In situ observation of wet solidus from xenoliths and its control on rheological structures of lithospheric mantle beneath Ichinomegata, NE Japan

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A fundamental question about lithosphere-asthenosphere boundary (LAB) is what causes the rheological contrast between lithosphere and asthenosphere. Two major proposed solutions for this problem are: (1) abrupt appearance of interstitial melt (e.g. Hirschmann 2010, Green 2010) and of hydroxyls (e.g. Karato 2010, 2012) in the top of asthenosphere. In order to address this issue in the arc environment, where hydrous upper mantle is expected, we investigate depth variations of deformation microstructures and presence or absence of fluid/melt phase in mantle xenoliths from Ichinomegata volcano, where reliable estimates of derivation depths of the xenoliths are available.
Ichinomegata volcano is a 60-80 ka mar (Kitamura 1990) located on Oga peninsula, in a back-arc side of NE Japan. In this area, active subduction of the Pacific Plate beneath the North American Plate has been supplying water to the overlying wedge mantle (e.g. Kumagai et al. 2014). Mantle xenoliths were found in andesitic-dacitic pyroclastic rocks (Katsui et al. 1979). They are either plagioclase- (and/or spinel-pyroxene symplectite after plagioclase) bearing or plagioclase-absent spinel peridotites (Takahashi 1978, 1986). We examined three plagioclase peridotites and six spinel peridotites to identify phases and microstructures along grain boundaries and their distributions.
Interstitial phases were examined with FE-SEM. Fluid phase is identified by the presence of fluid inclusions in olivine and etch pits on the interphase boundaries. Melt phase is identified by the presence of interstitial glass containing vesicles with growth textures of contacting olivine. Two equigranular and tabular granular plagioclase peridotite containing pargasite, one granular spinel peridotite, and one porphyroclastic spinel peridotite are shown to have fluid phases. Two porphyroclastic spinel peridotites, one porphyroclastic spinel peridotites containing amphibole as inclusion in clinopyroxene, and one equigranular spinel peridotites are shown to have melt phase according to above criteria. The chemical compositions of glasses and their petrographic features are consistent with those reported by Takahashi (1986). The samples with interstitial melt recorded a rapid heating event (referred as "preheating" by Takahashi (1986)), and exhibit homogeneous Ca distribution in olivine suggesting persistence (>1000 yrs) of "preheating" forming interstitial melt.
The xenolith samples were compared in terms of the rock textures, depths, and temperatures before xenolith extraction, which are based on pressure-dependent thermometers of T_{BKN} and $T_{Ca\text{-}in\text{-}Opx}$ (Brey and Köhler 1990) from chemical compositions of pyroxenes rims (see our companion presentation). There are systematic correlations between the presence of fluid/glass with rock textures, phase assemblage, and pressure and temperature conditions. Fluid phase is found in equigranular samples registering low pressure and temperature (0.7-1.2 GPa and 831-1016 °C), and melt phase in porphyroclastic samples registering high pressure and temperature (1.2-1.6 GPa and 1045-1084 °C). The boundary between the disappearance of the presence/absence of melt and fluid is ca. 1.2 GPa and 1000 °C, which are almost the same as the wet peridotite solidus experimentally determined by Grove et al. (2006). The coincidence of textural transition from equigranular to porphyroclastic and that of intergranular phases from fluid to melt during high temperature "preheating" stage suggests that the appearance of interstitial melt at high-temperature at wet solidus might govern the rheology of hydrous wedge mantle. The wet solidus may have migrated according to the thermal state beneath the LAB, which might represent dynamics of the

LAB region hypothetically assumed above hydrous wedge mantle.

Keywords: wedge upper mantle, petrology, rheological structure, LAB

