Low–T thermochronology constraints on the development of the Australian Great Escarpment

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High elevation passive margins, such as southeastern Australian, are characterised by steep escarpments that separate a dissected coastal plain from a low relief, high altitude inland plateau. Apatite (U-Th)/He and fission track (AFT) analyses of two coast-perpendicular traverses across the coastal lowlands, escarpment and plateau in southern New South Wales have been performed to test the prevailing models of escarpment formation, namely retreat into a downwarped rift shoulder, escarpment retreat and down-wearing of high elevation rift in response to flexural rebound. The data provide quantitative constraints on the amount and timing of erosion since time of break-up. He ages from the coastal plain (87-119 Ma) suggest that the coastal lowlands developed very rapidly after rifting and continental break-up at 85-100 Ma. The He age data are inconsistent with the erosion of a downwarped rift margin, and cannot be explained by a constant post break-up rate of lateral escarpment retreat across the coastal plain or by constant down-wearing. The escarpment formed either by rapid retreat or rapid in-place excavation soon after break-up, followed by a period of landscape stability and low erosion. AFT ages from the coastal plain range (99-227 Ma) indicate that at the time of break-up the samples now exposed were already in the upper part of the Partial Annealing Zone. The data limits the amount of erosion of the coastal lowlands to 3-4 km. At the present coast line one sample records a fission track age corresponding to the time of break-up, indicative of more than 4 km erosion. Modelling the He data suggests that the exhumation (cooling) in the area along the present coastline took place within 28 Myr of break-up, at a minimum vertical erosion of 130 m/Myr. The rapid denudation period across the coastal plain in this region took less than 50 Myr (from the coast to the escarpment base), which corresponds to an average vertical erosion rate of 45 m/Myr. Old fission track ages are randomly distributed across the coastal plain maybe indicating that erosion was driven by river incision and degradation of the ancient plateau, rather than escarpment retreat into the plateau. Apatite He (183-247 Ma) and fission track ages (220-261 Ma) of the plateau indicate that the highlands remained stable throughout continental break-up, and have experienced average erosion rates of less than 10 m/Myr since the late Palaeozoic.

Plutonic evolution of an island-arc picritic magma: Galmoenan massif, Koryak highland, Far East Russia

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Gabbro-pyroxenite-dunite plutons (GPDP) and high-Mg picrite-to-basalt volcanics (PBV) belong respectively to the lower and the upper associations of the same Late Cretaceous-Paleocene intraoceanic paleo-arc system in Koryak highland and Kamchatka peninsula. The dunites of the Koryak gabbro-ultramafic massifs represent the source of several currently exploring platinum placer deposits.

The purpose of our study is to model the origin of the island-arc gabbro-ultramafic complexes. The geochemistry of melt inclusions in Kamchatka ultramafic volcanics (Kamenetsky et al., 1995) was combined with the new data on clinopyroxene (SIMS) and whole-rock (ICP-MS) geochemistry of the Galmoenan plutonic massif. The COMAGMAT computer program (Ariskin, 1999) was used for modeling magma differentiation processes.

We showed that GPDP and PBV are the products of closely similar primitive subduction-related picritic magma. The cotectic olivine+clinopyroxene crystallization of Galmoenan ultramafics covering a wide range of olivine and clinopyroxene Mg numbers (89 to 82 and 90 to 84 respectively) suggests polybaric crystallization. The model polybaric fractional crystallization correlates well with the petrography and mineral composition of Galmoenan ultramafics. Some deviations of actual clinopyroxene compositional variations (REE and Y versus Mg#) from the model trends are attributable to (1) local dunite/melt interaction (higher Mg#) and (2) rapid cooling and crystallization of trapped melt in gabbro (faster enrichment in incompatible elements).

According to the accepted model the olivine± Cr-spinel (dunite) accumulation occurred under pressure of at least 1.0 GPa. The uplifting ultramafic solid body was accreting by olivine-clinopyroxene cumulates crystallizing from the associated melt. The uplifting terminated at the upper-crustal subvolcanic level, where pyroxenite-gabbro and gabbro bodies were rapidly crystallized and locally chilled.

References

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