Melting experiments on tonalite and its implications for origin of rhyolitic magma

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Partial melting of andesitic rocks have been proposed as the one of hypothesis for the origin of rhyolitic magma. In the present experiments, melting behaviors of tonalite have studied under high pressure - high temperature conditions, and its relation to the origin of rhyolitic magma was discussed.

Tanzawa tonalite was used for the starting material of the present experiments. In order to make fine powder of this tonalite sample, it was pulverized by a swing mill, and then grounded by a SiN mortar. This powdered tonalite was sealed in Ag-Pd or Au-Pd capsule, and used for the present experiments. High pressure - high temperature experiments were carried out by using 500 MPa type internally heated gas pressure vessel, installed at Tokyo Institute of Technology. The specimen was held at 100 - 450 MPa and 900 - 1100 C for 5 - 50 hours, and quenched by dropping the sample to the colder end of the high pressure chamber. The recovered specimen was polished and its chemical composition was measured by EPMA. The oxygen fugacity was not controlled in the present experiments.

The phases observed in the recovered specimens were melt, plagioclase, OPx, CPx and magnetite. Quartz was also observed in the experiments at around 900 C. The chemical compositions of the solid phases were a little different with grain to grain, indicating that the specimens have not been in the equilibrium condition. However, we can observe a general trend in the variation of melt composition with change in pressure - temperature conditions. Although no obvious change was found in the melt composition with increasing pressure, SiO2 content of the melt was increased with temperature. These results are consistent with the previous melting experiments on the rocks with the similar compositions. Since the composition of melt resembles to that of rhyolitic magma, it have been proposed that rhyolitic magma is generated from partial melting of tonalitic rocks. However, there are considerable differences in the compositions of alkali elements between rhyolites and the melts generated from tonalites. K and Na content in the melts generated from tonalites are apparently smaller than that of rhyolites. For example, K content in the rhyolites amounts to approximately 3 wt%, while that of melts is lower than 2 wt%. The pressure - temperature dependences of melt composition observed in the present experiments suggest that the observed difference in alkali content can not be explained by the difference in pressure - temperature condition. Therefore, it seems difficult to produce ryolitic magma from the 'simple partial melting' of tonalitic rocks.