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Ge and Ga behaviour during subduction-related metamorphism of basic rocks

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Ge and Ga are can be used as fluid tracers in hydrothermal systems, as their solubility in fluid is temperature dependant [1,2]. Physico-chemical conditions of hydrothermal processes would result either in Ge enrichment [3], or Ge depletion of the basaltic crust in presence of hydrothermal sulphides [4]. Variations in Ge and Ga concentrations were investigated in a series of HP¬-LT metabasites (peak P-T conditions: 1.7-2.3 GPa and 550-600°C) from the Ile de Groix (France), to examine their behaviour during the fluid-rock interactions and associated metamorphism related to subduction. The studied metabasites represent former MOR-type basalts, which underwent a pre-HP low-temperature hydrothermal alteration [5].

Whole rock Ga and Ge concentrations were analysed by SN-ICP-MS ($\pm$ 8%; 1σ). The Ga abundances in eclogites and blueschists (21.0-21.6 ppm) are similar to the values measured in tholeiitic basalts (18-22 ppm; [6]), while they decrease slightly in the greenschist facies metabasites (16.9-20.5 ppm). The Ge abundances measured in the metabasites (1.2-2.1 ppm) are generally higher than those of tholeiitic basalts (1.4-1.5 ppm; [6]), suggesting Ge enrichment during the low-T hydrothermal alteration. Similarly to Ga, the decrease of the Ge abundances in greenschists (1.2-1.9 ppm) compared to blueschists and eclogites (1.6-2.0 ppm) indicate that a fraction of Ge and Ga left the metabasites during the fluid-rock interactions related to the retrograde metamorphism.

Ga and Ge abundances in minerals were obtained using LA-ICP-MS ($\pm$ 8-15%; 1σ). Garnet and epidote are major phases in the metabasites. They are the main hosts for Ge (3.3-8.2 ppm in Grt; 2.4-12 ppm in Ep) and Ga (2.6-8.6 ppm in Grt; 33-112 ppm in Ep). Glaucophane and omphacite also contain significant amounts of Ga (3-15 ppm). The different generations of garnet and epidote formed during the prograde and retrograde metamorphic stages [5] can be distinguished using the Ge/Si and Ga/Al ratios. Ge/Si in garnet increases from blueschists to eclogites (prograde metamorphism), i.e. with increasing temperature from 500 to 550°C [5], in line with the Ge/Si increase in garnet rims. Ga/Al values remain relatively constant. By contrast, Ge/Si in garnet in greenschists (retrograde path) is similar to garnet in blueschists. In epidote, the Ga/Al ratios increase during the prograde path, while the Ge/Si decrease. At peak conditions (500-550°C [5]), Ge seems to be preferentially incorporated in garnet than in epidote. These results allow evaluating the Ga and Ge exchange behaviour during the various P-T conditions.

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