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Serpentinization and Ca-metasomatism of the Rodingite Dykes Intruding Ultramafic Olistostromes of Kimi Flysch, Evia Island (Greece)

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Background

In Kimi region (Evia island, Greece) the Maestrichtian-Paleocene flysch is composed by sedimentary rocks (sandstones, shales, cherts), intercalations of Upper Cretaceous limestone (Robertson, 1990), as well as olistostromes of serpentinized peridotites. The ultramafics are strongly associated with rodingite dykes, ophicalcites and talc schists. Rodingites appear as veins with horizontal (E-W) or NNE-SSW direction. They are composed by three distinct concentric zones, characterized by specific mineral assemblages. The ultramafic host rocks consist of two thin irregular zones of successive metasomatized serpentinite and chloritite near the contact with the rodingite dykes.

Aims and Objectives

The present study aims to investigate the relation between serpentinization and rodingitization, as well as the physicochemical conditions under which Ca-metasomatism affected the exhumed mantle rocks of Kimi. For the purpose of this study the following methods were followed: a) Field work emphasized on the ophiolitic ultramafic rocks intruded by rodingite dykes. b) Mineralogical analyses c) Whole rock chemical analyses d) Stable O-C isotopic analyses of calcite e) Data processing.

Results

Petrographical and geochemical investigation of the rodingite rocks included the study of their marginal, transitional and core zones. As calcite occurs in some of the studied samples, rodingites were further divided into two groups, corresponding to non-carbonated (Group-I) and carbonated (Group-II) dykes. Their texture ranges from cryptocrystalline to microcrystalline, usually porphyroblastic including idiomorphic (hydro)garnet and vesuvianite porphyroblasts. In both rodingite groups, chlorite and/or diopside predominate in the marginal zones, whereas vesuvianite and/or garnet are the main mineral phases of the core zones. Tranistional zones include all the aforementioned minerals in various and unequal amounts. Accessory minerals include relict spinel, prehnite, epidote, apatite, allanite, amphibole, dolomite, quartz and opaque Fe-Ti oxides.

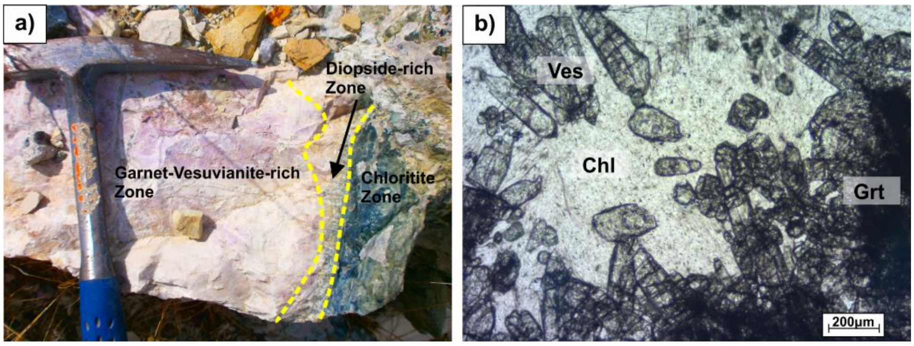

Figure 1. a. Macroscopic image of rodingite dyke b. Rodingite photomicrograph (PPL) consisting of chlorite (Chl) – garnet (Grt) matrix with vesuvianite porphyroblasts.

Calcite appears in the form of veins or within cavities in the rodingite groundmass. Garnet is mainly classified as (hydro)grossular, whereas a few (hydro)andradite crystals also occur. Chlorite is classified mostly as penninite, whereas clinopyroxene is classified as diopside. Ultramafic rocks are divided into serpentinized peridotites, metasomatized serpentinites and chloritites. Serpentinitic rocks include mostly serpentinite, bastite grains, garnet porphyroblasts, as well as relict pyroxene grains with accessory spinel. Regarding their whole rock chemistry, rodingites are mainly CaO enriched and depleted in SiO_2 and total alkalies, whereas their LOI contents are quite high. The carbonated rodingites (Group-II) show significant enrichment in light rare earth elements (LREE). Stable isotopic data in calcite crystals of the rodingite, ophicalcite and red mudstone samples present a wide range of $\delta^{13}C$ and $\delta^{18}O$ VPDB contents. Metasomatized serpentinites show higher CaO and SiO_2 contents compared to those of chloritites.

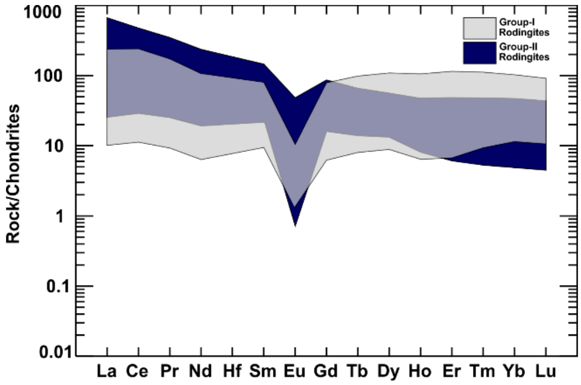

Figure 2. CN-normalized REE patterns [after McDounough and Sun (1995)] of Group-I and Group-II rodingites.

Discussion and Conclusions

Rodingitization is strongly associated with serpentinization, evolved under alkaline conditions, in a Supra Subduction Zone (SSZ) within the closing oceanic basin (Robertson, 1990). The occurrence of three distinct zones within the rodingite dykes corresponds to gradual fluid infiltration with H2O/rock ratio and CO2/H2O ratio increasing, and T decreasing towards their cores. Ultramafics are characterized by a transition from an outer metasomatized zone to an inner chloritit ic rim near the contact with the rodingite dykes. Rodingitization likely evolved into two metasomatic events characterized by different XCO2 conditions. Vesuvianite was formed at a late stage of the first metasomatic event under Ca2+/OH- rich fluids and low CO2/H2O ratio (Hatzipanagiotou et al., 2003; Li et al., 2004; Li et al., 2008; Koutsovitis et al., 2013). The occurrence of additional calcite in some the rodingite dykes corresponds to a second metasomatic event of higher XCO2 conditions. The CaO enrichment and SiO2-alkali depletion is associated with clinopyroxene and anorthite breakdown dissolution during serpentinization (Frost et al., 2008). LREE enrichment is significantly higher in carbonated rodingites, indicating the presence of carbonic-LREE complexes in the metasomatic fluids, whereas Zr mobility can be associated with the presence of PO43--LREE and LREE-OH- complexes (Aja et al., 1995; Veyland et al., 2000). REE are hosted within monazite and allanite. Stable isotope data indicate the participation of hydrothermal and seawater fluids. The closure of the oceanic basin is accompanied by the formation of Kimi flysch and the incorporation of the ultramafic olistostromes.

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