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Volcanic degassing by conduit magma convection: Links and gaps to magmatic volatiles

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Volcanic degassing occurs at various phenomena such as, different types of eruptions, continuous degassing, diffuse degassing through soil gases and hot springs. Links between the volcanic degassing and magmatic volatiles are controlled by degassing processes, in particular by P-T-time path of the magmas, and the degassing processes are different for the different styles of the volcanic degassing. Among the various degassing phenomena, the continuous degassing is the phenomenon which discharges majority of the volcanic gases (Andres and Kasgnac, 1988; Shinohara 2008); therefore it provides a fair estimate of an average composition of the volcanic degassing. Conduit magma convection is the mechanism to drive the continuous degassing volcanoes, not only of basaltic magmas but also of silicic magmas such as at a rhyolitic volcano of Satsuma-Iwojima (Kazahaya et al., 1994; Shinohara and Tanaka, this meeting). As degassing of the conduit magma convection occurs at low pressure, composition of the volcanic gas is similar to the volatile composition of the magma, except for highly soluble volatiles such as Cl and F. Agreement between the H2O/S ratios of volcanic gases and magmatic volatiles in melt inclusions is observed at various volcanoes with the continuous degassing activity. In contrast, CO2 does not show such a simple behavior as S and H2O. Commonly CO2 contents in melt inclusions are lower than that expected from CO2/S ratio in volcanic gases and the dissolved S content, suggesting that the trapped melt was supersaturated with CO2. CO2 in melt inclusions also often shows a large scatter with higher contents relative to simple degassing trends on the H2O-CO2 system, and the high-CO2 content is often attributed to buffering the melt composition by a large amount of very CO-rich bubble (>50 mol%; CO2-fluxing). However, there is no example of the intensive degassing of such highly CO2-rich volcanic gases, and the CO2-fluxing is not the major process of volcanic degassing. This discrepancy can be resolved by considering mixing of degassed and un-degassed magma in the convecting magma column (Witham, 2010). Another important gap is that melt inclusions are trapped often during the eruptions whose gas composition does not represent that of the present degassing activity. Two populations of CO2-H2O contents were observed in basaltic melt inclusions of Miyakejima 2000 eruption and are attributed to the CO2-fluxing by the vapor phase separated from deep-seated magmas (Saito et al., 2010). The CO2-fluxing, however, does not readily imply an activity of a CO2-rich magma, as the amount of the erupted basalt is three order of magnitude less than the amount of degassed basalt during ten years after the eruption. It is more likely imply that the melt inclusions preserve the processes occurred during the magma ascent to the eruption, and does not represent volatile composition of the bulk magma chamber.