Chemical and isotopic signatures of the thermal groundwaters from Kuldur spa (Russia)

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Kuldur spa is the most famous and great resort located in the Russian Far East, Amur River region. The geological structure is defined by the contact zone of Paleozoic granites and Proterozoic gneiss. The granite country rocks are intensive altered and fractured. The typical feature of studied waters is a high temperature (up to 100 °C), low TDS (< 0.5 g/l), high pH (> 9). The cations are mostly Na^+, less Ca^{2+} and a few Mg^{2+}. The main anion is HCO_3, the second - SO_4. Water is usually enriched with F-, Si, Al, W, Mo, etc. All waters content high amount of radon (up to 32.4 kBq/l).

The purpose of this work is to study the chemical and isotopic signatures of nitric thermal waters from Kuldur spa and characterize their circulation processes. For solving this task, multiple isotopes δD, $\delta^{18}O$, ^3H, $^3He/^4He$, $^4He/^{20}Ne$, $\delta^{13}C$, $^{234}U/^{238}U$ together with geothermometer calculation were utilized.

The main gas component is N_2 (up to 98 vol.%) with a trace amount of noble gases (Ar, Kr, Xe, He and Ne), in both dissolved and escaping gas. The methane, carbon dioxide and oxygen contents are minor. The $^3He/^4He$ ratio is low 0,19-0,25 and can be considered as dominated by a crustal source. The $\delta^{13}C_{DIC}$ values vary from -30 to -18.1 ‰ and testify on the biogenic origin of carbonate specimens. The $\delta^{18}O$ and δD are parallel with GMWL showing that the recharge source of thermal water is local meteoric precipitation. Value of ^3H are very low up to 0.7 TE which indicate the long circulation time and also confirm no dilution of deep thermal waters with shallow cold water. Our calculation based on Na-K and SiO_2 geothermometers indicates that these thermal waters are reached 130°C and the corresponding circulation depth is about 5 km. According to the $^{234}U/^{238}U$ dating, the circulation time of the studied thermal groundwater is at about 400,000 years.

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