3D thermo-kinematic modelling of the Papua New Guinea UHP terrane

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The world's youngest eclogites, exhumed from depths of ca. 90 km since 8 Ma, are located in the D'Entrecasteaux Islands in the active Woodlark rift of southeastern Papua New Guinea. These (U)HP rocks formed during/following subduction of Australian margin-derived volcaniclastic sediments, and were exhumed during rifting within the larger obliquely convergent Australian-Pacific plate boundary zone. Several (U)HP exhumation mechanisms have been proposed including diapiric rise of buoyant crust from mantle to crustal depths, and rifting of heterogeneous crust ahead of the east-to-west propagating Woodlark seafloor spreading center. In order to constrain the relative importance of different exhumation mechanisms through time (i.e., timing and rates of diapirism vs crustal faulting), we use thermochronologic data from Goodenough Island, the western-most of the D'Entrecasteaux Islands, to obtain 3D thermo-kinematic models (Pecube). New apatite fission-track age-elevation profile (2536 m elevation to sea-level), yielded ages range from ca. 3.5 Ma to ~1 Ma, with confined track lengths of 14-16 microns, indicative of rapid cooling.

More than 100,000 Pecube models were run to evaluate scenarios involving only vertical exhumation velocities (i.e., simulating simple buoyancy due to diapirism). These preliminary models assume steady-state topography, and do not incorporate orientation of faults in the crust (i.e. only vertical exhumation rates are assessed). Preliminary results were obtained for scenarios involving: (i) one continuous exhumation phase from 8-0 Ma, (ii) two exhumation phases with different exhumation rates (increasing and/or decreasing), and (iii) three exhumation phases with variable exhumation rates. The first two scenarios (i and ii) result in poor correlations between model-derived and observed data. Notably, scenario (i) and (ii) produce indistinguishable ages for all thermochronometers, uniformly short fission-track lengths, excessive temperatures at the Moho and geplogical starting parameters (depth, T) that are incorrect.. Scenario (iii) has the lowest misfit between model-derived data vs observed thermochronometer ages and AFT lengths. The best-fit scenario suggests exhumation starting at 8-6 Ma with very high rates (8-10 km/Myr), then at ~2 Ma exhumation is very slow, followed by exhumation starting ca. 1 Ma, at very high, but poorly constrained rates (1-9 km/Myr). Although depth-time paths are presently not known in detail, results suggest initial exhumation from (U)HP depth, residence at near crustal levels, with the final phase of exhumation through the crust during crustal extension.