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EPMA and LA-ICP-MS monazite dating in the Western Gneiss Belt, Northern Thailand: An Over 200-Ma Spread of Dates

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The Western Gneiss Belt in northern Thailand preserves multiple tectono-thermal events reaching medium-grade metamorphic conditions. We use the accessory mineral monazite to constrain the timing of these events. We document the texture and chemical composition of monazite, and use electron probe microanalyzer (EPMA), and laser ablation inductively coupled plasma-mass spectrometry equipped with a quadrupole (LA-ICP-MS) or with a time of flight analyzer (LA-ICP-TOF-MS) to obtain precise age data form garnet-bearing paragneiss and orthogneiss samples from the Inthanon metamorphic core complex. Orthogneiss localities are intruded by foliated biotite-garnet leuco-mylonitic granite emplaced at 40 Ma.

Garnet-bearing paragneiss samples preserve two episodes of garnet growth (grt-core and grt-rim), with some samples showing partial resorption. The composition of the grt-core is linked to at least two metamorphic events. Both EPMA and LA-ICP-MS dating indicate two age populations at 200 and 80 Ma, with LA-ICP-MS results being about 2030 Ma older than EPMA results. Monazite inclusions in garnet cores yield $^{238}U/^{206}Pb$ dates around 200 Ma, while monazite at garnet rim shows a homogeneous composition with dates around 80 Ma. Monazite in the matrix shows sector zoning with both age populations and the youngest dates are typically found in Y-rich monazite overgrowths.

Monazite in the orthogneiss exhibits patchy zoning, indicative of multiple resorptions and reprecipitation events. EPMA dating yields dates of approximately 185 Ma and 60 Ma, with a trend toward younger ages. In contrast, LA-ICP-MS dates show an older range of 230–210 Ma, with a younger cluster around 75 Ma, and a lead loss trend down to 20 Ma. Trace element mapping using LA-ICP-TOF-MS confirms the patchy distribution of dates, without any core-to-rim trend. U-rich zones that cut through the grain yield approximately 40 Ma.

Our results show that monazite is a valuable geochronological tool for constraining the evolution of polymetamorphic terranes. It not only records the peak of metamorphism but also captures retrograde processes and metamorphic overprints in the Western Gneiss Belt of Northern Thailand. The main age peaks identified are 230–200 Ma, ascribed to medium P-T regional metamorphism and magmatism related to the closure of the Paleo-Tethys Ocean. The ~80 Ma peak is associated with monazite overgrowths and likely reflects metamorphic overprint and associated granitic activity during the collision of Sibumasu and the West Burma block. The third event, dated between 40–20 Ma, is related to large-scale shearing and local thermal events associated with the Paleogene India-Eurasia collision.

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