Global and regional catastrophes resulting from changes in the geological environment and climate

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Global and regional natural catastrophes are important in changing the face of the Earth as a whole or its separate regions; they make a great impact on forming the biosphere, evolution of living organisms, thus forming and changing the environment. In our viewpoint the global natural catastrophes are geologic and climatic events leading to sharp changes in the environments on a global scale, while regional catastrophes are catastrophes, which lead to changes in a separate only.

At present the Earth experiences alternating glacial and interglacial stages. The analysis of geologic history and climate evolution on the Earth shows that interglacial stages coincide with abundant occurrences of intraplate (plume) magmatism, occurrences of magnetic superchrons and high ocean level, i.e. greater area of the World Ocean that most likely is related to the lack of continental glaciers. On the other hand glacial stages are related to predominant magmatism of convergent boundaries of lithosphere plates, as well as forming of orogenic belts and reduction of ocean level most likely due to abundant continental glaciers.

The last interglacial stage started 250 Ma with significant eruption of Siberian traps, when $1{,}2x10^6$ km^3 of the basaltic magma erupted within 1 Ma. Abundant eruption of basalts and correspondingly evolved gas resulted in the extinction of half of species of the living organisms on our planet [Khain, 2001]. It was a global catastrophe in the history of the Earth. Abundant intraplate magmatism took place during the whole warm stage (over 200 Ma) and was associated with the Pangea splitting.

The glacial period which we are experiencing at present started about 37 Ma with the origin of Circum-Antarctic current, resulting from splitting of the Antarctica from India (80 Ma), Australia (53 Ma) and origin of the South- Antilles basin (38 Ma) between Antarctica and South America. This current stipulated for the moisture supply into the Antarctica and gave rise to first glaciers.

The second stage of climate deterioration (about 15 Ma) is associated with the increase in ice volume in the Antarctica and first glaciers in the Arctic. The climate deterioration resulted from changes in location of continents and their relief. So, at that time mountain uplifts generated in the South Asia and Central-American isthmus formed.

The third episode of cooling was related to the growth of Himalayan and Tibetan plateau, being the largest topographic units of our planet. As it was mentioned, the Tibetan plateau is of such height and width (5 km high, 4,7 mln. sq. km), so that it is responsible not only for the regional circulation of air masses but for origin of monsoons and global atmospheric circulation on the whole Earth. In addition, owing to the intensive destruction and weathering of bed rocks there was absorption of atmospheric CO_2 by the surface layer of the Earth, that is one of the most significant reasons of cooling [Raymo, Ruddiman, 1992].

If the Tibetan-Himalayan region is important for global climate changes, so the Central Asia and in particular Baikal region demonstrates own regional processes that were responsible for climatic and environmental changes which are well recorded in the sedimentary records from Lake Baikal and Lake Hovsgol. The records show expansion and retreat of steppe (Baikal region) and desert (Hovsgol Lake basin, Selenga River, Mongolia) in different glacial-interglacial periods.

Sharp changes in landscape in the Central Asia took place 2.8-2.48 Ma and thus, mountains in the region reached the maximum height almost similar to the recent one that is evident in Sr isotope record, in changes of species composition and abundant diatoms, origin of dense lacustrine silt of glacial origin. The latter is an evidence of mountain-valley glaciation [Kuzmin et al., 2000; Karabanov et al., 2001.].

It was found that peneplene with relatively low height was predominant relief in Lake Baikal basin prior to 2.8 Ma. Coniferous broad-leaved forests prevailed prior to 2.8 Ma. [Bezrukova et al., 1999]. In the period from 2.8 to 2.48 Ma almost all elements of arboreal broad-leaved flora became extinct and boreal coniferous forest became predominant. The most significant feature about the flora after 2.48 Ma were high-altitude arctic deserts. Studies of changes in the species composition of fauna of large and small mammals in the basin of Lake Baikal and Lake Hovsgol also indicate abundant steppe and semi-desert fauna complexes [Vangengeim et al., 1969, Erbaeva et al., 2004]. Thus, the first reliably dated stage of abundant steppe and semi-desert flora and fauna, revealed in continuous sedimentary records from large lakes took place 2.8-2./48 Ma and was associated with large stage of tectonic activation in the region resulting in origin of maximal (similar to recent) height of mountain ranges.

A continuous alternation of glacial-interglacial cycles of various duration and intensity during the Late Pliocene-Pleistocene led to expansion/degrading of steppe and semi-desert flora and fauna in cold/warm periods, correspondingly. Though it is known that such a relation was not direct and thus during the optimum of interglacials the areas occupied by steppe/semi-desert ecosystems became wider in the studied region. Alternation of such stages was found in continuous records of changes in the environment and climate obtained from lacustrine sediments, in particular dynamics steppe/forest index from pollen records. These records can become basic for understanding sharp changes of climate and the environment.

Lacustrine sediments originated in the last transitional period and in the Holocene can be important in order to understand regularities of expansion of steppe and semi-desert ecosystems. Application of recent mathematical methods of reconstructing quantitative parameters of the paleoclimate of this time interval [Tarasov, Bezrukova, Karabanov, 2007] allowed revealing of intervals of steppe expansion for this region for the last 13 Ka. On geochronological scale these intervals are comparable with cycles of intensification of iceberg discharge into the northern part of the Atlantic Ocean or with Bond cycles [Bond et al., 1997]. Studies of cyclic pattern of the climate in the Holocene should be continued based on diatom and geochemical records. A

particular significance should be given to archives of paleoenvironment preserved in bottom sediments of small lakes such as Kotokel, where the thickness of the Holocene sediments can reach as thick as 7 m [Bezrukova et al., Doklady of Academy of Sciences, in press]. Similar records can be obtained from bottom sediments of small lakes of Mongolia and Tran Baikal.
The example of the huge recent catastrophe is a mudflow, which covered a unique valley of geyser on Kamchatka. However, further natural processes in the region suggest that the nature continues its fight with “negative processes” and there is a gradual revival of this unique site.

Thus, it can be concluded that natural processes and the evolution of the Earth itself is a doctor of natural catastrophes.