

継続的噴煙活動による全球火山ガス放出量

The global volcanic gas flux from subduction zones by continuous degassing

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Global volcanic volatile fluxes from subduction zones by the continuous degassing are estimated based on the compilation of the SO₂ fluxes and the gas compositions. Previously Andres and Kasgnoc (1998) compiled the measured SO₂ fluxes and estimated that the global SO₂ flux by the continuous degassing is 9.7 Mt/a in which 9.2 Mt/a is from subduction zones. As the SO₂ flux by explosive eruptions is about 1 Mt/a, the continuous degassing is the major emission source of volcanic gases to the Earth's surface (Shinohara, 2008). The previous estimate, however, is likely significantly underestimated because the compilation did not include several large flux volcanoes, such as Popocatepetle, Ambrym and volcanoes in Kamchatka. By compiling the recent SO₂ flux datasets, the global SO₂ flux and that from the subduction zones are estimated to be 18 and 15 Mt/y, respectively. Both estimates are about twice of the previously estimated values.

Volcanic volatile fluxes can be estimated by multiplying the SO₂ flux with the concentration ratios of the volcanic gases. Previous studies estimated the concentration ratio of the volcanic volatiles by compiling fumarolic gas composition data, because volcanic gas compositions were available only for the accessible fumaroles. The fumarolic gas degassing is commonly small in flux and often studied during waning stage of the eruptive activity. Recent development of the Multi-GAS techniques enabled to measure volcanic gas composition discharged from the open-vents, that are the major degassing sources of the continuously degassing. The recent compilation indicates that the volcanic gas composition of the open-vent degassing with the large SO₂ flux is different from the high-temperature fumarolic gases. For example, the previous studies estimated the average CO₂/SO₂ ratio of the Japanese volcanic gases is 2.2 or 6.5, however, the average ratio obtained based on the measured composition of the large flux continuously degassing volcanoes is 0.9. The large ratios estimated by the previous studies are due to the contribution of the fumarolic gases of Usu and Showashinzan volcanoes, which are high in temperature but quite small in fluxes and with the CO₂/SO₂ ratios larger than 10. The estimated average composition of Japanese volcanic gases are H₂O/SO₂= 50, CO₂/SO₂=0.9 and Cl/SO₂=0.2 mol ratios.

The number of the volcanic gas composition measurements of the open-vent degassing is still limited at volcanoes other than in Japan, and the estimated of a precise average composition is difficult. The observed composition ranges from the average composition for the Japanese volcanoes to CO₂-rich composition, similar to the global estimate by the previous studies. The volcanic gas compositions are different at the different subduction zones; Japan and Kamchatka have relatively small CO₂/SO₂ ratio around one, whereas Italian volcanoes have large ratio over six. In contrast, the H₂O/SO₂ ratios and the CO₂/Cl ratios of the open-vent degassing are around 50 and 5, respectively. Although more detailed data set is necessary to the precise estimate, a middle value of the composition range is considered as the average composition; H₂O/SO₂=50, CO₂/SO₂=2 and Cl/SO₂=0.5. Based on this composition and the SO₂ flux, the global volcanic volatile flux by the continuous degassing is estimated as H₂O=200, CO₂=21, SO₂=15 and Cl=4.4 Mt/a. Because of the small H₂O/SO₂ and CO₂/SO₂ ratios, the estimate H₂O and CO₂ fluxes are about four times less than by the previous studies, such as Hilton et al. (2003) and Fischer (2008).

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