Resolving Discrete Metamorphic Events in the Madurai Block of Southern India from a Continuum of 800-450 Ma Monazite Ages

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Over 400 electron microprobe monazite ages for ultra-high-temperature (T>900 °C) metapelites of the Madurai Block of southern India define a broad age spectrum between 450 and 800 Ma, with a mode of 530 Ma that can be interpreted in many ways. We studied a pelitic granulite from Usilampatti to assess the meaning of these age data. This sample has resorbed garnet relics enclosed by polygonal intergrowths of ilmenite-spinel-cordierite-monazite that equilibrated texturally and chemically during garnet breakdown close to the metamorphic peak. A later stage of hydrous retrogression is recorded by cordierite, which underwent widespread alteration. Yttrium maps show distinct cores of high-yttrium monazite, which grew early in the rock's history before garnet breakdown at peak temperature conditions.

U-Pb isotopic analyses were made of 40 spots from 13 monazite grains using the Sensitive High-Resolution Ion MicroProbe (SHRIMP-II). The data span an age range of 800-500 Ma, with two concordant populations that have weighted mean 206 Pb/ 238 U ages of 774±17 Ma and 578±11 Ma. The older ages are from high-Y cores that predate ultra-high temperature metamorphism, while the younger ages are from low-Y monazite that grew during ultra-high temperature metamorphism. A spread of analyses between 775 and 580 Ma is within error of a discordia between the two concordant populations, and reflects variable degrees of Pb loss from older high-Y inherited monazite during ultra-high temperature metamorphism. Most analyses, however, form a broad discordant population that overlaps with the younger concordant analyses and suggests isotopic disturbance of peak metamorphic monazite during hydrous alteration of cordierite.

This spread of SHRIMP ages matches the spread in electron microprobe ages reported for the entire terrane, indicating that electron probe data are recording a real spread of isotopic ages. However, the dominance of monazite affected by hydrous retrogression in the Usilampatti sample indicates that the 530 Ma mode of the electron probe age distribution reflects complex kinetically-controlled processes of partial isotopic disturbance while peak metamorphism occurred significantly earlier at 580 Ma.

Keywords: geochronology; granulite; Madurai; metamorphism; monazite; India.