Mantle carbon and sulfur fluxes in subduction zone

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Carbon and sulfur dioxide have been discharging for a long time from the Earth´s mantle to the atmosphere through volcanic and hydrothermal activity. In contrast to noble gases, they do not accumulate in the atmosphere but are chemically trapped as compounds in oceanic sediment and terrestrial deposits. Some of them may be recycled again into the mantle. Subduction-zone volcanism is a key area to study these volatile transfers to the mantle and/or the recycling. The mantle C flux at mid-ocean ridge (MOR) was assessed from the spreading rate of oceanic plates and their C content (1) and from the MOR-^{3}He flux and $CO_2/^3$He ratio in basalt glasses (2). On the other hand, the degassing rate at convergent plate margins was estimated by the flux observation in arc volcanoes (3) and the ARC-^{3}He flux and $CO_2/^3$He ratio in volcanic gases (4). Recently MOR-^{3}He flux has been revised to 530 mol/y by an ocean general circulation model (5), which is about half of the previous value. Based on the new value and argument of global ^{3}He flux (6), ARC-^{3}He flux could be corrected to 110 mol/y. From the literature, we have selected 26 arc volcanic gas and steam well data whose temperatures are higher than 200℃. Their C is well explained by the mixing of three components, MORB, Sediment and Limestone (7). Since the average $CO_2/^3$He ratio of these data is $1.9\pm1.0\times10^{10}$, ARC-C flux would become $2.1\pm1.1\times10^{12}$ mol/y, which is consistent with 1.9×10^{12} mol/y by the most recent estimate (8). The mantle S flux of $0.1\text{-}2.6\times10^{11}$ mol/y at MOR has been reported by a new experimental crushing and extraction method of MORB (9), which is significantly smaller than the old value of 2.7×10^{12} mol/y (10). On the other hand, the ARC-S flux of 3.15×10^{11} mol/y was estimated by the SO_2 flux from volcanoes (8). We discuss here the ARC-S flux based on the ARC-^{3}He flux and $SO_2/^3$He ratio in high temperature volcanic gases.

Reference (1) Javoy et al., 1982. Nature 300, 171-173 (2) Marty and Jambon,1987. EPSL 83, 16-26 (3) Hilton et al., 2002. RiMG 47, 319-370 (4) Sano and Williams, 1996. GRL 23, 2749-2752 (5) Bianchi et al., 2010. EPSL 297, 379-386 (6) Torgersen, 1989. Chem Geol 79, 1-14 (7) Sano and Marty, 1995. Chem Geol 119, 265-274 (8) Fischer, 2008. Geochem J 42, 21-38 (9) Kagoshima et al., 2012. Geochem. J. 46, e21-e26 (10) Alt et al., 1985. Init. Rep. DSDP 83, 283-287