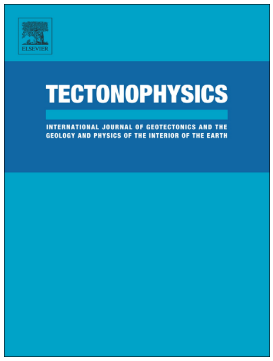

Rapid cooling and exhumation as a consequence of extension and crustal thinning: Inferences from the late Miocene to Pliocene Palu Metamorphic Complex, Sulawesi, Indonesia

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Rapid cooling and exhumation as a consequence of extension and crustal thinning: Inferences from the Late Miocene to Pliocene Palu Metamorphic Complex, Sulawesi, Indonesia

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Abstract

Metamorphic complexes forming high mountains of 1.5-2 km in Western Sulawesi were previously considered to be Mesozoic or older basement of Gondwana crust. However, many of the metamorphic rocks are much younger than previously thought. Some have Eocene sedimentary protoliths. New geothermobarometric and geochronological data from metamorphic rocks of the Palu Metamorphic Complex (PMC) and associated granitoids provide information on the timing and mechanisms of Neogene metamorphism and contemporaneous rapid exhumation. The metamorphic rocks are strongly deformed and some were partially melted to form migmatites. Schists contain relict andalusite, cordierite, staurolite and Mn-rich garnet which are wrapped by a pervasive fabric. $^{40}Ar/^{39}Ar$ dating of biotite, white mica and amphibole from strongly deformed, mylonitic schists and recrystallised amphibolites reveals cooling occurred in the Early Pliocene (c. 5.3-4.8 Ma) in the northern part and during the Late Pliocene (c. 3.1-2.7 Ma) in the southern part of the PMC. U-Pb, $^{40}Ar/^{39}Ar$ and (U-Th)/He analyses of various minerals from PMC metamorphic and S-type magmatic rocks give very similar mid to Late Pliocene ages, indicating very fast cooling and rapid exhumation, and show the high speed at which tectonic processes, including magmatism, exhumation, and reworking into a sediment, must have occurred. The high rates could be unique to this area but we suggest they record the true speed of metamorphic complex exhumation in a very young orogenic belt. Rates in older orogens appear lower because they are averages measured over longer periods of time. Contemporaneous magmatism and deformation are interpreted as a consequence of decompressional melting due to extension and thinning of the crust, promoted by possible detachment faults and normal faulting at the major NW-trending Palu-Koro and Tambarana Faults. In contrast, I-type magmatic rocks, separated from the PMC by the Palu-Koro Fault, were exhumed from upper crustal levels by erosion at moderate rates.