Geophysical Research Abstracts
Vol. 12, EGU2010-5941, 2010
EGU General Assembly 2010

Zircon mineral trace element chemistry as a function of metamorphic grade along a traverse of lower Archean crust, Tamil Nadu, south India

Daniel Harlov (1), Daniel Dunkley (2), Edward Hansen (3), and Tomokazu Hokada (2)

(1) Deutsche GeoForschungsZentrum, Experimental Geochemistry and Mineral Physics, Potsdam, Germany (dharlov@gfz-potsdam.de, +49 331 288-1402), (2) National Institute of Polar Research, 3-10 Midori-cho, Tachikawa-shi, Tokyo-to 190-8518 Japan , (3) Department of Geology, Hope College, Holland, Michigan 49423 USA

Trends in whole-rock and mineral chemistry are seen along a 95 km traverse of lower Archean granitic orthogneissic crust, in the Eastern Dharwar Craton, Tamil Nadu, south India (Hansen and Harlov 2007 J Petrol 48, 1641). Going from north (amphibolite facies) to south (granulite-facies) along the traverse, chemical trends include whole-rock depletion of Rb, Cs, Th, and U; enrichment in Ti and F with depletion in Fe and Mn in biotite and amphibole; increases in Al with decreases in Mn in orthopyroxene; and enrichment of fluorapatite in F coupled with depletion in Cl. In the northern most portion of the traverse the principal REE-bearing minerals are allanite and titanite. South of a clinopyroxene isograd, separating the granulite- and amphibolite-facies zones, monazite grains independent of fluorapatite are the major REE- and Th-bearing phase. Further south independent monazite is rare but Th-free monazite inclusions are common in fluorapatite. During prograde metamorphism, independent monazite was replaced by REE-rich fluorapatite in which the monazite inclusions later formed. The loss of independent monazite was accompanied by a loss of whole-rock Th and possibly a small depletion in LREE.

Zircon grains along the traverse preserve domains of magmatic zoning with ages between ca. 2.70Ga and 2.55Ga, recording the emplacement of granitic protoliths. Magmatic zircon was modified during metamorphism in two distinct ways: (i) zircon along cracks, growth zones and margins is replaced by U-enriched zircon, commonly with abundant silicate inclusions; and (ii) grain margins are dissolved and overgrown by faceted rims of U and Th depleted zircon. Type (i) replacement textures are variably found in samples along the whole traverse, whereas type (ii) overgrowths appear near the clinopyroxene isograd and increase in proportion to the original protolith zircon southwards, such that most samples in the southern half of the traverse contain only minor remnants of protolith zircon relative to overgrowth zircon. Thorium and U contents of magmatic zircon do not have simple relationships to whole-rock Th-U-Zr contents, or to either type of metamorphic zircon. Instead, high U – low Th compositions of type (i) zircon may reflect equilibration with Th-bearing phases at amphibolite to lower granulite-facies conditions, whereas type (ii) low U – low Th overgrowths reflect whole-rock depletion in Th and U (but not Zr). Ages for type (ii) overgrowths cluster around 2.5Ga, similar to those obtained for identical zircon from the southern margin of the Eastern Dharwar Craton (Clark et al. 2009, Gondwana Res. 16, 27), whereas ages from type (i) zircon scatter towards protolith ages, consistent with partial resetting through recrystallisation of magmatic zircon.

Whole-rock U-Th-Zr compositions are decoupled from magmatic zircon, and coupled with type (ii) overgrowths, demonstrating that chemical changes along the traverse were produced during metamorphism, rather than reflecting differences in the protoliths. Most mineralogical features along the traverse can be accounted for by progressive dehydration and oxidation reactions. Trace element depletion is best explained by the action of externally derived low-H_2O activity brine migrating from a source at greater depth, possibly preceded or accompanied by partial melting.