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Isotopic and hydrochemical evidence for the origin of hot groundwaters from Khoja-Obi-Garm thermal area (Pamir-Tien Shan region)

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New isotopic data for aquatic (δ18O, δD) and gas (δ13C, 3He/4He, 4He/20Ne) phases together with the detailed hydrogeological and geological study of the area allowed to identify the genesis of the low-enthalpy nitric thermal waters from the unique Khoja-Obi-Garm thermal area (the Pamir-Alai mountain system, Central Asia).
Thermal groundwaters from springs and boreholes studied area are characterized by temperatures varying from 57 to 93 oC, high pH (up to 8) and low TDS (less 0.5 g/l). The principal cation is Na+, its content can reach 100 mg/l, while the content of Ca2+, Mg2+, and K+ are generally low. The dominant ion is usually HCO_3- (up to 112 mg/l) and SO42- is the second one. The sulfate concentrations are varied from 2 mg/l to 133 mg/l from spring to spring. The high content of SiO_2 (up to 140 mg/l) and F (up to 18 mg/l) was found. Also, these therms are rich in Li, Rb, Cs, and Al. In some boreholes, the high concentration of radon (at about 814 Bq/l) was detected.
The specific feature of these waters is a predominance of N2 in the gas phase (up to 83-98 vol.%), while other gases (O_2, CO_2, Ar, Kr, He & Ne) are nonessential. Gas content at Khoja-Obi-Garm spa waters is usually not high, does not exceed 30 ml/l. Our data indicate that N2 and O_2 are atmospheric gases, but CO_2 is exactly biogenetic gas (δ13CTIC -30‰ – -22 ‰. In boreholes 3He/4Hecor. values are below the atmospheric ratio (at about 0.02Ra) and very close to crustal value, however in some thermal springs 3He/4He ratios increase significantly (up to 0.3Ra). This is possible to cause by the presence of a weak mantle helium component (less 5%).
The isotope data obtained (δ18O – - 13.1 ‰ δD — -79.8 to -84,2 ‰ prove the meteoric origin of the waters, since most data are plot along the GLMW.
The measured values of 3H in the thermal groundwaters are very low (less 0.8 TE), which suggests a long residence time for these waters.
Thermodynamic speciation indicated that these groundwaters are supersaturated with clay minerals and low-temperature zeolites but undersaturated with carbonate and main alumosilicate minerals. The estimated subsurface temperatures for these thermal waters vary from 140 oC to 156 oC based on the silica geothermometer and 193-197 oC using K/Na temperatures. Based on these temperatures and geothermal gradients in this area (at about 70 oC/km) we can suggest that circulation depth of thermal groundwaters has been estimated to be about 2–3 km. Also, we conclude that dissolution of albite, feldspar, and quartz plays a fundamental control on groundwater chemistry.

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