Hydrothermal mineralization in arc-type submarine volcanoes

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The variety of alteration minerals found in the Brothers, Macauley and Giggenbach submarine volcanoes in the Kermadec arc [1] is influenced by temperature, composition of fluids including magmatic, seawater and hydrothermal, mixing of these various fluids, degree of water-rock interaction, microbial activity, plume materials and intermittent rock fracturing and exhumation of deep hydrothermal alteration induced by tectonic activity. Compared to subaerial active hydrothermal systems, the Kermadec submarine systems have abundant barite and only minor amounts of anhydrite, carbonates are absent, lusssatine is more common than lussatite, natroalunite and kaolinite are not as pervasive and metal sulfide deposition is massive due, in part, to the presence of seawater.

Hydrothermal activity is initiated by the influx of magmatic fluids. The magmatic fluid separates into 2 phases: 1] rising magmatic vapour condenses into highly acidic low salinity waters that deposit platy natroalunite (+/- kaolinite) in narrow ≤100um thick fractures within a “crack zone” and 2] metal-rich, saline waters with high P(H_2S) that precipitate out enargite, bornite, chalcopyrite, pyrite, digenite-chalcocite, sphalerite and galena at 330-350^{o}C or marcasite and pyrite (+/- sulfur) at ≤200^{o}C (Fig. 1). As the magmatic fluid influx and temperatures decrease and water-rock interaction increases the altering waters become more mature and massive metal deposition ebbs. Increasing seawater influx further cools the hydro-thermal system. Interaction among rock, mature hydrothermal waters and seawater produces barite, anhydrite, zeolites, opal, celadonite, smectites and goethite. Fe-Mn oxides/oxyhydroxides and smectite are precipitated where tempe-ratures have cooled to ambient seawater and where material from the plume are dispersed.

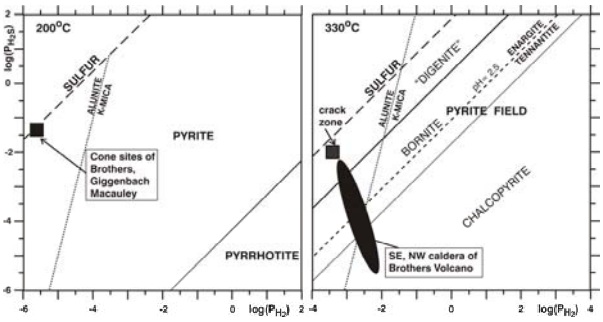

Fig.1 LogP(H_2) vs logP(H_2S) of altering fluids based on mineral assemblages.

References

[1] Reyes A.G. (2003) *GNS Science Report*, **2003/29**, 40p.