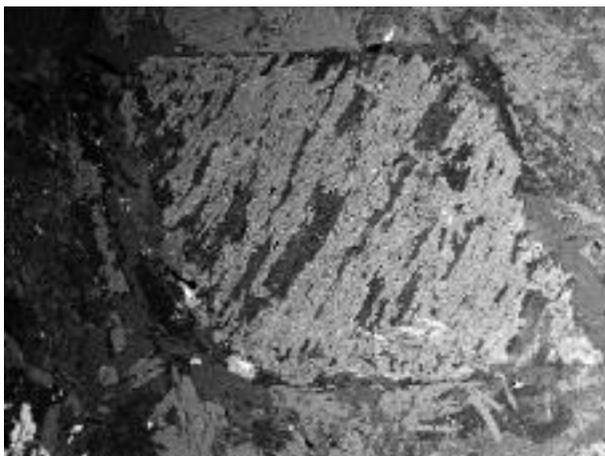


LAWSONITE PSEUDOMORPHS IN THE SCHISTS OF SYROS, GREECE

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Lawsonite, $\text{CaAl}_2\text{Si}_2\text{O}_7(\text{OH})_2 \cdot \text{H}_2\text{O}$, is a common mineral in blueschist-facies metabasalts and metagreywackes and is considered to be an index mineral of high-pressure, low-temperature metamorphism (Comodi and Zanazzi, 1996). On the island of Syros, some outcrops of glaucophane schist, chlorite schist, and graphitic schist display prominent features 0.2 to 3.0 cm in size with a diamond-shaped cross-section that have been interpreted as pseudomorphs after porphyroblasts of lawsonite. These features serve as a testament to the previous high-pressure, low temperature blueschist mineral assemblages held by these rocks during the late Cretaceous (Bröcker and Enders, 1999), during which P-T conditions are believed to have varied between 12-20 kb and 450-500°C (Schliestedt et al, 1987). Lawsonite would have been stable under P-T conditions proposed for the Cretaceous event, but would have become unstable during the subsequent lower pressure Miocene greenschist event. It may have reacted during decompression to form other minerals, perhaps creating the some of the pseudomorphs now visible on Syros, as suggested by Sperry (2000).

The mineral assemblages of the lawsonite pseudomorphs on Syros vary, but typically include the components zoisite/clinozoisite + phengite + paragonite \pm chlorite \pm albite \pm quartz \pm calcite, and, rarely, remnant lawsonite. Occurrences of pseudomorphs after lawsonite have also been reported in other parts of the world, including Ile de Groix, France and the Sesia zone of the western Italian Alps, where the assemblages zoisite/clinozoisite + phengite/paragonite + chlorite + albite + quartz (Shelley and Bossiere, 1999) and zoisite/clinozoisite + paragonite + albite + calcite \pm pumpellyite (Pognante, 1989), respectively, have been reported. Despite such reports, however, the reactions behind the formation of the lawsonite pseudomorphs have not been resolved, and in fact, there has been recent argument that the pseudomorphs of Groix might be after albite rather than lawsonite because the pseudomorphs in the locality have not been found to contain remnant lawsonite (Shelley and Bossiere, 1999).



One distinctive pseudomorph, shown here in a backscattered electron image, displays alternating bands of zoisite and phengite/paragonite in a perfect diamond shape. The mica is mostly phengitic. Accessory minerals include titanite and apatite. The estimated mode of the pseudomorph is 64% zoisite, 35% phengite/paragonite and 1% titanite/apatite. The matrix of the rock is fine-grained glaucophane with patches of albite and actinolite.

It is known that in most cases the migration of aluminum during metamorphism is small (Carmichael, 1969). Hence the preservation of the shapes of the

lawsonite porphyroblasts in the rocks on Syros could be due to the limited diffusion of the aluminum component of the lawsonite during the lower pressure event. The pseudomorphs bearing the simplest mineral assemblage, such as the sample shown here, reveal that ideally lawsonite breaks down to zoisite, with the leftover aluminum and silicon going to phengite. In this scenario, approximately two thirds of the aluminum can go to zoisite, and the rest must combine with potassium, magnesium, iron, and silicon that has diffused into the pseudomorph from the matrix to form phengite (or, to a more limited degree, with sodium to form paragonite). (See Figure 10 and Table 2.)

In other samples, the proportion of phengite is greater than that of zoisite. In this case, a greater proportion of the aluminum has gone into making phengite, leaving less aluminum for

the formation of zoisite. Calcium is leftover and forms calcite. In some cases there appears to have been some migration of calcium out of the pseudomorph. In some samples, there are calcite veins surrounding the pseudomorphs. In another sample, there is no zoisite present. All of the aluminum in the original lawsonite has gone into phengite, in this case, leaving all of the calcium to go into the formation of calcite.