Geophysical Research Abstracts
Vol. 21, EGU2019-11696-2, 2019
EGU General Assembly 2019

Volcanic gas emissions from Taftan and Damavand, the Iranian volcanoes

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Volcanic gas sampling and SO_2 flux measurements were performed at Taftan volcano (3920 m asl, SE Iran, Makran volcanic arc) and Damavand volcano (5610 m asl, Northern Iran, Alborz mountains). Both volcanoes possess near-summit fumarolic fields with moderately intensive gas jets with temperatures up to 160 °C (Taftan) and 175 °C (Damavand). Gases of both volcanoes contain (mmol/mol): H_2O (910-930), CO_2 (50-70), SO_2 (3-7), H2S (2-5), HCl (5-8) and HF (0.1-0.13). Both volcanoes are also similar in terms of minor gas species (mmol/mol): He (0.0005-0.0012), H2 (0.001-0.002), N2 (0.15-0.50) and Ar (0.0010-0.0016). The measured helium contents in Taftan and Damavand gases are 4-6 times higher than those in the majority of arc volcanic emissions. Methane content in Damavand gases (1 mmol/mol) is ∼4500 times higher than that of Taftan. 3He/4He isotopic measurements expressed as R/Ra values were found at 7.0-7.5 Ra at Taftan and 6.65 Ra at Damavand. This corresponds to CO_2/3He ratio of ∼1.0E+10 that is characteristic for a subduction zone. The δ34S of the total sulfur is +7.5±1 permil and δ13C (CO_2) is –5.9 permil (Damavand) and – 4.3 permil (Taftan). Mini-DOAS measurements of the SO_2 fluxes showed 20 ±12 t/d SO_2 at Taftan and 43 ±20 t/d SO_2 at Damavand, which places both volcanoes as small SO_2 emitters.

Concentrations of major gas species (H_2O/CO_2/S/HCl ratios) and isotopic data (3He/4He, CO_2/3He, δ34S) shows that both volcanoes have distinct arc signature of the volcanic gas composition. This result is especially important for Damavand, which has an uncertain tectonic affinity but is usually considered as hotspot/plume volcano. We suppose that the current fumarolic activity of both volcanoes (and high chlorine contents in particular) is explained by boiling two-phase ultra-acidic hydrothermal systems within the volcanic edifice. The existence of such hydrothermal systems is supported by a constant influx of magmatic gas. Chemical and isotopic compositions of Taftan and Damavand gas emissions strongly resemble Ebeko volcano (Kurile Islands), which fumarolic system is fed by boiling of a hyper-acid brine at ∼250– 300 m depth below the summit at temperature of 250–300 °C (Kalacheva et al., 2016).

1. Kalacheva, E., Taran, Y. A., Kotenko, T., Hattori, K., Kotenko, L., & Solis-Pichardo, G. (2016). Volcano-hydrothermal system of Ebeko volcano, Paramushir, Kuril Islands: Geochemistry and solute fluxes of magmatic chlorine and sulfur. Journal of Volcanology and Geothermal Research, 310, 118–131.