CO_2-rich melt in the asthenosphere

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Carbon dioxide (CO_2)-induced partial melting of mantle peridotite is expected as the cause of the seismic low-velocity and high electrical conductivity in the asthenosphere, but not directly evidenced. Petit-spot [1], diminutive volcanoes at the deformation front of the outer rise of the northwestern Pacific plate, should provide important insights to investigate the nature of the asthenosphere, because of following discussions and observations. Models for the eruption of petit-spot volcanoes [1,2,3,4] suggest that magma exudes from the upper-most asthenosphere in response to plate flexure. The primary petit-spot magma includes approximately 10% of CO_2 and 1% of H_2O [5]. However, because these previous studies discussing about petit-spot volcanism have not constrained the processes and conditions of the generation of petit-spot magmas, we must clarify whether or not the petit-spot melt is generated in the asthenosphere.

Recently, we presented the results of melting experiments to define the genesis of primitive CO_2-rich alkali magma forming petit-spot [6]. The results suggested that primitive petit-spot melt last equilibrated with depleted peridotite at 1.8–2.1 GPa and 1280–1290 ˚C. The equilibration pressure of petit-spot magma corresponds to the pressure of the lower lithosphere. However, to explain the higher equilibration temperature of petit-spot magna than estimated termerature of the lower lithosphere, we conclude that petit-spot originates from CO_2-rich silicate melt in the asthenosphere, which is always produced because of the existence of CO_2-rich fluid or carbonate. Therefore, geochemistry of petit-spot lavas could contribute to quantitative determination of amount of CO_2 in the asthenosphere. The linkage between the lithology of the seismic low-velocity layer and global carbon recycling should be investigated using petit-spot lavas to understand the role of carbon in Earth's dynamics and evolution.

References

[1] Hirano et al. (2006) *Science* **313,** 1426–1428.
[2] Valentine and Hirano (2010) *Geology* **38,** 55–58.
[3] Yamamoto et al. (2014) *Geology* **42,** 967–970.
[4] Machida et al. (2015) *Earth Planet. Sci. Lett.* **426,** 267–279.
[5] Okumura and Hirano (2013) *Geology* **41,** 1167–1170.
[6] Machida et al. (2017) *Nature Communications* **8**, 14302.