Continental Crust Subduction and Exhumation: insights from eastern Papua New Guinea

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Eastern Papua New Guinea is the only known region on Earth where previously subducted continental crust is being exhumed in a transient plate boundary zone characterized by a rifting to seafloor spreading transition. During the Cenozoic, the Australian passive continental margin was subducted northwards beneath a late Paleogene–Early Eocene island arc. Eclogite and blueschist relicts occur in the lower plates of metamorphic core complexes (MCCs). Thermochronology (U-Pb, $^{40}Ar/^{39}Ar$, fission track (U-Th)/He), thermobarometry and fabric analysis indicates HP and UHP exhumation occurred at plate tectonic rates (cm/yr) and was diachronous from ~13-0.5 Ma, proceeding from east to west, prior to and synchronous with seafloor spreading in the Woodlark Basin (≤6 Ma).

In-situ ion probe analysis of zircons in variably retrogressed mafic eclogites from Fergusson and Goodenough Islands yielded $^{238}U/^{206}Pb$ ages of 8–2 Ma. Trace and REE geochemistry support an interpretation of zircon growth under eclogite-facies conditions. The presence of coesite, in an eclogite containing 8 Ma zircons that crystallized at 650–675°C, indicates some rocks were subducted to depths of >100 km. (U-Th)/He apatite ages provide constraints on exhumation to shallow crustal levels by 1.5 Ma.

Retrogressed mylonitic blueschists (>1 km thick) occur in the lower plate of the Prevost Range MCC (eastern Normanby Island), located <30 km west of the active sea floor spreading rift tip. Complex $^{40}Ar/^{39}Ar$ mica and plagioclase spectra are interpreted to record mineral growth and cooling from ~8–3 Ma. Southeast of the active rift tip, garnet amphibolites from the Misima MCC lower plate yielded $^{40}Ar/^{39}Ar$ amphibole and mica ages interpreted to record cooling and exhumation from ~13–8 Ma.

In eastern Papua New Guinea counter-clockwise rotation of the Woodlark plate relative to the Australian plate led to reactivation of a former subduction thrust, and resulted in extensional eversion of HP and UHP rocks. Mylonites preserve stretching lineations and top-to-the-north shear indicators parallel to the Plio-Pleistocene plate motion. Eastern Papua New Guinea provides an unprecedented opportunity to study the exhumation of the youngest known HP and UHP rocks, in an active tectonic setting.