H_2O / F ratios in asthenosphere inferred from volatile compositions of petit-spot lavas

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Mid-oceanic ridge basalts (MORBs) have ever been a key to understand the compositions of oceanic upper mantle. Although it is well known about depleted source mantle below the MORBs, they are largely limited area of youngest part of oceanic lithosphere. Some previous studies have tried to estimate the volatile compositions (i.e. H_2O, CO_2, and halogens) of upper mantle by MORBs (Dasgupta and Hirschmann, 2006; le Roux et al., 2006; Rosenthal et al., 2015).

Petit-spot volcano, a newly recognized volcanism into tectonic processes on the Earth, erupts by tectonic force associated with plate-flexure of outer rise. The lavas (foidite to hawaiite) are highly enriched in incompatible elements, likely originated from asthenosphere. Their samples show high vesicularity in spite of the eruption under high hydrostatic pressure at approximately 6000 meters below the sea level, indicating high levels of volatile contents in magma.

We report the volatile compositions in quenched glass rinds of petit-spot lavas from the northwestern Pacific Plate in order to recognize the volatile compositions of asthenospheric mantle below the older part of oceanic lithosphere. They are much higher than most of the previously reported MORBs without seawater alteration. The H_2O / F ratio of the studied samples is relatively constant (average: 14.6 ±1.4, 1 s.d.). It may represent the ratio of asthenosphere below both of young and old lithosphere, because H_2O and F in magma behave similar incompatibility during mantle melting and crystallization. The obtained H_2O / F ratio is consistent with those of average MORB glasses (~13), but higher than those of HIMU and EM OIBs ($H_2O/F < 10$).

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