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The Influence of the Earthquakes on the Compositional Change in Basement Groundwater (on the Example of the South Tatarian Arch)

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The groundwater composition of deconsolidated zones in the Precambrian crystalline basement of the Volga-Ural anteclise's South Tatarstan Arch was monitored during the period from 1998 to 2003. Chemical and gas compositions of basement waters and fluid levels were monitored in five wells. Other monitoring parameters included total dissolved solids, density and acidity of water and the contents of methane, heavy hydrocarbon gases, hydrogen, helium, carbon dioxide, dissolved organic substances (bitumen carbon) and total nitrogen.
In order to study the temporal relationship between variations in water composition and seismic activity, sampling was carried out right after seismic events. Earthquake recording in Tatarstan allowed water sampling to be conducted almost immediately after seismic events. Some regularity in the variation of salt and microelement compositions of water has been outlined. Earthquake frequency has been found to be related to salt and microelement compositions of water. Water samples have shown decreased total dissolved solids content. At the same time, the total iron content decreases and the boron content increases. Peaks of tectonic activity have been found to coincide with increased methane contents. Earthquake peaks have also been found to coincide with maximum hydrogen contents over the whole observation period. A similar relationship has been found for nitrogen
Archaean/Proterozoic groundwater monitoring shows changes in total salt, trace-component and gas compositions. These can be related to geological processes of various intensities occurring in the Earth's crust. The total hydrocarbon content of groundwaters has been found to depend on the intensity of geological processes, which indicates the possible entry of additional gas amounts from deconsolidated zones of the crystalline basement into the sedimentary Devonian. It has been established that the most informative indicators of the relationship between groundwater parameters and endogenous processes are methane, hydrogen and total nitrogen. The compositional change in basement groundwater can be associated with degassing of the mantle in magma chambers of the Earth's crust. It has been found that earthquakes with magnitudes of 4 to 4.5 stimulate a methane discharge, and those with magnitudes of up to 5 inhibit it (Goryachev et al., 2000). Recent degassing processes have been detected by the repeated leveling data (Kuznetsov, 2000) and periodical seismic events, e.g. by the analyses of isotopic composition of carbon from oil of the Novo-Elkhovo field before and after earthquakes. Analyses of the basement gases extracted from the superdeep 20009 well have shown that their isotopes and other components are unstable in time. Isotopic composition of carbon in methane changed from –10 to –90%. This behavior is peculiar to the products of reaction between carbon monoxide and hydrogen. Basement methane composition explains why that of associated gases from the Devonian is lighter than that of the Carboniferous.