Petit-spot lavas as a window into the geochemistry of the asthenosphere

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The dynamics of the Earth's interior is reflected in processes at the Earth's surface, where rigid plates (lithosphere) are subjected to stress as they move on the underlying ductile asthenosphere. At the time that plate tectonics theory was developed in the 1970s, scientists believed that the asthenosphere was molten, although the true nature of the asthenosphere remains enigmatic. Hirano *et al*. [1] reported petit-spot volcanoes on the subducting old Pacific Plate off the Japan Trench. The melt that feeds these volcanoes possibly originates from the asthenosphere, and the melt is likely to ascend along fractures related to a concave flexure of the outer rise. Such tiny volcanoes are likely to be ubiquitous in zones of plate flexure, which have recently been reported from the oceanward slope of the Tonga, Chile, and Java trenches [2-4]. It is possible that such zones are not restricted to the outer-rise flexure of lithosphere prior to subduction, as similar flexing has been reported from the extensional Basin and Range [5] and southern offshore of Greenland [6]. Petit-spot melt is expected to provide information on asthenospheric components located just below the lithosphere.

Important clues to the origin of petit-spot lavas are the EM-1 signature [7] and the high levels of carbon dioxide (CO_2) in the magma prior to degassing [8]. Carbonatite melt has been proposed as a key material in explaining the electrical conductivity of oceanic asthenosphere [9] [10]. The high CO_2 contents of petit-spot lavas raise the possibility that CO_2 affects the source components and their melting, although we must also consider lithospheric contamination during ascent of the magma. The lava of petit-spots provides information on the geochemical characteristics of, and partial melting in the asthenosphere.

[1] Hirano *et al*. (2006) *Science* **313**, 1426-1428. [2] Hirano *et al*. (2008) *Basin Res*. **20**, 543-553. [3] Hirano *et al*. (2013) *Geochem. J.* **47**, 249-257. [4] Taneja *et al*. (in press) *Gondwana Res*. [5] Valentine & Hirano (2010) *Geology* **38**, 55-58. [6] Uenzelmann-Neben *et al*. (2012) *Geophys. J. Int.* **190**, 1-7. [7] Machida *et al*. (2009) *Geochem. Cosmochim. Acta* **73**, 3028-3037. [8] Okumura & Hirano (2013) *Geology* **41**, 1167-1170. [9] Gaillard *et al*. (2008) *Science* **322**, 1363-1365. [10] Sifré *et al*. (2014) *Nature* **509**, 81-85.