The birth of Gondwana: Timing and thermal spikes constrained from chemical dating of monazites

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The khondalite belt of Kerala in southern India represent one of the vast supracrustal belts in the East Gondwana fragment which was subjected to extreme crustal metamorphism at ultrahigh-temperature conditions during late Neoproterozoic, coinciding with the final assembly of the Gondwana supercontinent. Petrologic evidence including the direct association of spinel+quartz in various textures in these rocks indicates metamorphic temperatures over 1000°C at pressures over 7 kbar for the peak assemblage (Fig. 1a). U-Pb-Th chemical dating of monazite in textural association with spinel +quartz included within garnet yields an age of 599±12 Ma. Monazite in the matrix assemblage shows an age of 524±11 Ma. Monazite cores included within mesoperthite shows ages of 597±12 Ma to 602±13 Ma, while their rims have ages of 548±10 Ma to 567±10 Ma. The older age from homogeneous monazite occurring with garnet is identical to the core ages of monazites occurring within mesoperthites (597±12 Ma to 602±13 Ma). Monazite occurring as inclusions within quartz and biotite in the matrix shows core ages of 599±7 Ma and 509±9 Ma respectively. The oldest ages from monazite cores included in quartz are comparable with those obtained from monazite cores in association with spinel + quartz and mesoperthite. In some cases, the cores of monazites included within garnet show Paleproterozoic ages, which are mantled by Neoproterozoic-Cambrian rims (Fig. 1b).

The data show that the age peak at ca. 600 Ma is common in all cases, marking the timing of the early ultrahigh-temperature granulite facies event in this terrane. The 575 Ma age is also commonly represented in most cases, which comes from the rims immediately surrounding the cores. This study therefore interprets the peak ultrahigh-temperature metamorphic event in the Trivandrum Block to be between ca. 580-600 Ma. Homogenous monazite in association with the second generation of spinel + quartz in the matrix showing an age of 524±11 Ma indicates a re-heating event that possibly attained high temperatures of up to 820°C as we show in a petrogenetic pseudosection of the rock. Monazites in mesoperthites as well as rims of monazites included within garnet also show another peak at ca. 550 Ma. Therefore, the reheating event is considered to be between 520 and 550 Ma. From the ages of monazites in various textural associations, it is possible to trace the thermal perturbations (Fig. 1c) during the final assembly and post-assembly stages of the Gondwana supercontinent.

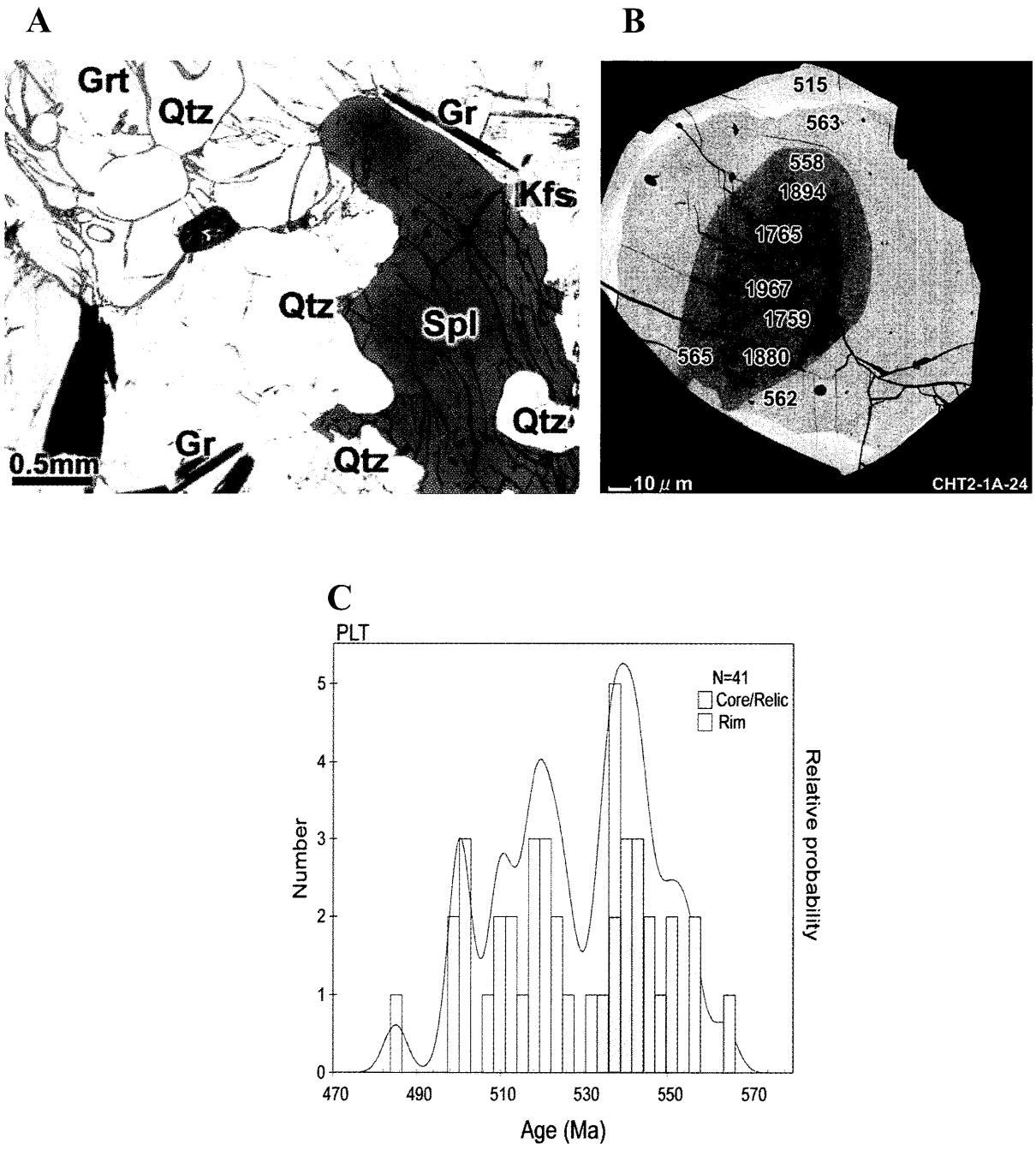

Fig. 1. (a) Thin section photomicrograph of khondalite (granulite facies metapelite) from southern Kerala, India showing spinel + quartz assemblage formed during ultrahigh-temperature metamorphism. (b) Monazite grain included within garnet from the khondalite showing Paleoproterozoic cores mantled by late Neoproterozoic rims. Ages in million years. (c) Probability plots of monazite age data from the khondalites showing various age peaks that can be correlated with distinct thermal spikes during the syn- and post-assembly stages of Gondwana.