The tectonometamorphic evolution of the Attica-Cycladic blueschist belt: constraining P-T paths from compositionally zoned minerals in high-pressure quartz-mica schists from Syros, Greece

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The island of Syros, Greece, lies within the Attica-Cycladic subduction complex of the Eastern Mediterranean. Lithologies on Syros have mineral assemblages transitional between the epidote-blueschist and eclogite facies (Okrusch and Brocker, 1990). High-pressure assemblages preserved on Syros are inferred to have formed as a result of northward subduction of the African plate beneath the Eurasian plate during the Alpine Orogeny commencing around 80 Ma (Okrusch and Brocker, 1990; Brocker and Enders, 1999). A greenschist-facies overprinting during the Oligocene-Miocene is observed locally in rocks from Syros, and may be related to exhumation processes and fluid infiltration of higher-grade assemblages situated near ductile shear zones (Trotet et al., 2001).

The pressure-temperature evolution of the Attica-Cycladic subduction complex can be constrained using high-pressure metamorphic assemblages found on Syros. As a first approach, petrographic analysis may be used to determine the reaction sequence followed by quartz-mica schists during their metamorphic evolution. Three distinct mineral parageneses have been identified in the quart-mica schists of Syros: a matrix assemblage containing index minerals transitional between the eclogite and epidote-blueschist facies, an inclusion assemblage preserved in poikiloblastic matrix minerals, and an overprint mineral assemblage of chlorite + albite ± epidote considered indicative of greenschist-facies metamorphism (Breecker, 2001).

Compositional zoning in garnet may be used to further constrain P-T paths from thermodynamic modeling and P-T-X-M phase relations of low-variance, two- or three-phase NFM mineral assemblages. Rocks from Syros contain two distinct three-phase matrix assemblages (+ paragonite + muscovite + epidote + quart z+ H_2O ± chlorite) used for modeling: (i) garnet + glaucophane + clinopyroxene and (ii) garnet + glaucophane + chloritoid. P-T path calculations were performed with program GIBBS (Spear, 2001) operating in differential thermodynamic mode using the thermodynamic dataset of Holland and Powell (1998). Input parameters consisted of matrix mineral compositions and initial P-T conditions estimated from geothermobarometry (Trotet et al, 2001). Incremental changes in P-T conditions were calculated by specifying the changes in Xalmandine, Xspessartine, and Xgrossular taken from garnet zoning profiles. For two-phase NFM mineral assemblages, Xacmite or Xriebeckite was held constant.

P-T-X-M phase relations were also investigated with program GIBBS operating in integrated thermodynamic mode using the thermodynamic dataset of Holland and Powell (1998). Input parameters consisted of matrix mineral compositions, modal abundances, and P-T conditions estimated using geothermobarometry. Isopleths of constant compositional parameters and molar abundances were plotted. The intersection of these isopleths with calculated P-T paths was investigated to determine whether the proposed P-T trajectories could produce the compositional zoning observed in garnet and blue amphibole.

Calculated P-T trajectories from compositional variation in garnet using alternate assumptions about equilibrium mineralogy during garnet growth yielded similar, negative dP/dT values from core to rim, indicating garnet growth during heating and decompression. Contour diagrams of compostional parameters and molar abundances of garnet and blue amphibole are also consistent with heating and decompression during mineral growth. This surprising result has also been documented for Alpine hornblende-muscovite schists using quantitative P-T path modeling of garnet (Selverstone et al., 1984), and may provide information about the controls tectonic processes exert on metamorphic recrystallization.