Exsolution and dissolution of CHO fluids upon isobaric magma mixing

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Understanding the behavior of volatile components upon magma mixing is important to comprehend the eruption dynamics, especially the triggering mechanism, as it controls the density of magmatic systems through exsolution or dissolution of fluids (bubbles). However, due to the non-ideality of the H_2O–CO_2 binary solution, the behavior of volatiles is not easy to understand. Yoshimura and Nakamura (2010) showed that H_2O-rich melt may vesiculate by CO_2-fluxing owing to a decrease in the H_2O fugacity in the silicate melt. Magma vesiculation is expected to occur through a similar mechanism by mixing with CO_2 –rich magma, although the detailed conditions have not been clarified. In this study, we calculated the changes in the solubility of the volatile components in the H_2O–CO_2 binary system upon magma mixing, and also the changes in the amount of bubbles (free-fluid phase) at 100 MPa and 100˚C. In the mass balance calculation, it was assumed that magmas consist of melt and bubbles, and crystallization of basaltic melt was excluded from the preliminary calculations. The changes in the bubble content before and after the mixing were obtained for the following three initial situations. Case (1): basalt contained bubbles, but rhyolite was bubble-free, though saturated with volatile components; Case (2): rhyolite contained bubbles, but basalt was bubble-free, though saturated with volatile components; and Case (3): both basalt and rhyolite contained bubbles. The changes in solubility were investigated by employing various mixing ratios in each case.
Our findings showed that the total bubble content in the system increased under the following conditions. In Case (1), when the basaltic system is CO_2–rich, and the rhyolite melt is H_2O–rich; in Case (2), when the rhyolitic system is CO_2–rich and the basaltic melt is H_2O–rich; in Case (3), when the bubble content in the basaltic system is large, both the basaltic and rhyolitic systems are CO_2–rich; and when the bubble content in basalt is small, the basaltic system is H_2O–rich, and the rhyolitic system is CO_2–rich. These results suggest that the total amount of bubbles may increase during the course of mixing of magmas with different volatile compositions. Injection of CO_2–rich basalt into H_2O–rich rhyolite, which is common in arc volcanoes, may trigger volcanic eruptions.

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