DEGASSING SYSTEM OF SATSUMA-IWOJIMA VOLCANO

KAZAHAYA Kohei, SHINOHARA Hiroshi, and SAITO Genji
Geological Survey of Japan

Magma convection in a conduit has been proposed as a mechanism responsible for intensive and continuous degassing of magmatic volatiles from basaltic to andesitic volcanoes. Driving force of the convection could be a density difference between dense magma degassed at shallow level and less dense non-degassed magma supplied from deeper level. Once the convective degassing started, it could continue until the whole magma chamber is degassed or collapse of a conduit occurs. The aim of this study is to extend above mentioned degassing mechanism to more viscous rhyolitic magma systems, and illustrate magma processes more quantitatively.

Mt. Iwodake, a main rhyolitic lava dome of Satsuma-Iwojima island, is placed near the north-western rim of submarine Kikai caldera (ca. 18km in diameter) whcih is the youngest caldera in Japan that formed 6300 B.P. Inside the caldera, post-caldera products, mainly composed of submarine lava dome, accumulated over 60km^3, suggesting quite high magmatic activity is continuing since caldera-forming eruption occurred.

Volcanic gases have been releasing for longer than 800 years from the summit crater of Iwodake. Isotopic results of the summit volcanic gases indicate most of these gases are composed of magmatic origin. The highest fumarole temperature was measured up to 900 °C. Magmatic volatile fluxes were estimated to be 0.5-1 kt/d SO_2 by COSPEC and 14k-27 kt/d H_2O using SO_2/H_2O of fumarolic gases. The latest magmatic eruption in 1934 inside Kikai caldera forms a small island (Showa-Iwojima) composed of pyroxene rhyolite.

Analyses of melt inclusion in the phenocrysts show volatile content of 1-1.5wt% H2O and 0.01wt% S (Saito et al., in press). Assuming that the present degassing magma has a volatile content similar to the Showa-Iwojima magma, we can calculate the mass rate of the magma degassing using magmatic volatile fluxes to be 1.0-2.7 Mt/d (0.14-0.4 km^3/y). Since the degassing is believed to have been continued longer than 800 years, the minimum estimate for volume of the degassed magma is >150 km^3. Magma degassing under very low pressure condition (<20 bar) is suggested from high temperature of fumarolic gas (900 °C) and compositional similarity between volcanic gases and volatiles in melt inclusions. It is quite difficult to imagine the placement of the large magma chamber at such low pressure condition. Consequently, magma convection in a conduit is required as a mechanism for intensive degassing of a large and deep magma chamber inside the caldera.

Magma convection may be driven by the density difference between degassed and non-degassed magma in a conduit. Degassing of 1wt% water would make the density difference of 50 kg/m^3. Magma convection processes are tested using two simple models, concentric double walls pipe and sphere ascent. By use of the magmatic parameters, conduit diameter of 30-70m is necessary to drive the convection in a conduit. Although there are no estimates on conduit diameters, the calculated diameter may not be impractical. In the figure, a possible magma chamber model is illustrated. Upper high temperature rhyolitic magma and is supplied magmatic gases and heat from the underlain basaltic magma (Saito et al., in press).

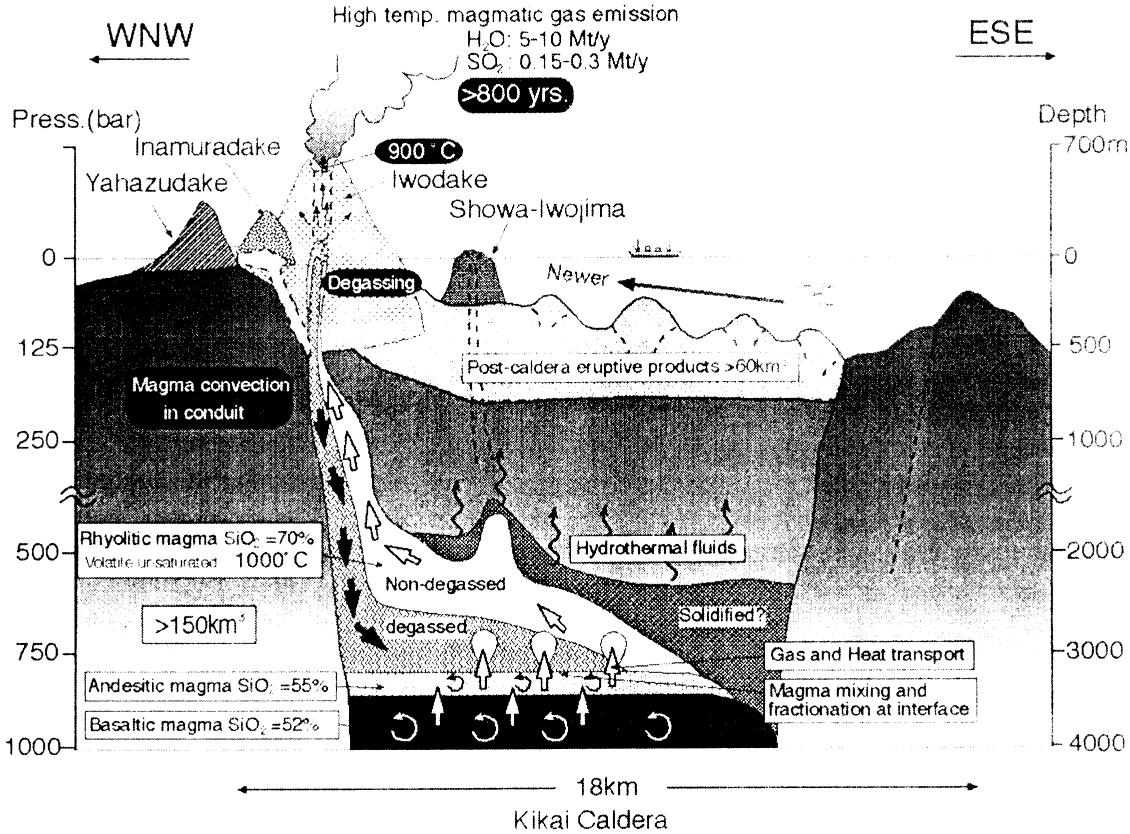

Figure A schematic illustration showing magmatic processes of Satsuma-Iwojima volcano, Japan.