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Experimental constraint on magma genesis for petit-spot in the northwestern Pacific: the first step

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A comprehensive investigation for petit-spot in the northwestern Pacific had been conducted using geological, petrological, electromagnetic, and seismological approaches. During the investigation, we faced some critical problems for petit-spot genesis as follows. (1) Although the ”plate flexure model” (Hirano et al., 2006, Science) is trying to explain the eruption mechanism by magma exuding where the Pacific plate flexes and fractures before subducting, it does not explain the melting mechanism. (2) Supposing that the ”plate flexure model” accompanying outer rise formation only constrains petit-spot genesis, volcanoes should be continuously distributed along with outer rise. However, distribution of the petit-spot in the northwestern Pacific, as an example, is limited to three regions, and is not continuous at least. This observation suggests that the restriction by melting mechanisms is the key to understanding the petit-spot genesis. (3) The ”small-scale recycled plate material melting model”, proposed on the basis of Sr, Nd, and Pb isotopic composition of lavas (Machida et al., 2009, GCA), is strong constraint on melting mechanism. However, the nature of source material is still not clarified, because the model is absolutely qualitative. Furthermore, (4) we could not detect heat anomaly, as well as melting region, by electromagnetic and seismological observations. In order to solve these problems, independent-determination of temperature and pressure for magma production on each volcanic edifice will be the breakthrough, thereby addressing construction of a comprehensive model for petit-spot genesis. We thus consider that multiple saturation experiment is the best way to determination of melting conditions. And, as the first target, we select a youngest knoll situated in flexed region of the northwestern Pacific plate.

We conducted melting experiments using 1/2-in.-diameter piston cylinder type high-temperature and high-pressure apparatus at Kyoto university. A starting material was prepared from mixture of oxide and carbonate reagents, representing the major element compositions of a primary magma equilibrated with Fo=90 olivine (obtained by the olivine maximum fractionation model) and including 10% CO_2 (estimated on the basis of vesicularity of lavas (Okumura and Hirano, in prep.)). All experiments were configured by complete melting of starting material under a target pressure and 1400^{o}C in graphite capsule within outer sealed platinum capsule for 2 hours, followed by equilibrating of melt and solid phases under a target temperature with constant pressure for 2 hours. As a result, the primary magma is saturated with olivine and orthopyroxene or clinepyroxene at 1280^{o}C and 2.1-2.2 GPa. Therefore, it is revealed that petit-spot magmas were equilibrated with depleted peridotite (harzburgite) at the lower part of lithosphere, in consideration of 82 km deep for lithosphere-asthenosphere boundary beneath WP2 (Kawakatsu et al., 2009, Science) in the northern Pacific.

Keywords: petit-spot, multiple saturation experiment