

Coexisting andalusite, kyanite, and sillimanite: Sequential formation of three Al_2SiO_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% Fe_2O_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 Al_2SiO_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 Al_2SiO_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).