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Extended Abstracts

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title: **Formation and evolution of hydromineral systems in Mongol-Baikalian region and prospect assessment of the resources use**

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The Mongol-Baikalian region is considered as a vast area (in total it makes more than 500 000 square kilometers) including Baikal Rift zone, the neotectonic lifting in Trans-Baikal area and Mongolia as well as the hilly plain of the Onon-Kerulensk interfluvium. As a hydrographical object, the area belongs to the following basins: to Lake Baikal, which is a unique reservoir on our planet, and to Amur River (in its upper flow) up to the confluence of Shilka River and Argun' River.

An author's conception of the region integrity as a major hydrogeological system of the first order within the terrestrial branch of the Pacific volcanogenic belt is suggested in the poster presentation. The main peculiarity of the system is the fact that rift lakes (Lake Baikal, Khubsugul Lake, Gusinoe Lake, Kotokel Lake, etc.) on its area contain fresh and ultra-fresh waters practically with the same chemical composition and mineralization along the water column – from surface up to the bottom. The lakes are characterized by an active water exchange in the water body, what is confirmed by isotope hydrochemistry data and by hydrochemical calculations. This is the uniqueness of the Mongol-Baikalian region. The big lakes of the other rift systems (Europe, Asia, Africa, America) have a near-bottom system of complicate water exchange, where formation of the gas and chemical content occurs due to the system interaction "water-bottom", and where pollution processes take place and they except possibility of using lake waters as drinking water.

According to the long-term studies of the mineral water regime and hydro-geological mapping with the use of new original methods and aero-cosmic information, fracture tectonics and isotope data, also with participation of the poster authors and Mongolian colleagues "The Map of mineral waters in Mongolia" (1:2 500 000) was worked out and published.

As a basis of the map are taken new theoretical developments and a new mapping technology. The classification criteria were worked out by the authors.

The map contains the following information:

- The map legend includes a new classification of mineral water on physical and chemical characteristics, chemical, gas and isotope compound and temperature. For the first time, balneological classification with indications for treatment of different diseases with the use of mineral ground waters and mineral lake waters is given.
- The map has a hydrological zoning of the territory of Mongolia with indication of the hydromineral provinces and regions with different formation conditions and spacial distribution of different types of hydromineral resources (balneal ground waters, industrial and thermo-energetic waters, mineral lake and therapeutic mud).
- Information given for different water points is explained in the legend, so the map can be used without annotation.
- Hydrogeological formations ground water systems of the area with data on hydrogeodynamic and hydrogeochemical characteristics for ground water as well as hydrogeochemical peculiarities of aqueous solution, brine, and bottom sediments for mineral lakes are given.
- For the first time the map is supplied with the theme of spa climatic zoning and information on spa object construction in Mongolia.

- New mineral water types revealed by authors are shown on the map, among them Khingan type of carbonaceous thermal waters unknown before.
- Elements and salts which are deficit mineral raw material on their concentration –“liquid ore” (Li, Sr, B, Bromine, I, K) are displayed on the map.
- For the first time aquiferous fractures are indicated with the use of isotope information (H^2 , Rn, He, $^3He/^4He$), timed to unloading site mineral waters of crust (on H^2 and He) and amphycte ($^3He/^4He$) genesis.
- For recreation and tourism purposes a new version of the map in the scale of 1:5 000 000 was separately published.

The map can be used for further development planning of spa constructions, survey of the new mineral water deposits, hydro-mineral raw materials as well as for students and young scientists as a tutorial aid including hydro-geological tasks and translations from English into Russian.

The main task of the report determining its theoretical importance, novelty and corresponding to its title was formulated as “Basic theoretical justification of unique for Mongolian-Baikal region system for studies and rational use of hydromineral resources aimed to their integrated quantitative assessment for economically profitable and ecologically safe use in the economics”. The possibility of fulfillment of such program for a short, 2-years period (2008-2009) is based on a perennial scientific potential of the project executors and on the professional experience of joint research done by Russian and Mongolian specialists resulted in making and publishing of a unique “Map of Mongolian Mineral Waters” with the scale 1:2 500 000 (2003). The authors of this map recognized both in these countries and worldwide are the participants of this project. In Russia, maps of mineral waters of Baikalian part of the region were also done, but for a while they are not published. At present, the authors are creating a common map for the whole Baikal-Mongolian Region for publishing. This is justified by the fact that before, scientific and methodological analysis of maps done for Mongolia and Russia separately showed their unconformity in the boundary zone of these countries and give no possibility for basic scientific generalizations and for assessment of the possibility of use of hydromineral resources in the common Russian-Mongolian system. Hydrological mapping using permanent integrated survey of the whole region is not justified due to complex character of expeditions in mountain areas with difficult access and to absence of permissions from boundary authorities, only boundary line remained, and the line of State boundary between Mongolia with Russia and China crosses united water bearing system without reflecting natural and geological-hydrological boundaries of united water-bearing systems of mountain-folded structures in the regions of recent and modern volcanism. It is especially complex at expedition activities which cannot be fulfilled for a short period of time. Therefore for the mapping, we developed a new technology of hydrogeological survey of the structures of recent and modern volcanism by large areas of mineral waters discharge. Such a technology is developed taking into account modern achievements of worldwide sciences, by special parameters it is pioneer one. For their studies we selected the most important water units, characteristic representatives of different types of hydromineral resources (medical, industrial and thermal energy waters). These units are partially presented on the maps made before, but they are yet poorly studied or known only due to information from local population. For studies and mapping, we selected such units in 2008, and while studying we revealed and proved that they are yields of different types of hydromineral resources

perspective for practical use at joint exploitation which is quite real nowadays due to progress in cooperation between our countries. Such yields investigated in detail in 2007-2008 are: 1) unique in the region.

- From seismic and tectonical point of view, Mongolian-Baikal region is very active with rather complex composition of extension (Baikal Rift) and compression zones (Khangay and Khentey-Dauria neotectonic lifts). Formation and evolution of nitrogen hydrothermal systems in these zones are connected genetically with the source of the heat income. In Baikal Rift this is a regional heat field in which fissure-vein hydrothermal systems of deep circulation are formed. These are mainly siliceous nitrogen waters in the anion composition of which sulphate dominates (Goryachinsk type of hydrotherms). At neotectonic lifts, the source of the heat income is connected with mantle plumes. By its chemical and gas composition, acrotherms of Khentey are analogous to thermal waters of Khangay arc lift related to the area of Cenozoic tectonic-magmatic activation. These are also siliceous nitrogen waters, however, in difference with therms of Baikal Rift, the sulfate-ion in them is not major. Therefore the anionic composition can serve as a criterion for outlining of boundaries of arc lifts of Khangay – Khentey and Baikal Rift. Within Mongolian-Baikal region (at the flanks of Baikal Rift) there are hydrothermal systems connected with the areas of development of marine volcanism and having local heat sources. Here exceptionally subthermal and thermal carbon dioxide and carbon dioxide – nitrogen mineral waters are developed, they are connected with mofette stage of volcanic activity. On the base of some sources, health resorts are functioning, the pouring of mineral waters is organized, but their resources are used not completely.
- Lake systems including highly-mineralized surface waters, silt brines, as well as rocks forming lakes bed and their basins slopes are very peculiar. At present, main attention is paid to the perspectives of extraction of important microelements (bromine, lithium, iodine, boron, etc.) from lacustrine systems. Recent studies carried out by the authors on the territory of Mongolian-Baikal region showed that the brine from some lakes (Borzinskoye, Khara-Torum, Tsagan-Nor, etc.) contains enough important microelements for organization of their industrial extraction. We have to notice that besides halogenesis process connected with salts concentration during evaporation under the conditions of arid climate, there is some lakes microelements income from deep supply sources.
- Let us notice for conclusion that in 2007-2009, our investigations were supported by international grant. The program “Russia-Mongolia” is continued at present, it will be finished in 2011 with final report and of draft of the map of hydromineral resources of Mongolian-Baikal region with the scale 1:2 500 000 ready for publication.
- The activities within the grant are investment character with additional financing both from Russian and from Mongolian party, it allowed to drill search and trial holes with depth up to 120 m in productive zones of neotectonic faults at the most important for studies and consecutive use thermal waters, maximal forecast temperature of which (by siliceous geothermometer) at the depth of vapor hydrotherms formation (ca. 3-4 km) is ca. 150°C.

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