瀬戸内火山帯における沈み込み開始期の熱および物質輸送のダイナミクス

Dynamics of heat and material transportation during subduction initiation in the Setouchi Volcanic Belt

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Kowledge of subduction initiation is critical for better understanding dynamics of plate tectonics, but is difficult to obtain because of its episodic and transient nature resulting in incomplete and fragmental records. The key issue is elucidation of heat and material transportation in a subduction zone during the subduction initiation. The aim of this study is clarify spatial and temporal changes of thermal state and material distribution involved in volcanisms of the Setouchi Volcanic Belt to scrutinize subduction initiation by exploiting its excellent records of the processes of subduction initiation.

The Setouchi Volcanic Belt (SVB) in the Southwest Japan arc has a record of igneous activities which show temporally and spatially continuous distributions in the forearc region in the Miocene period. The SVB is characterized by the occurrence of primitive volcanic rocks such as high-Mg andesite (HMA) and basalt. Previous studies in the Shodoshima Island and Osaka argued that HMA magmas are generated by highly wet melting of the wedge mantle involving slab melt from the subducting young and hot Shikoku Basin in the early stage of subduction initiation (Furukawa & Tatsumi, 1999; Shimoda & Tatsumi, 1999; Tatsumi et al., 2006). However, there are several issues that must be addressed: (1) HMAs are very poor in water; (2) the estimated melting conditions for HMA and basaltic magmas are very disparate: hydrous and 1050 to 1150 ℃ vs. less hydrous and 1300 ℃, which are supposed to have been close in time and space in the mantle; and (3) the proposed magma genesis is highly dependent on data in a particular and restricted domain (< 20 km in width) in spite of the wide extension of SVB (600 km in width) consisting of several domains with higher concentration of volcanisms.

There are three sectors of higher frequency of volcanic rock distribution in the SVB on the scale of about 100km scale, each of which may correspond to a separated domain of magma generation. We selected north-eastern part of the Shikoku (NE Shikoku), as study area, where magma genesis has not scrutinized yet. We measured whole rock composition of lavas by using XRF, LA-ICP-MS, and ICP-MS and mineral chemical compositions of phenocrysts with EPMA, and obtained K-Ar ages for samples collected from this sector in the SVB.

Our estimation of a primary magma for HMAs in the north-eastern Shikoku, which is based not only on whole rock major element compositions but also on chemical zoning of phenocrysts, is more magnesian (> 11.6 wt% MgO) than that of the previous study. Geothermometer of Sugawara (2000) combined with liquidus drop after Méderd & Grove (2008) and alpha MELTS program (Ghiorso et al., 2001; Asimow et al., 2003) constrains melting condition of the primary magma as 1GPa and 1200-1240 ℃ with 1.5-0.9 wt % H2O. The pressure and temperature are close to the basaltic magma generating conditions proposed by Tatsumi (1982). Because of the similarity of major element compositions, the generation conditions of the HMA magma could be common throughout the SVB. By contrast, the whole

rock trace element compositions and K-Ar ages show spatial and temporal variations, which suggest variability in timing and extent of supply of a slab-derived component (marked by high LILE/HREE) and/or an enriched mantle component (marked by high HREE abundance). There is a tendency that these components were added in a later stage in a given area.
We argue that achievement of temperature over 1200℃ just beneath the crust for generation of HMA and basalt magmas with temporal changes of source material and involvement of slab-derived fluid components were caused by several local mantle upwellings. Such upwelling induced by the subduction initiation might have entrained slab and/or enriched source components at the leading edge of subducting slab.

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