

Fumarolic vs hydrothermal fluxes of magmatic volatiles from Kuril island arc, NW Pacific

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Kuril island arc is a part of the Kamchatka-Kuril subduction zone, ~ 1100 km long, with ~40 active terrestrial volcanoes. In 2016 there were 4 erupting volcanoes within the arc with different types of eruptions: lava flows (Snow volcano), ash explosions (Chirinkotan and Chikurachki), phreatic explosions (Ebeko). Many volcanoes are characterized by a permanent fumarolic activity with temperatures of the vents from >900°C (Kudryavy, Iturup Island), to the boiling-point temperature of the secondary steam vents from boiling volcano-hydrothermal systems. Many volcanoes host hydrothermal systems discharging ultra-acid Cl-SO₄ waters where Cl and S are of magmatic origin. At least five volcanoes of the arc: Ebeko (Paramushir), Sinarka and Kuntomintar (Shiashkotan), Pallas (Ketoy) and Kudryavy (Iturup) have fumarolic fields with strong and hot (>400°C) gas vents. In 2015-2016 we measured fluxes of SO₂ using scanning mini-DOAS instrument at the four most powerful volcanic gas emitters of the Kuril Chain that count for more than 90% of the whole permanent fumarolic activity of the islands (Ebeko, Kuntomintar, Pallas, Kudryavy). At each fumarolic field the direct sampling and MultiGas measurements have been performed allowing estimating fluxes of main components (S, CO₂, HCl). The hydrothermal flux of Cl and S from 10 most powerful volcano-hydrothermal systems of Kurils including the southernmost Kunashir and the northern Paramushir islands has also been estimated using measurements of flow rates and the chemistry of draining streams. The total volcanic (fumarolic) flux of SO₂, CO₂ and HCl from the Kuril arc can be estimated as 1200 t/d, 1000 t/d and 250 t/d, respectively (with about 20% of uncertainty). The hydrothermal flux of magmatic S (as SO₂) and Cl is calculated as 250 and 130 t/d, respectively. Assuming that a significant part of S in hydrothermal systems is lost as minerals, the hydrothermal flux of magmatic volatiles can be estimated as a half of the fumarolic flux. The CO₂/S ratio for Kuril volcanoes is variable among volcanoes but nearly constant within a fumarolic field and is found in the range of 0.2 to 4.5 (mole ratio). The highest hydrothermal flux was measured for Ebeko volcano (80 t/d of HCl and 150 t/d of S as SO₂), with the hydrothermal S flux higher than the fumarolic flux. Hydrothermal output at Kuril islands is also manifested by numerous coastal hot neutral springs with a high chloride content, but this Cl has a mixed seawater-magmatic origin, and sometimes it is not easy to distinguish the magmatic fraction. This study was supported by Russian Science Foundation, project 15-17-20011

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