

Gas geochemistry of the Kamchatka-Kurile arc: Implications for fluxes and recycling of volatiles in subduction zones

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Abstract. The data base on the chemical and isotopic composition of hot spring and volcanic gases from Kamchatka Peninsula and Kurile islands includes data for more than 200 distinct groups of thermal and cold springs and fumarolic fields from 10 volcanoes. Several important tectonically distinct areas can be seen at Kamchatka, all of them extending nearly parallel to the modern volcanic front: eastern peninsulas, for-arc region, volcanic front, back side of the volcanic front, Central Kamchatkan depression, Sredynnyi Ridge, and Western Kamchatka. There are more than 60 active volcanoes along the whole Kamchatka-Kurile arc, more than 15 high-temperature geothermal systems with boiling spring and steam vents, numberless amount of hot and warm springs with different gas and water compositions. Ratios $^3\text{He}/^4\text{He}$, $\text{C}/^3\text{He}$, N_2/He , He/Ar , and C/Cl for fluids with high He/Ne were plotted versus the distance from the Kamchatkan trench, as well as the latitude from northern Kamchatka to southern Kurile Islands. The highest $^3\text{He}/^4\text{He}$ were measured in hydrothermal fluids of Uzon caldera, Pauzhetka

and Mutnovsky fields (up to 8.6 Ra), but not in volcanic gases where even in 920°C Kudryavy gases $^3\text{He}/^4\text{He}$ do not exceed 6.7 Ra. In contrast to many other subduction zones, the for-arc region in Kamchatka is characterized by high $^3\text{He}/^4\text{He}$ in hot spring gases (5.4 Ra, Kronotsky Peninsula). The lowest $^3\text{He}/^4\text{He}$ and highest N_2/Ar were measured at Western Kamchatka in exploration gas wells (0.06 Ra).

We calculated the volatile output from Kamchatka-Kurile island arc using data and estimations of fluxes (SO_2 , CO_2 , H_2O , N_2 , Cl) from volcanoes, high-temperature hydrothermal systems and measured discharge rates of springs or groups of springs. Our output fluxes are more than one order of magnitude higher than those estimated by Hilton et al. (Rev. Mineral., vol. 47, 2002) for the same region, and therefore, the disbalance between output (via arc) and input (via trench) for CO_2 , H_2O and N_2 for the Kamchatka-Kurile arc is much less than it was calculated earlier.