Time scales of intracratonic orogeny

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Intracratonic orogeny represents an intriging endmember of the tectonic spectrum in that deformation is temporarily focused into regions of lithosphere that more generally exhibit plate-like behaviour. There is a general consensus that intracratonic orogeny is driven by stresses generated at plate boundaries. If this assertion is true, there should be a strong correspondence between the evolution of plate margin systems and events within mechanically coupled continental interiors.

The intracratonic Petermann and Alice Springs orogens in central Australia form components of a shifting pattern of intraplate deformation whose duration spans the early stages of Gondwanan assembly (c. 600 Ma) to the establishment of a (c. 450-300 Ma) convergent margin along east Gondwana. These orogens have two important similarities. Firstly is the development of comparatively narrow deep foreland basins, which may be coupled with large-scale footwall depression beneath crustal-scale thrust sheets. These observations point to the involvement of weak lithosphere in the intraplate orogenesis. Secondly both record apparently long (> 70 Ma) durations of deformation. The 450-300 Ma Alice Springs Orogeny terminated rifting and associated basaltic magmatism, providing an obvious thermal link for localizing the deformation. However an intriguing aspect of the Alice Springs Orogeny is the existence of a long-lived high-T thermal regime marked by the emplacement of crustally derived melts throughout the entire c. 100 Ma orogenic history. Simple calculations suggest that it would be difficult for the lower crust to remain above the solidus for c.100 Ma without significant inputs of heat from the mantle.

The Alice Springs Orogeny coincided with the development of a long-lived convergent margin along eastern Gondwana. The development of the margin was characterised by upper plate extension punctuated by transient collision/accretion linked to the incorporation of buoyant colliders. A challenge in understanding the geodynamic evolution of the continental margin-interior system is to decipher event timing within the overall long-lived record of intracratonic deformation in comparison with events on the margin. Within the Alice Springs Orogen, phases of contractional deformation generally coincide with collisional events on the adjacent margin with the locus of most intense deformation coinciding with the footprint of pre-orogenic rifting and mantle-derived magmatism. This suggests that the mantle-driven thermal regime initially associated with rifting, played a central and on-going role in controlling the intracratonic response during the development of the adjacent east Gondwana plate margin.

Processes and timescales of magma genesis and differentiation at Lopevi Volcano, Vanuatu, SW Pacific

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Recently erupted basaltic and andesitic lavas of Lopevi Volcano, one of the most active in Vanuatu, were analysed for whole rock major and trace element abundances, Sr and Nd isotopic ratios and U, Th and Ra isotopic compositions; forming the first detailed U-series study of an individual volcanic centre within the Vanuatu (New Hebrides) arc. The data are used to constrain the processes and timescales of magma genesis and evolution beneath the volcano, leading towards a better understanding of the relationship between magma supply and eruption, which is invaluable for volcanic hazard assessment.

MgO contents of lavas erupted throughout 2000-2003 cluster at around 4-5 wt%, whereas those from earlier eruptions (during the 1930's and 1960's) exhibit a wider range, extending to more primitive MgO contents (up to 8.5 wt%). Fractional crystalisation is an important mechanism of differentiation at Lopevi, exerting strong control on major and trace element variations. Increases in SiO_2, Na_2O, Al_2O_3, TiO_2 (and to a lesser extent K_2O and P_2O_5) and decreases of CaO and Fe_2O_3 with decreasing MgO are consistant with the removal of a mineral assemblage dominated by olivine and pyroxene. Unlike volcanic rock suites of many other arc volcanoes, Dy/Yb ratios at Lopevi do not systematically decrease with increasing SiO_2, demonstrating that amphibole cannot be an important fractionating mineral during magmatic differentiation at mid-lower crustal depths beneath the volcano.

Enrichment of LREE relative to HFSE and HREE, high Ba/La ratios relative to MORB, uniform HFSE/HFSE ratios (e.g. Ta/Nb) along with ^{238}U excesses (1.250-1.400) in Lopevi lavas identify the contribution of a fluid component to a relatively homogeneous, slightly depleted mantle source. Furthermore, the sub horizontal array displayed by the data on a U-Th equiline diagram indicates this addition occurred significantly recently. ^{226}Ra excesses in the lavas suggest that crustal residence times of magmas at Lopevi are <8000 years. $^{87}Sr/^{86}Sr$ ratios lie between 0.703992 and 0.704078 and are characteristic of volcanoes similarly located in the central Vanuatu arc, above where the D'Entrecasteaux Ridge is being subducted and accreted (cf. northern and southern sections of the Vanuatu arc).