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GR Focus Review

Spatial and Temporal Radiogenic Isotopic Trends of Magmatism in Cordilleran Orogens

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Abstract

An intrinsic feature of Cordillera-style orogenic systems is a spatial trend in the radiogenic isotopic composition of subduction-related magmatism. Magmatism is most isotopically juvenile near the trench and becomes increasingly evolved landward. A compilation of radiogenic isotopic data from the central Andes, U.S. Cordillera, and Tibet (the most well-studied examples of modern and ancient Cordilleran systems) demonstrate such spatial trends are long-lived and persist throughout the life of these continental subduction margins. The consistency of the isotopic trend through time in magmatic products is surprising considering the plethora of orogenic processes that might be expected to alter them. In addition to longevity, spatial isotopic trends encompass a broad spectrum of geochemical compositions that represent diverse petrogenetic and geodynamic processes. The two end-members of the spatial isotopic trends are represented by melts sourced within isotopically juvenile asthenospheric mantle and melts sourced from isotopically evolved continental lithospheric mantle and/or lower crust. Mantle lithosphere generally thins towards the magmatic arc and trench in Cordilleran orogens because sub-lithospheric processes such as delamination, subduction erosion, and subduction ablation, operate to thin or remove the continental mantle lithosphere. With time, magmatic additions may impart the isotopic composition of the mantle source on the lower crust, giving rise to an isotopically homogenous deep lithosphere. The results of this analysis have significant implications for interpreting temporal and spatial shifts in isotopic composition within Cordilleran orogens and suggest that the continental mantle lithosphere may be a significant source of magmatism in orogenic interiors.