



Spatial variations in gas and stable isotope compositions of eastern Anatolian thermal fluids

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We investigate helium isotope compositions and CO₂/3He ratios of gas samples and stable isotope (oxygen, hydrogen, carbon and sulfur) compositions of water samples collected from various geothermal fields in eastern Anatolia. Most of sampling sites are located close to recently active volcanoes (e.g. Ararat, Tendürek, Süphan, Nemrut Caldera) around Lake Van. R/Ra ratios of the fluids (R=3He/4He sample and Ra=3He/4He atmosphere) that range from 0.85 to 7.76 are significantly higher than the crustal production value of 0.02–0.05 Ra. Fluids with notably higher R/Ra values are generally found in volcanic areas. CO₂/3He ratios of the samples vary over a wide range (2.0 x 10¹⁰ – 3.8 x 10¹³) and are higher than that of upper mantle (~2 x 10⁹). Oxygen – hydrogen isotope values of the waters are conformable with the Global Meteoric Water Line and indicate a meteoric origin. δ³⁴S contents of sulfate in thermal waters cover a range from +12.2 to +45.7‰ (vs. CDT). δ¹⁸O values of sulfate fall in the range -2.5 to +15.6‰ (vs. VSMOW). The carbon isotopic values in dissolved inorganic carbon (DIC) in eastern Anatolia waters are between -17.5 and +5.55‰ (vs. VPDB). The δ¹³C (CO₂) values of gas samples vary from -14.6 to +1.4‰ (vs. PDB). The mixing between mantle and various crustal sources appears to be the main control on the C-isotopes. CO₂ is mostly derived from the crust. Considering that limestone is the main source of carbon (~85 to 99% of the total carbon inventory), carbon flux from the crust is found to be at least 10 times that from the mantle. The mantle-derived helium which is probably transferred to the crust beneath the eastern Turkey by recent magmatism is found to range up to 96% (e.g. Nemrut Caldera) of the total He content in fluids. The temperatures calculated by SO₄-H₂O isotope geothermometry lie between 40 and 196°C which are broadly consistent with estimates from chemical geothermometers.