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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 Erath'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).

Keywords: Volcanic gas, Subducgtion zone, volatile flux, continuous degassing