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Metasomatic alteration of zircon and apatite during albitization of the Godzilla Megamullion during emplacement

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The Godzilla Megamullion is the largest oceanic core complex currently known, and is adjacent to the spreading center of the Parece Vela Basin, an extinct back-arc basin in the Philippine Sea. Zircon U-Pb dating of gabbroic and leucocratic rocks from the Godzilla Megamullion have revealed that fault-induced spreading over the ~125 km length lasted for ~4 m.y., with continuous magmatic accretion at the spreading axis [1]. During decollement-style faulting and exhumation in the waning stages of spreading, the gabbro was partially albitized by NaCl due to infiltration of seawater at moderate P-T via the following idealized reaction: $CaAl_2Si_2O_8 + SiO_2 + NaCl + 2\ H_2O = NaAlSi_3O_8 + Al(OH)_3 + ½\ CaCl_2 + ½\ Ca(OH)_2$. In the albitized gabbro and associated granitoid veins, the zircons were metasomatically modified in actinide-enriched areas. These areas are characterized by a high porosity and thorite inclusions. Apatite grains were also metasomatically altered from fluorapatite to apatite with both high Cl and OH components on the halogen site.

Experimentally, zircon has been shown to be modified by both $Ca(OH)_2$- and $CaCl_2$-bearing fluids at high P-T in a quartz-absent gabbroic system via a coupled dissolution-reprecipitation process to zircon with ZrO_2 inclusions and rim grains [2]. These textures resemble what is seen in zircon from the albitized regions of the gabbro. In a similar manner at high P-T, fluorapatite can be metasomatically altered to hydroxyl-apatite using a $Ca(OH)_2$-bearing solution [3], whereas fluorapatite can be metasomatized to chlorapatite in the presence of a $CaCl_2$-bearing solution [4]. These experimental results indicate that albitization played a key role in the chemical alteration and recrystallization of zircon and fluorapatite from the Godzilla Megamullion gabbro. Similar results have been seen in the albitization of titanite-bearing granites where the titanite is converted to rutile during albitization, which has been confirmed experimentally as well [5].

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