PRESSURE-TEMPERATURE CONDITIONS OF METAMORPHISM IN ECLOGITES, SYROS, GREECE

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INTRODUCTION

Equilibrium parameters are determined for eclogitic rocks from six sample locations along the eastern half of Syros. Previous work suggested that the greenschist rocks of Syros predominately occur in the south of the island at the base of the north-dipping sequence, whereas the blueschist rocks are most prevalent in the northern part of the island at the top of the sequence. However, rocks of varying eclogitic compositions crop out across Syros. Eclogites are high-pressure, low-temperature rocks containing the minerals omphacite and garnet. The distribution of eclogites suggests a relationship between structural level and metamorphic conditions that may be more complex than previously reported. The samples studied here are distributed from the northern to the southern end of the island so that the relationship between metamorphic grade and structural level may be examined.

METHODS

The island of Syros was divided along a north-south transect. Thirteen sampling regions were defined on the eastern half of the island. Locations were based on mafic outcrop presence and quality. Within each outcrop, several rock types (based on field observations) were generally present containing garnet, phengite, and omphacite. One representative sample was collected from each basic rock type within each outcrop.

Forty-one hand samples were collected. From these, thirty standard thin sections perpendicular to foliation were made at UCLA for petrographic analysis.

Modal mineral estimates were made for each thin section. Fabric and textures were noted. Regions of co-occurrence among phengite, omphacite and garnet grains were identified. Six samples (one from each sampling region) were chosen for SEM analysis. At Amherst College, mineral compositions were determined for garnet, phengite and clinopyroxene grains occurring in close proximity. The compositions of other constituent minerals were also determined via the SEM/EDS. Additionally, a garnet x-ray map was created for each sample.

The equilibrium constant K_{eq} of a given cation exhange reaction between two minerals can be determined from the rim chemical compositions of those minerals. From K_{eq} and thermodynamic data, a line of stability in P-T space can be determined for a reaction. The intersection point of two such lines based on two different equilibria in a single rock represents the pressure and temperature at which those reactions reached equilibrium.

This procedure was carried out using the program of Ravna and Terry (2004). The garnet-cpx-phengite barometer, the garnet-phengite thermometer and the garnet-cpx geothermometer were used to estimate equilibrium P and T for each of the six samples. Ferric iron was calculated using charge balance and Fe^{3+}=Na-Al as suggested by Ravna and Terry (2004). Chemical data for rim composition were averaged per mineral type in each slide.

RESULTS

Sampling locations are distributed along the east side of the island in mafic and mélange units.

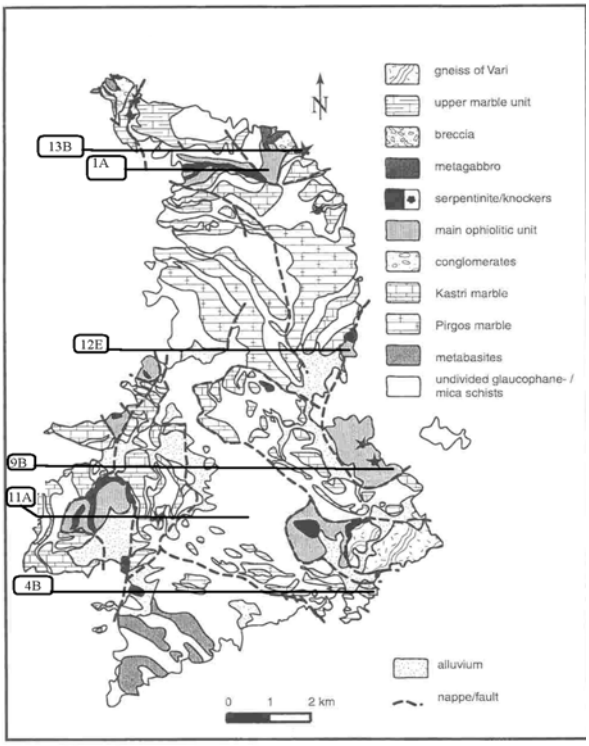

Figure 1: Sample locations. Adapted from N. Hopfer in Schumacher and Helffrich (2003).

Figure 2: EAH-03-4B in outcrop; pen for scale.

Hand samples are massive to schistose, varying according to phengite content. Color ranges from dark green to blue, defined by glaucophane and omphacite. Visible garnet ranges from 1/2mm to _ cm in diameter and comprises 1-25% of the rock. Omphacite varies from 10-65% modally. Glaucophane ranges from 0-75% modally. Varying amounts of epidote and rutile are often visible, and some schistose rocks contain calcite veins.

In thin section, micas define the foliation. Omphacite and glaucophane grains are subidioblastic to xenoblastic relative to garnets, micas and epidote-group minerals. Quartz tends to be fairly fresh. Pressure shadows are common around garnets, which are poikilolitic. Pressure shadows contain quartz, micas and glaucophane. Rutile and epidote-group minerals tend to occur in the interstices and as overgrowths on omphacite and garnet.

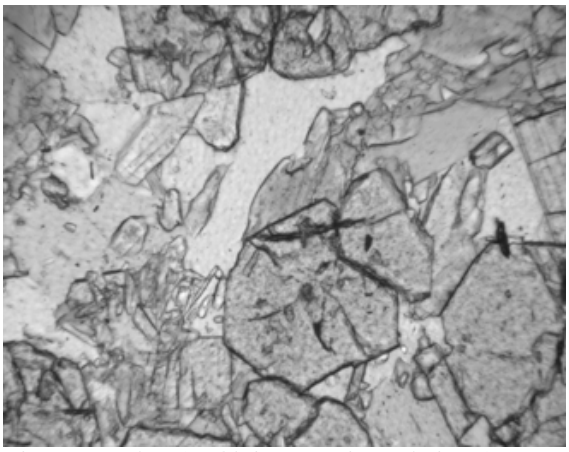

Figure 3: EAH-03-4A in ppl. Field of view 2mm.

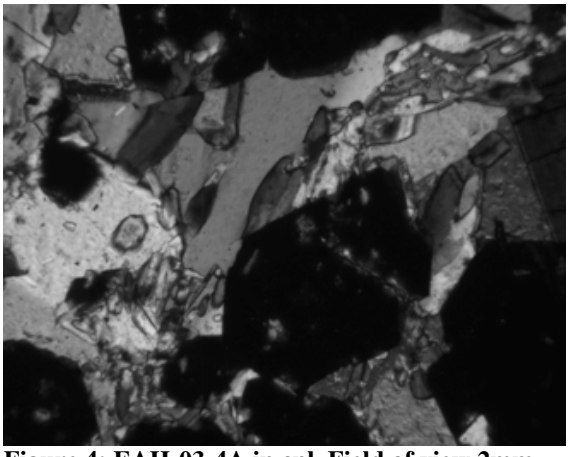

Figure 4: EAH-03-4A in cpl. Field of view 2mm.

Several different mineral types and EDS analysis locations are noted in Figure 5. Note freshness of phengite and epidote relative to omphacite and poikilolitic garnet.

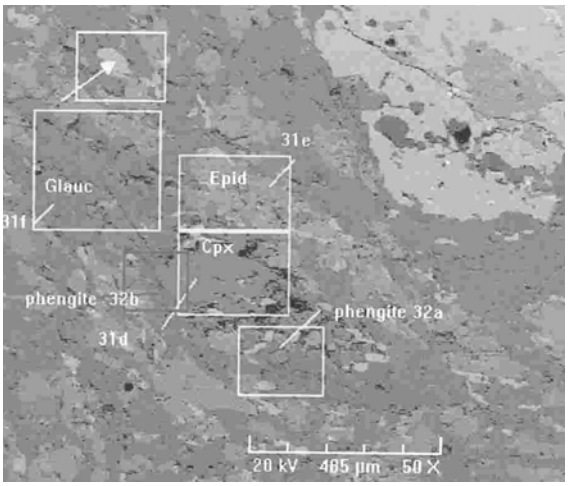

Figure 5: Backscatter image of EAH-03-4B at 50X.

At preliminary examination of chemical analyses, clinopyroxene and phengite do not show significant zoning. Cpx and phengite grains are small, and cpx grains are non-idioblastic. Cpx compositions are averaged within each sample, as are phengite compositions. Garnets are apparently chemically zoned. Thus garnet core compositions are excluded from analyses and rim compositions are averaged for each sample.

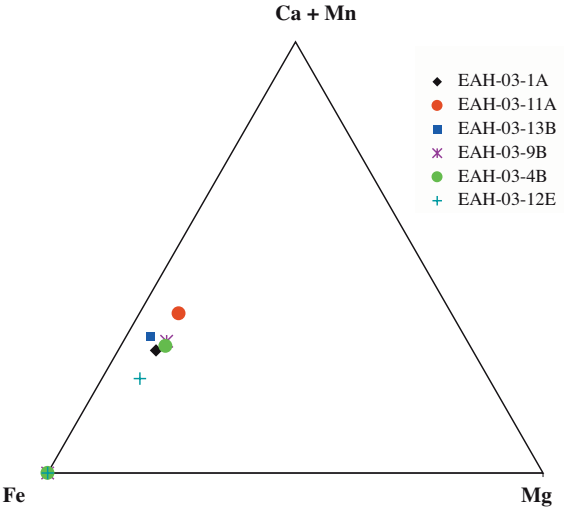

Figure 6: Average garnet rim compositions.

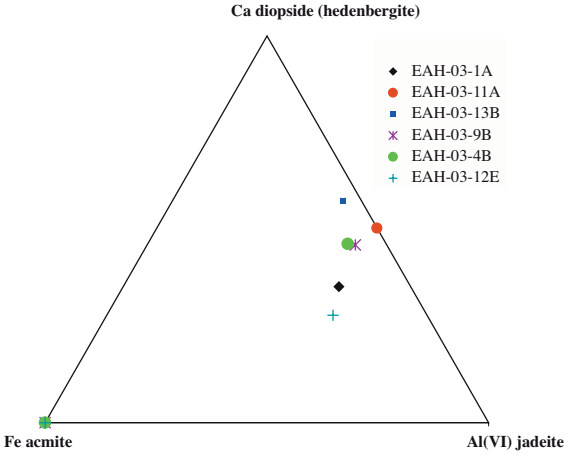

Figure 7: Average pyroxene compositions.

Preliminary estimates for equilibration temperatures and pressures of each sample are shown here.

Sample #	T	P
1A	449	16.4
11A	449	25.4
13B	465	20.4
9B	675	24.6
4B	498	21.5
12E	697	24.7

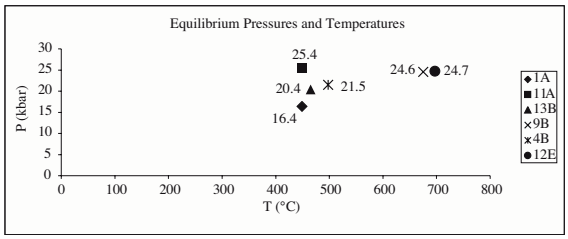

Figure 8: Estimates for equilibrium conditions.

DISCUSSION

Ravna and Terry (2004) report an error of +/- 65˚C and +/- 0.32GPa for results from their calculations. Samples 12E and 9B show significantly higher temperatures than the other four samples, exceeding this expected range. These deviations are more likely due to analysis of core data and interior mineral zoning than to genuine differences in conditions of metamorphism.

Chemical analyses from rims and cores require additional examination before the significance of these calculated temperatures and pressures can be explored. Garnet maps will be analyzed to estimate P-T-t paths for the samples. P-T conditions for samples will be compared to sample location to determine the relationship between metamorphic grade and structural level in Syros eclogites.

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