Geophysical Research Abstracts
Vol. 19, EGU2017-5226-1, 2017
EGU General Assembly 2017

Monazite behaviours during high-temperature metamorphism: a case study from Dinggye region, Tibetan Himalaya

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Monazite is a key accessory mineral for metamorphic geochronology, but its growth mechanisms during melt-bearing high-temperature metamorphism is not well understood. Therefore, the petrology, pressure–temperature and timing of metamorphism have been investigated in pelitic and psammitic granulites from the Greater Himalayan Crystalline Complex (GHC) in Dinggye, southern Tibet. These rocks underwent an isothermal decompression process from pressure conditions of >10 kbar to <5 kbar with constant temperatures of 750–830°C, and recorded three metamorphic stages of kyanite-grade (M1), sillimanite-grade (M2) and cordierite-spinel grade (M3). Monazite and zircon crystals were analyzed for ages by microbeam techniques either in mounts or thin sections. Ages were linked to specific conditions of mineral growth by comprehensive studies on zoning patterns, trace element signatures, index mineral inclusions (melt inclusions, sillimanite and K-feldspar) in dated domains and textural correlations with coexisting minerals. The results show that inherited domains (500–400 Ma) are common in monazite even at granulite-facies conditions. Few monazites formed at the M1-stage (∼30–29 Ma) and recorded heterogeneous Th, Y, and HREE compositions, which formed by recrystallization related to muscovite dehydration melting reaction. These monazite grains were protected from dissolution or lateral overprinting mainly by the armour effect of matrix crystals (biotite and quartz). Most monazite grains formed at the M3-stage (21–19 Ma) through either dissolution-reprecipitation or recrystallization that was related to biotite dehydration melting reaction. These monazite grains record HREE and Y signatures in local equilibrium with different reactions involving either garnet breakdown or peritectic garnet growth. Another peak of monazite growth occurs during melt crystallization (∼15 Ma), and these monazites are unzoned and have homogeneous compositions. Our results documented the widespread recrystallization to account for monazite growth during high-temperature metamorphism and related melting reactions that trigger monazite recrystallization. In a regional sense, our P–T–t data along with published data indicate that the pre-M1 eclogite-facies metamorphism occurred at 39–30 Ma in the Dinggye Himalaya. Our results are in favour of a steady exhumation of the GHC rocks since Oligocene that was contributed by partial melting.

Key words: U–Th–Pb geochronology, Monazite, Recrystallization, Pelitic granulite, Himalaya