Oxidation state of magmas at an immature subduction zone-inferred from sulfur speciation of boninitic and tholeiitic melt inclusions

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Oxidation state of arc magmas highly influences the chemical behaviors of redox sensitive elements such as chalcophile and some siderophile elements in subduction zone. Therefore, Oxidation state of arc magmas is essential to understand arc magma geneses and evolutions of ore deposits. It has been suggested that sub-arc mantle is oxidized by subducted materials such as fluid, sediments and oceanic crust. However, recent studies contradicted that the oxidation state of primary arc magma (sub-arc mantle) is similar to the average upper mantle and oxidation is caused by differentiation associated with crystallization and interaction within preexisting crust (e.g. Lee et al., 2012, Science, v336, p64).

In order to constrain oxidation state of primary arc magmas at an immature subduction zone, we have analyzed $S^{6+}/\Sigma S$ of boninitic and tholeiitic melt inclusions within Cr-spinel from Bonin Islands and Guam by soft X-ray microbeam at SPring-8/BL27SU. Boninite in Bonin Islands uniquely formed at the early stage of subduction formation (~50 Ma) by melting of highly depleted hydrous mantle and 0-7 myrs later, related arc tholetiites erupted in southern Bonin Islands and Guam by melting of depleted mantle (Ishizuka et al., 2011, EPSL, v306, p229). Compositions of melt inclusions fully cover compositional ranges of whole-rocks and some boninitic melt inclusions have MgO higher than 20 wt%, showing that they are very primitive magmas. $S^{6+}/\Sigma S$ of boninitic and tholeiitic melt inclusions are 0.57 to 0.78 and 0.47 to 1, respectively; $S^{6+}/\Sigma S$ of all high-MgO (7 to 12 wt%) tholeiitic melt inclusions are > 0.9. Oxygen fugacities of primary boninite and tholeiite are estimated to be $\Delta FMQ > +1$ and $> +1.5$, respectively by experimental results of Jugo et al. (2010, GCA, v74 p5926), indicating that sub-arc mantle is oxidized even at an early stage of subduction zone. Between the period of eruption of boninite and tholeiite, not only mantle sources but also the subducting component in term of oxidation state of sub-arc mantle may have changed.