Monazite chemistry and chronology reveal diachronous movement of the Main Central Thrust, central Nepal

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Combination of chemical X-ray mapping and *in situ* Th-Pb dating of metamorphic monazite reveals differences in the age of movement of the Main Central Thrust (MCT) in the Annapurna vs. Langtang regions of central Nepal. The MCT is identified based on structural, lithologic and isotopic discontinuities, and marks a major thrust surface separating the Greater and Lesser Himalayan sequences (GHS and LHS). Many GHS monazite grains have low-Y, high-T, prograde metamorphic cores overgrown by high-Y post-anatectic rims. Ion microprobe dating of cores vs. rims brackets the age of peak metamorphism, and rim ages date cooling due to thrust movement. At Langtang, thrusting occurred in-sequence. From structurally highest to lowest, the major structures are: the Langtang Thrust (21-16 Ma; low-Y mnz = 22-23 Ma; GHS on GHS), the MCT (16-10.5 Ma; low-Y mnz = 16-23 Ma; GHS on LHS), the Ramgarh Thrust (10.5-8.9 Ma; LHS on LHS), and the Lesser Himalayan Duplex (<9 Ma; LHS on LHS). Late-stage alteration occurred in one GHS sample at 9±1 Ma.

Preliminary application of the same geochemical approaches to GHS rocks near Annapurna (~150 km west of Langtang) permits tectonic comparison of the two areas. The most important difference is that all ages from low-Y monazite cores at Annapurna are ≥20 Ma, including samples within 500 m of the MCT. That is, there is no evidence for 16 Ma, low-Y cores in GHS monazite. Furthermore, low-Y monazite cores in structurally high rocks are 28.5±1 Ma, far older than any cores found at Langtang. Age similarities include 20-12 Ma cooling, and a late-stage hydrothermal event at 10±1 Ma. New discoveries include age-homogeneous monazite grains from leucocratic bodies that are ~30 and ~38 Ma.

One way to reconcile some of these disparate structure-age relationships is if the MCT at Annapurna is the equivalent of the Langtang Thrust at Lantang. However, this requires that the thrust surface cuts up section towards Langtang, and implies age diachroneity for initial movement of the MCT: c. 20 Ma at Annapurna vs. c. 16 Ma at Annapurna. This hypothesis can be tested via more comprehensive petrologic characterization and chronologic microanalysis of both GHS and LHS rocks.

Trace-element zonation in monazite from garnet-bearing migmatites and associated granites, SE Brazil: Implications for crustal anatexis

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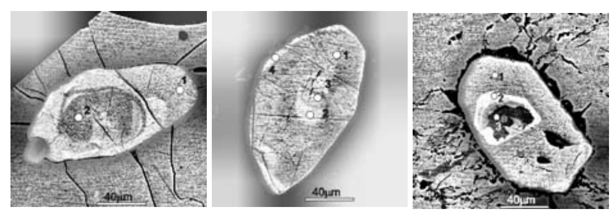
Back-Scattered Electron Images (BSE)

Complex trace-element zonation patterns are revealed by BSE images of monazite from garnet-biotite migmatitic gneiss and associated anatectic granite in the Atibaia region, São Paulo, Brazil.

Mesosome ***Leucosome*** ***Anatectic Granite***



The core (darkest area) has the highest Y and HREE concentrations (pre-magmatic monazite ?). The monazite from anatectic granites shows the dark core surrounded by a well shaped light area with lower Y and HREE concentrations. The largest area (grey) in monazite from leucosome and anatectic granite has high LREE concentration (magmatic monazite produced during anatexis?).

REE Patterns

REE patterns of monazite from garnet-biotite migmatitic gneisses (mesosome) obtained by LA-ICPMS are typically less fractioneted than those of monazite from leucosomes and associated granites. Despite the strong compositional zonation displayed by BSE images, the chondrite–normalized REE patterns are quite similar among the different areas of a single monazite. Monazite from anatectic granites is more enriched in LREE than monazite from migmatite and shows strong negative Eu anomalies and small positive Er and Yb anomalies.