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Fluid-induced Blueschist Preservation on Syros, Cyclades, Southern Greece

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Local examples of preservation of high-pressure, low-temperature (HP-LT) mineral assemblages within retrograde metamorphosed greenschist are recorded from the Cyclades, Greece. Several models have been proposed to explain the preservation of HP-LT rocks in these areas. On Sifnos, a capping effect of impermeable marble units below the preserved blueschists caused diversion of the upward, cross-layer infiltration of retrograde fluids [1]. On Tinos, blueschist preservation occurred due to retrograde fluid flow channelization along lithological contacts with high flux rates [2]. HP-LT minerals were preserved in regions adjacent to these contacts where fluid fluxes were smaller.

We propose a different mechanism of blueschist preservation based on observations from a costal section near Fabrika on Syros. At this locality a high strain zone cuts through a retrograde greenschist. Along the fault a dark blue halo occurs within the greenschist. Whole rock analyses along a profile from the fault into the greenschist show that only the areas directly adjacent to the deformation zone show chemical evidence of metasomatism, whereas the areas further away are chemically similar to greenschist. Point counting of 1000 evenly spaced points in thin sections of the profile shows a clear blueschist to greenschist transition with a blueschist mineral assemblage (glaucophane+phengite+calcite) nearer to the metasomatic zone and a typical greenschist mineral assemblage (epidote+chlorite+albite) farther away.

We propose the following model to explain preservation of HP-LT mineral assemblage in this locality. During retrograde metamorphism a water-rich fluid infiltrated the blueschist rock from below. This occurred close to the brittle-ductile transition. This fluid caused a reaction front to propagate into the overlying blueschist at which its mineral assemblage glaucophane+phengite+calcite was replaced by the greenschist mineral assemblage epidote+albite+chlorite. Upwards-flowing fluid passing through the reaction front is buffered to higher X(CO_2) by the reaction glaucophane+phengite+calcite+H_2O=albite+chlorite+epidote+quartz+CO_2. This fluid travels faster along paths of structural weakness (e.g. shear zones, faults). If this fluid reaches colder regions more rapidly such that the fluid chemistry is unable to “keep up” with the position of the reaction equilibria as the temperature falls, X(CO_2) will be effectively shifted back into the blueschist stability field and blueschist will be preserved, specifically within high flux regions, such as shear zones and faults.

[1] Matthews & Schliestedt (1984), Contributions to Mineralogy and Petrology, 88, 150-163.
[2] Breeding et al. (2003), Geochemistry Geophysics Geosystems, 4, 1-11.