and from structure of their climatic systems. Caves climatic systems determine structure of ice formations and length of water flow before freezing from a place of its inflow in cavity. A chemical compound of ice may depend also from other reasons: receipt in ice of a gypsum or dolomitic flour, residual sediments, a dust, fragments of rocks, other types of ice (for example, falling of siblimation crystals from cave sealing in icing), anthropogenous pollutions. Complex seasonal and spatial dynamics of ice chemical compound shows, that selection of individual samples of ice in caves without knowledge of a history of ice formation in a concrete place of cavity is completely useless and does not give any scientific information. Absolutely similar it is possible to say about chemical analysis of cave ice from cores.

Thus, one of the important directions of development of glaciospeleology is continuation of research of climatic systems of separate caves and features of accumulation of a cold and ice in them. It will help us to understand better not only features of accumulation of ice in concrete caves but also to construct mathematical models of these processes and to make more reliable regional forecasts of caves glaciation.

In many respects research of cave ice restrain by absence of a uniform terminology. The terminology of speleology, speleological meteorology and climatology available now does not answer modern conditions of science development. Introduction of glaciological terminology in speleoglaciology, begun by V.E. Dmitriev (1980), has resulted that now in it speleological and glaciological terminology try to coexist in spite of glacilological terminology has mainly genetic character and speleological - mainly descriptive character. It quite often lead to mistakes. Most frequently in Russia the mess occurs with terms «ice-coated core» and «cave glaciers». If the first means in most cases icing generated by condensate or floodwater, the second may mean only large ice formations (ice massif or block) in caves. In some cases icings movement in caves was marked which sometimes wrongly accept as glaciers. As glaciologists do not know such objects outside of the caves, the special term for them is not making yet. Therefore while it is quite lawful to name them as «moving icings».

Absence of a uniform terminology in cave climatology say about absence of a common opinion on formation and evolution of climatic systems in caves, that also constrains development of speleoglaciology. Existence of ice in caves directly depends on structures of climatic models of caves. If we cannot understand, how the modern climatic conditions of caves are formed, for us it will be not clear both formation and evolution of cave ice in underground cavities. It means, that while there is no full clearness in cave climatology, development of speleoglaciology will restrain. On the other hand, development of speleoglaciology may become a push for creation of the uniform theory of a cave climate.

Speleoglaciology – is a very perspective scientific direction as it studies basically the permanent ice developing in cavities outside of areas of other natural perennial ice existence. Therefore only in caves the information, which is ciphered in thicknesses of cave ice, may be received. It is necessary only to take advantage of this information correctly. And generally speaking, it is necessary to hasten, as proceeding climate warming is capable to destroy these unique accumulators of the climatic information completely.

We see such problems on the near future, which is quite capable to solve modern speleoglaciology:

1) Reception of long-term observation data over dynamics of ice accumulation and ablation (ice mass balance) in separate natural caves and artificial cavities of different morphology and the sizes.

2) Revealing of simple dependences of glaciation change (as ice mass balance) in concrete cavities at conditions of climate variations for caves of different size, of different morphology, located in different climatic zones and high-altitude zones.

Mavlyudov B.R.