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Behavior of Bio-Essential Elements during Subvent Hydrothermal Alteration of Volcanic Rocks at the Suiyo Submarine Volcano

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Microorganisms require so-called bio-essential elements to catalyze for enzyme action, to construct their bodies. Mo, Mn, Cu, Zn and B are representative bio-essential elements and P is also essential major elements. Marine hydrothermal systems discharge high concentrations of metals. These elements are most likely leached from host rocks. It is known that many discharging hydrothermal fluids are depleted in P and Mo. It is not revealed the controlling mechanism for the depletions. One of purpose for this study is to understand the behavior of bio-essential elements in subvent environments. The hydrothermal field of the Suiyo submarine volcano was drilled in order to examine the hydrothermal process and possibility of subvent microorganisms. The Suiyo Seamonut is one of volcanologically active Seamount in Ogasawara Sitiyo Islands on Izu-Ogasawara (Bonin) Arc. The Seamount is located about 240km northwest of Chichi Island. Sea-depth of caldera floor is 1,370m. The volcanic rocks samples at the top of the cauldron wall are the calc-alkaline rock series dacite and the low potassium andesite. Hydrothermally active area at the western top of Suiyo Seamount is extending around 300m in N-S, 150m in E-W direction. As a result of these drilling, altered and less altered igneous rocks were recovered. Chemical compositions were determined on 12 bulk samples of drill cores to examine the elemental behavior during hydrothermal alteration. Also electron microprobe analyses were performed on the representative samples to examine the elemental distribution within the thin section scale (1cm x 1cm). Petrography and X-ray diffraction study indicate the various degree of alteration among the examined samples. Less altered rocks still exhibit the original igneous texture. Highly altered rocks are divided into two groups; (a) group characterized by extensive (70 - 90 %) replacement of original igneous mineral assemblage with abundant clays (mainly chlorite and sericite) and sulfide and (b) group cemented with large amounts of anhydrite and disseminated sulfide (mainly pyrite). P in examined samples exist as apatite. Five types of apatite are recognized; (1) chlorapatite interpreted as original igneous minerals in less altered rocks, (2) chlorapatite with pyrite around altered feldspars, (3) chlorapatite in plagioclase grain (4) hydroxyapatite in hydrothermal disseminated pyrite grain, (5) Al-phosphate in chlorite.

Notable feature is behavior of P during alteration. Electron microprobe analyses and bluk chemical composition indicate (1) the depletion of phosphate minerals in altered rocks (below 0.1 wt%) and (2) co-precipitation of phosphates with hydrothermal sulfides. In heavily altered rocks, apatite with sulfide minerals almost distribute nearly partly altered feldspar. On the other hand, apatite can not be found in secondary phase that the original igneous minerals are completely replaced by clay minerals (chlorite and sericite). Dissolution and precipitation of apatite may be controlled by pH and temperature of hydrothermal fluid related water rock interaction. Fig.8 shows stability fields of apatite. The apatite saturation-line and the dependence H3PO4 are calculated using data from Krauakopf (1979). In stability field of K-feldspar, dissolved phosphate easily may re-precipitate because of low solubility of apatite.

These data suggest that the bio-essential elements will be available for subvert microorganisms right after these elements are leached from rocks before sulfide precipitation.