Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SCG60-02 Room:201A Time:May 25 11:15-11:30

Subduction Initiation and spatial and temporal variation of magma generating condition in the Miocene SW Japan

MORISATO, Fumitoshi[1*] ; OZAWA, Kazuhito[1]

[1]Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo

Introduction

The relationships between arc magmatism and thermal and chemical structures of subduction zones have been investigated in two dimensions (e.g., Spiegelman & McKenzie, 1987; Tatsumi, 1989). However the necessity of a three-dimensional point of view is indicated in Northeast Japan (Tamura et al., 2002; Ueki & Iwamori, 2007) and 3-D numerical simulations (Honda, 2011). Processes involved in the initiation of 3-D structures in actual subduction have not been well studied because of the fragmental nature of geological records during subduction initiation (Umino & Ishizuka, 2010 etc.).

In the Miocene Southwest Japan, temporarily (12˜18Ma) and spatially (˜900km) wide spread magmatism occurred during the initiation of subduction (Sumii, 2000; Tatsumi et al., 2001, etc.). The migration of magmatism has been discussed with 2-D model (Kimura et al., 2005). Clustering of volcanic rocks spacing of ˜50km and elongating crossing the arc (west Shikoku, east Shikoku, and Kii Peninsula) and corresponding crustal structures strongly suggests 3-D mantle dynamics must be invoked. We tried to decipher 3-D heat and material transportation in the mantle by estimating spatial and temporal change of magma generating conditions of the Setouchi Volcanic Belt.

In the Setouchi Volcanic Belt, magma generating condition has been estimated from multiple-saturation experiments on andesitic lavas (Tatsumi & Ishizaka, 1982, etc.), geochemical characteristics (Shimoda et al., 1998, etc.), and modeling thermal structure (Furukawa & Tatsumi, 1999). The primitive andesitic magmas with more than 4 wt% H_2O was inferred to have been generated through reaction between wedge mantle and slab-derived melt (Tatsumi et al., 2006). We try to put proper constraints on melting conditions of mantle with least assumptions by exploiting useful information from volcanic rocks.

We focus on the eastern Shikoku cluster. We analyzed whole-rock compositions of andesites by using XRF and LA-ICP-MS in the central area (Kanayama, Kiyama, and Goshikidai area) and western margin (Shichiho-san area). We also used literature data from eastern margin (Shodo-shima area: Tatsumi et al., 2006).

Result and Discussion

In the central area, the variation of major element composition can be explained by fractional crystallization of a parental magma containing up to 2wt% H_2O (alphaMELTS) and magma mixing between the daughter magmas. Extensive degassing is not required if the water content (0.48˜1.7 wt%:Henmi et al., 1976) and a small amount of vesicles in the lavas are taken into consideration. We constrain a range of primary melt compositions from the most magnesian zone in oscillatory zoning of orthopyroxenes. The primitive magma was estimated to be SiO_2=56.8˜57.1 wt%, MgO=13.2˜11.7 wt%, and H_2O=0.9˜1.5 wt%. Such melt can be in equilibrium with harzburgitic mantle at ˜30km in depth (alphaMELS) and 1240˜1200 degrees Celsius (Sugawara, 2000; Medard & Grove, 2008).

The variations of HFSEs and HREEs against SiO_2 as a differentiation proxy, indicate later andesites in the central area were derived from more fertile material, although common sub-arc mantle was melted in three areas in the initial stage. The abundance of LILEs indicates the source materials of the central area and the eastern margin were significantly affected by slab-derived fluid in the later stage. The potential temperature and the initial depth of melting are estimated to be 1300˜1250 degrees Celsius and ˜75km respectively by assuming melting of a fertile lherzolite with 25% melting degree.

We proposed a model that the clustering of magmatism formed by upwelling of forced convection induced by subduction initiation. The temporal change of the source material is attributed to upwelling of deeper part of the mantle and involvement of slab components by deeper penetration of the slab. 3-D thermal structures in the steady-state subduction may be inherited from to dynamics of subduction initiation.

Keywords: Subduction initiation, Primary magma, Southwest Japan, Setouchi Volcanic Belt, Mantle dynamics