Variation in Subduction magmatism -Spatial variation of volcanic rocks in Sengan region, NE Japan-

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Subduction zone is considered to be major entrance of mass flux from the surface into the Earth's interior. It is important to know physical and chemical processes of subduction zone to understand the current activities and history of the Earth. Volcanic rocks are major output from the Earth's interior, and may retain material information from the inside. Studying volcanic rocks of subduction zones is one of such approaches to understand the subduction zone processes, especially of the mantle wedge.

Previous studies on subduction zone volcanic rocks mostly focus on 2D variations on across-arc or a larger spatial scale. Recently, 3D along-arc heterogeneous structures in the mantle wedge of about 50 km scale are suggested in studies of seismic tomography (Hasegawa et al., 2004), distribution of volcanoes (Kondo et al., 1998) or topography (Tamura et al., 2002). This heterogeneous structure can be produced by the dynamic 3D model (Honda and Saito, 2003) as a roll-like structure of a small-scale convection under the back-arc. However, some essential factors such as distribution or migration of water have not been considered in the dynamic models. Origin of the along-arc heterogeneity has not yet been clarified. Purpose of this study is to constrain the origin of the along-arc variations of the volcanic rocks in the Sengan region, northeastern Japan arc (hereafter, referred to as NE Japan arc). We try to estimate temperature, pressure and composition of the source region of melt generation, in order to put more detailed constraint on structure and dynamics in the mantle wedge.

Tectonic setting of the NE Japan arc is relatively simple compared to the other regions such as Central Japan. Volcanoes are distributed densely near the volcanic front of the NE Japan arc. Especially in the region around lat. 39.80N, long. 140.80E over 20 Quaternary volcanoes are distributed and form a huge volcanic cluster called the Sengan region of about 25km*40km in area. The region is considered to be suitable target for studying and modeling a 3D structure described above.

Quaternary volcanic rocks were collected in the Sengan region and whole rock compositions and mineral compositions were analyzed. Published bulk compositions and K-Ar ages of volcanic rocks in the Sengan region from the literature are also compiled, and the spatial variations of magmatism are examined. From the major element compositions of bulk rock, it is suggested that the volcanoes in the Sengan region have a systematic spatial variations in composition. Based on the contents of major elements at the same MgO content (5.5 wt. %), volcanoes in the Sengan region are grouped into two: one with higher SiO2, P2O5 and alkali contents, and another with higher Al2O3 and CaO contents. The latter group is distributed at frontal, southern and northern sides around the former group like a horseshoe shape. These spatial variations are also recognized in terms of incompatible trace element compositions.

Observed variations of compositions of volcanic rocks in the Sengan region cannot be reproduced by a simple mass balance model that simulates crystal fractionation. The key features of the variations still remain even after application of olivine addition model (Takahashi, 1986). We utilize MELTS program (Ghiorso and Sack, 1995) with the bulk rock compositions and mineral compositions to examine these variations, and to investigate the liquid line of descent (phase relationship, P, T conditions and H2O content) of the basaltic suites of each volcanoes. These spatial variations in bulk chemical composition may reflect different conditions of melting in mantle wedge. Compared with the melting experiments of peridotite (Hirose and Kawamoto, 1995; Gaetani and Grove, 1998), these variations cannot be explained simply by different degree of melting and require multiple effects of different factors, such as temperature, pressure and H2O content.