

## **Coexisting andalusite, kyanite, and sillimanite: Sequential formation of three $\text{Al}_2\text{SiO}_5$ polymorphs during progressive metamorphism near the triple point, Sivrihisar, Turkey**

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### **ABSTRACT**

Regionally metamorphosed, muscovite-bearing quartzites from Sivrihisar, Turkey, contain coexisting andalusite, kyanite, and sillimanite. Kyanite is the most abundant polymorph and defines a lineation along with prismatic sillimanite, andalusite, staurolite, and elongate quartz. Andalusite is the most Fe-rich of the polymorphs (0.9–1.6 wt%  $\text{Fe}_2\text{O}_3$ , compared with 0.6–0.9 wt% for kyanite and sillimanite), and was ductilely deformed. Staurolite has partially pseudomorphed kyanite, and occurs intergrown with sillimanite. Garnet occurs in some metaquartzites and interlayered mica schists. Mica schists lack  $\text{Al}_2\text{SiO}_5$  polymorphs. Porphyroblasts in mica schists are chloritoid, chloritoid + staurolite  $\pm$  garnet, or staurolite  $\pm$  garnet with inclusions of chloritoid and staurolite.

Textural relations and relative deformation features among the three polymorphs suggest the crystallization sequence andalusite  $\rightarrow$  kyanite  $\rightarrow$  sillimanite, with growth of staurolite primarily in the sillimanite stability field. Results of garnet-biotite thermometry and estimates of peak  $P$ - $T$  conditions from petrogenetic grids are  $\sim$ 540–560 °C. Maximum pressure is not known, but there is no evidence for the high-pressure – low-temperature conditions that affected similar rocks to the northwest in the Sivrihisar massif. The stable coexistence of staurolite + sillimanite at peak metamorphic conditions suggests a maximum pressure of 5.5 kbar. The three polymorphs grew sequentially along a clockwise  $P$ - $T$  path that looped around the  $\text{Al}_2\text{SiO}_5$  triple point during incipient subduction of a continental margin sequence (burial: andalusite  $\rightarrow$  kyanite), followed by collision (heating and/or decompression: kyanite  $\rightarrow$  sillimanite).