Geophysical Research Abstracts
Vol. 21, EGU2019-5135-8, 2019
EGU General Assembly 2019

Cenozoic partial melting, multi-stage metamorphism and deformation of garnet gneiss in the Ailaoshan-Red River shear zone, Yunnan, China

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The Ailaoshan-Red River (ASRR) strike-slip shear zone is an important tectonic belt located on the western margin of the South China Plate and the southeastern margin of the Tibet Plateau. The ASRR strike-slip shear zone has been widely advocated to be the result of the long-term interaction between the Indochina and the South China block due to lateral extrusion of the Indochina block from the India-Asia convergence zone. Along the ASRR shear zone, four isolated narrow metamorphic complexes (Xuelongshan, Diancangshan, Ailaoshan and Day-Nui-Con-Voi) are exposed , which record the Mesozoic transpressional and subduction-collision deformation between the Indochina block and the South China block, as well as multi-stage metamorphism and deformation during these high-grade metamorphic rocks since the Cenozoic. Garnet gneisses are widely exposed in the Ailaoshan high-grade metamorphic complex, which are studied, combined with microstructural observations, cathodoluminescence, petrographic analysis, geothermobarometry, thermodynamic phase equilibrium calculations, U-Pb zircon and 40Ar/39Ar white mica dating. The results show that the metapelites in the Ailaoshan metamorphic complex record peak metamorphic of granulite facies (T=780∼840 °C, P=0.7∼0.9 GPa), which include dehydration reactions of muscovite, biotite and mineral assemblages of sillimanite+K-feldspar. S-type granites also widely intruded into the high-grade metamorphic complex related to partial melt produced by anatexis at peak metamorphic conditions within granulite facies. Zircon rims of S-type granites were dated indicating that partial melting occurred at 32±3.2 Ma. 40Ar/39Ar white mica ages of suggest that these high-grade metamorphic rocks experienced ductile shearing and cooling at 28.1±0.2 Ma. All these data also argue that the Ailaoshan high-grade metamorphic complex has undergone at least four stages of a continuous deformation-metamorphism evolution, which includes an early stage lower amphibolite facies metamorphic stage (M1) (T=640∼750 °C, P=0.52∼0.6 GPa), peak granulite facies metamorphism (M2) (T=780∼840 °C, P= 0.7∼0.9 GPa), post-peak near isothermal decompression (M3) (T=640∼700 °C, P=0.55∼0.6 GPa) with strong plastic transtensional left-lateral shear and late-stage retrograde-exhumation-shearing (M4) (P<0.6 GPa, T<500 °C). Together, these data show a clockwise P-T-t path. The extremely high heat flow implies a heat source a lower crustal level, which we relate to asthenospheric uprising during initial transpressional convergence, which subsequently allowed gravitational uprise of partially molten lower crust in a gneiss dome. Consequently, shear localization along ASRR strike-slip shear zone is the result of rheological weakening due to early gneiss dome formation.