Water cycle of a subarctic hydrothermal system

MALOV, A. I.*, BOLOTOV, I. N., TOKAREV, I. V. AND POKROVSKY, O. S.

Institute of Environmental Problems of the North of the UB RAS, 23 Severnoy Dviny Emb., Arkhangelsk, 163061, Russia (*malovai@yandex.ru)

The hot springs of the Pymvashor subarctic hydrothermal system are of considerable interest because the area is devoid of recent volcanism and is located in the permafrost region. We attempted to evaluate the activity of thermal waters with respect to host rocks to quantify the water residence time in this system. Therefore, we used the chemical composition of the thermal waters, thermodynamic modeling, $\delta^{18}O$ and $\delta^{2}H$ labels and isotopes, such as ^{14}C-$\delta^{13}C$, ^{234}U-^{238}U, and ^{230}Th-^{232}Th. The $\delta^{18}O$ and $\delta^{2}H$ values indicated the infiltration of atmospheric water in the recharge area of the hydrothermal system and suggested a stable paleoclimate in the area over the last 5-7.9 thousand years. The fresh water flows through deep parts of the aquifer system where it mixes with brine followed by discharge. The composition of the thermal water can be formed via a mixture of one part of the brines with 130 parts of the cold water end member. The results of thermodynamic modeling and mixing diagram analysis indicate that during water-rock interaction in the aquifer, the precipitation of calcite and the dissolution of gypsum and magnesite were accompanied by hydrolysis of the sodium aluminosilicates with precipitating clay secondary minerals. The low uranium concentration in the Pymvashor groundwater suggest a high α recoil loss due to radioactive decay of the precipitated and adsorbed 238U because in this case, the probability of 234Th release and 234U appearance in water increases ~ 4-fold compared to the probability of emission directly from the rock.