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# Geometry of intergranular fluids in the mantle xenoliths: Implications for the physical properties of upper mantle

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Recent magnetotelluric (MT) studies have revealed that crust and uppermost mantle are less resistive than dry rocks in various localities in the world. This suggests that interconnected fluid phases present more ubiquitously than previously realized. Intergranular fluids also decrease seismic wave velocities and changes Vp/Vs ratio, thus interpretation of the seismic tomographic images largely depends on the volume faction and geometry of the fluid phase. The conventional view on grain-scale fluid distribution is based on dihedral angle between minerals and fluids in isotropic monomineralic rocks (i.e. ideal equilibrium geometry). Natural rocks are, however, composed of ani-sotropic multiple phases and undergo textural adjustment to minimize interfacial and strain energy such as grain growth and dynamic recrystallization, which results in microstructural complexity. In order to understand real fluid distribution in deep-seated rocks, we conducted an X-ray CT study of xenoliths from the uppermost mantle from various localities.

The mantle xenoliths samples investigated were from Ichinomegata (NE Japan), Eifel (W Gernamy), San Carlos (AZ, USA), Bullen Merri and Shadwell (Victoria, AU), Kilbourne Hole (New Mexico, USA), Longang-hu (NE China), Gi-rona (Spain), Lanzarote (Canary islands), and Moses Rocks (Uta, USA). The micro-focus X-ray CT imaging was performed using Comscantecno ScanXmate-D160TSS105 in Tohoku University Museum with a tube voltage of 100 – 130 kV and current of 90 – 120 mA. The voxel size was typically 43 – 73 $\mu m^3$. The 3-D image analysis was carried out with a software package Slice[1].

All the observed spinel lherzolite and Harzburgite xenoliths contained up to a few vol% of intergranular pores, indicating that the rocks were saturated with a free-fluid phase. The imaged pore fluids are typically polyhedral and tens – hundreds of micrometers in scale; this suggests that they were formed via coalescence of smaller pore fluids. The fluids are localized in interphase boundaries (between different mineral phases), while most of the monomineralic triple junctions lack pore fluids. All these characteristics are consistent with the results of grain-growth experiments in a fluid-bearing bimineralic system[2]; in other words, the role of interfacial energy anisotropy and grain growth are crucial in determining fluid distribution in nature. In the ellipsoid approximation, the 3-D shape of the intergranular fluids show deformed rugby-ball shape with aspect rations larger than those of the equilibrium fluid geometry determined by the dihedral angle[3]. The geometry, distribution and thus connectivity of fluids cannot be assessed simply from dihedral angles.

The results of CT imaging suggest that no pervasive grain-scale fluid interconnection is established in the uppermost mantle. To explain the observed low electrical resistivity in the mantle which does not undergo partial melting, concentration (localization) and interconnection of CHO fluids in a larger spacing, such as in meter-scale shear zones should be necessary. Given the observed geometry of the inter-granular fluids, their effects on Vp/Vs ration is limited.

References: [1]Nakano et al. http://www-bl20.spring8.or.jp/slice/ (2006). [2] T. Ohuchi and M. Nakamura J. Ge-ophys. Res. 111, B01201, doi: 10.1029/ 2004JB003340 (2005). [3] Y. Takei JGR 107 (B2) doi:10.1029/2001JB000522 (2002).

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