Geochemical studies for seawater/rock interaction recorded on the submarine lava flows of 12 Ma in the *Hokuroku* district in Akita, Japan and their implication to phosphorus cycle on the modern ocean floor

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The phosphorus cycle on the modern surface environments of the Earth's is unclear. Many researchers consider that submarine basaltic rocks scavenge phosphorus by seawater/rock interaction. However, this argument is not supported by global data. In addition, uncertainties exist as to if submarine felsic rocks scavenge phosphorus during seawater/rock interaction. Thus, the purpose of this study is set to examine phosphorus behavior during seawater/rock interaction of submarine basalt and rhyolite, which ages are ca. 12 Ma. The samples are collected in the *Hokuroku* district in Akita prefecture: *Furutobe(basalt)*, *Oshigenaisawa(rhyolite)*, and *Hanaokanashizaka(basalt)*. Differences are examined in minerals and chemical compositions between outer and inner parts of basaltic pillow lava. Mineralogy and chemistry of single rhyolitic lava are examined according with different alteration patterns.
XRF analyses on bulk rock samples suggest basalt and rhyolite lost Si, Na, Ca with progress of submarine alteration. Basalt added Mg and Fe, and rhyolite added Mg and K during the same alteration. These results are consistent with combination of minerals identified by XRD and EPMA. The mobilization of elements in basalts from Furutobe is differ from others because Furutobe basalt suffered additional submarine hydrothrmal alteration.
It was found that basalt lost P, while rhyolite added P. Apatite and microcrystals of P-bearing unknown minerals are observed in basalt. In rhyolite, it is observed euhedral and anhedral crystals of 10-100 μm such as apatite, monazite, and xenotime. Primary apatite is observed in rhyolite phenocrysts, such as quartz, plagioclase, magnetite, ilmenite, and zircon. Secondary phosphate minerals are observed in vein, chalcedony developed in plagioclase pseudomorph, and Fe-bearing minerals. These clearly indicate the addition of phosphorus in altered rhyolite during seawater/rock interaction, and most likely phosphorus was supplied from seawater.
Therefore, it is suggested that basalt can supply phosphorus in ocean water as submarine alteration advanced, and rhyolite is a sink of phosphorus in the ocean floor. This knowledge is different from an established hypothesis that oceanic igneous rocks are sink of phosphorus.

Keywords: Phosphorus, Submarine alteration, Rhyolite, Basalt

