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A natural field example indicating spinel + quartz as a non-diagnostic assemblage for ultrahigh temperature metamorphis from the Highland Complex, Sri Lanka

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Though, co-existing spinel + quartz has been reported from a number of ultra-high-temperature (UHT) granulite terrains, experimental studies suggest that the stability of the assemblage could be shifted towards lower temperatures due to the incorporation into the spinel structure of Zn, Cr, Ti, Ni, V or Fe3+ at high oxidizing conditions. In this study, we report co-existing spinel + quartz within garnet-porphyroblasts in a non-UHT spinel- and cordierite-bearing garnet-sillimanite-biotite-graphite gneiss (khondalite) interbedded with orthopyroxene-garnet-biotite-bearing intermediate granulites from the Highland Complex (HC) in Sri Lanka. Zn-rich spinels were observed in four textural settings which probably formed during different stages along the PT trajectory followed by the khondalite: (a) spinel co-existing with tiny quartz (ZnO = 12.67-12.85 wt%), (b) spinel surrounded by sillimanite moats and in intergrowth with skeletal sillimanites (ZnO = 9.03-9.17 wt%), (c) symplectitic spinels at the margin of sillimanite (ZnO = 4.09-4.28 wt%), and (d) spinel co-existing with ilmenite or as isolated grains (ZnO = 7.61-7.97 wt% and $Cr2O_3$ = 5.99-6.27 wt%). Textural settings (a) and (b) occur within garnet-porphyroblasts, while textures of (c) and (d) are present within cordierite moats after garnet in the rock matrix.
Pseudosections calculated in the CNKFMASHTMnO system and conventional geothermobarometry suggest that the metamorphic peak conditions attained by the spinel + quartz bearing khondalites and associated intermediate granulites approached but not exceeded T of 900 °C at P of 7.5-8.5 kbar. After the peak of the metamorphism, the khondalite has undergone a stage of nearly-isobaric cooling down to T of 770 °C and P of 7.5 kbar, followed by a late stage of isothermal decompression down to P < 6.5 kbar and T of 770 °C. Hence, the stabilization of coexisting spinel + quartz to T < 900 °C could be due to the incorporation into spinel of large amount of Zn, which was probably associated with Zn-rich, exotic, metasomatic fluids, and possibly Fe3+ at relatively high oxidizing conditions. Thus, the khondalite of the HC provides a natural field example which shows that spinel + quartz assemblages alone cannot be used to infer UHT metamorphism for pelitic granulites.