Reconstructing pressure-temperature paths from metamorphic rocks of the Rhodope Mountains in Eastern Greece

Manlio Calentti, Class of 2020

During collisions between tectonics plates at convergent margins, a portion of continental lithosphere is dragged underneath the overriding tectonic plate, which metamorphoses the subducted lithosphere. In some regions, sections of rock can reach high-pressure (HP) and ultrahigh-pressure (UHP) depths, around 60km and 100+km, respectively. Following subduction, masses of metamorphosed rock can exhume to the surface, documenting records of subduction and exhumation along the path.

Subduction and exhumation paths are dynamic and complex, shown in Fig 1 (Hacker et al., 2007). Three points on the subducting slab are labeled, each following a different pressure-and-temperature (P-T) path. Because each rock on a particular subducting plate can follow a unique P-T path, reconstructing multiple histories provides a more in-depth view on the dynamic processes at these specific zones.

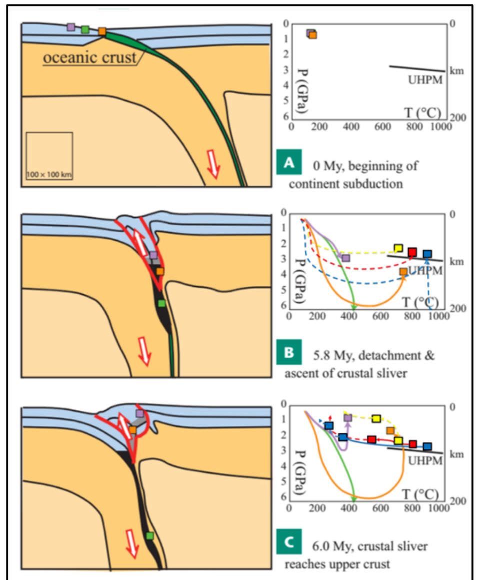

Figure 1: Diagram showing three independent points on a subducting crust. In **B** and **C**, blue, yellow, and red boxes correspond to eclogite, amphibolite, and pyroxenite, respectively, from the Kimi Valley. Solid lines are values from computed thermodynamic reactions, and dashed lines are estimated paths. Green, orange, and purple boxes are example points from *Hacker et al. 2007.*

This summer, I collected rocks from three localities within the Kimi Valley of the Rhodope Metamorphic Complex, a UHP locality in Eastern Greece: an eclogite, an amphibolite, and a pyroxenite. The primary objective of my research is to identify whether these rocks yield similar P-T paths, or if the data shows that each rock had a distinct P-T history, with the end result being a juxtaposition of rocks at the surface. Additionally, I aimed to test if the rocks reached UHP conditions.

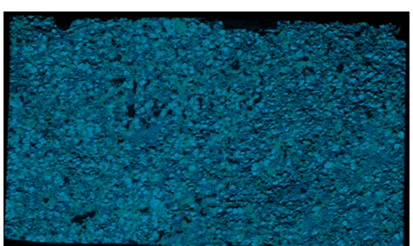

Figure 2: Mafic and ultramafic rocks with Aluminum and Magnesium element layers highlighting mineral. Each different color reveals a new mineral. Black corresponds to quartz, light blue to garnet, teal to pyroxenes, and green to sodic feldspars.

Using Bowdoin's Scanning Electron Microscope (SEM), I identified minerals in the three samples, as shown in Fig. 2 with an Electron Dispersive Spectroscopy (EDS) image of the eclogite. I identified commonalities amongst samples, such as the presence of garnet, amphiboles and pyroxenes, while noting different phases and unique accessory phases, which are minerals that compose less than two percent of rock. I identified ~300 minerals in each sample and measured the chemical composition of selected mineral pairs to calculate the peak metamorphic conditions of each rock. I then used this data to estimate and reconstruct the peak conditions to plot each rock's P-T path on a Pressure-vs-Temperature graph.

Though all three rocks have a mafic protolith, their histories are not identical. Boxes B and C of Fig. 1 show the calculated (solid) and estimated (dashed) P-T paths of each rock, with all coming near the UHP threshold. Since observed coesite, the UHP polymorph of quartz, was absent the paths could not have gone into the UHP domain, though coesite could have backreacted during exhumation. The P-T paths for the eclogite and the pyroxenite were estimated based upon the thermodynamic reactions in mineral pairs, but the amphibolite was projected using observations of mineral assemblages. Over the next few months, I will date the metamorphic events recorded to provide a precise P-T path that charts the histories for each rock type.

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References: Hacker, B. R., Gerya, T. V., & Gilotti, J. A. (2013). Formation and exhumation of ultrahigh-pressure terranes. *Elements*, *9*(4), 289-293.