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Relation of compositions of deep fluids in geothermal activity of Pleistocene-Holocene volcanic fields of Lesser Caucasus

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It is widely accepted, that geothermal activity in the conductive heat flow processes, such as volcanism and hydrothermal activity, is manifestation of the thermal mass transfer process in the Earth's crust, where geothermal and geochemical processes are closely connected. Therefore, geochemistry and isotope compositions of thermal mineral waters within and on periphery of volcanic clusters may represent key indicators for better understanding of geothermal activity in geodynamically active zones. Geochemical features of heat and mass transport in hydrothermal systems related to active volcanic and fault systems in continental collision related orogenic elevated plateaus such as Anatolian-Armenian-Iranian highlands are still poorly understood. In this contribution we attempt to fill these gaps in our knowledge of relations of geochemical and geothermal processes in collision zones. We present new data on chemical compositions, trace element geochemistry of thermal waters of Lesser Caucasus, (Armenia) as well as isotope analysis of free gases such as $^{3}He/^{4}He$, $^{40}Ar/^{36}Ar$, $\delta^{13}(CO_2)$, nitrogen $\delta^{15}N(N_2)$ and oxygen and hydrogen isotopes in water phases (δD, $\delta^{18}O$).

To reveal some specific features of formation of fluid systems related to thermal activity in the areas of collision related active volcanism and active geodynamics a complex geochemical (SiO_2, K-Na, Na-Li, Li-Mg) and isotope geothermometers ($\delta^{18}O(CaCO_3)$ - $\delta^{18}O(H_2O)$) were applied.

The distribution of $\delta^{13}(_2)$ values in free gases of mineral waters of Armenia demonstrates that gases related to Quaternary volcanic fields are characterized by relatively light $\delta^{13}(CO_2)$ values close to mantle derived gases, while on periphery of volcanic systems relatively heavy values of $\delta^{13}(CO_2)$ indicate strong influence of metamorphic and sedimentary derived carbon dioxide. Distribution of nitrogen isotopes $\delta^{15}N(N_2)$ demonstrate an inverse correlation with $\delta^{13}(CO_2)$ values and similarly to carbon dioxide indicate presence of metamorphic nitrogen on the periphery and strong influence of atmospheric (and mantle derived) nitrogen within volcanic fields.

Results of geochemical and isotope investigations, as well as estimated temperatures of the formation of the mineral compositions of thermal waters demonstrate, that these studied hydrothermal systems originated within thermal anomaly fields associated with young (Pleistocene-Holocene) volcanic fields in Armenia.

Basing on geochemical and isotope data, as well as on estimations of temperatures of water formation, calculated using various geothermometers, thermal anomaly fields, related to young volcanic activity and faults, within Armenian and neighboring areas of Lesser Caucasus are outlined. These results are used to reveal potential and promising areas for geothermal energy exploration in Armenia.

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