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Temporal histories of Cordilleran continental arcs: Testing models for magmatic episodicity

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Abstract

Magmatic activity in continental arcs is known to vary in a non-steady-state manner, with the mechanisms driving magmatic activity being a matter of ongoing discussion. Of particular importance is the question of what extent episodic magmatism in continental arcs is governed by external factors (e.g., plate motions) and internal factors (e.g., feedback processes in the upper plate). To test existing models for magmatic episodicity, which are mostly based on temporally and spatially limited records, this study uses large data sets of geochronological, geochemical, and plate kinematic data to document the Paleozoic to Mesozoic development of the North and South American Cordilleras in eight transects from British Columbia to Patagonia. The temporal distribution of U/Pb bedrock and detrital zircon ages, used as a proxy for timing of magmatic accretion, shows that some minima and maxima of zircon abundance are nearly synchronous for thousands of kilometers along the arc. Some age patterns are characterized by a periodicity of 50–80 Ma, suggesting a cyclic controlling mechanism. Other magmatic lulls or flare-ups find no equivalents in adjacent sectors, indicating that either discrete events or variable lag times may also be important in governing magmatic activity in continental arcs. Magma composition in Mexico, the Peninsular Ranges, and the Sierra Nevada varies episodically and proportionally with the temporal record of arc activity. During flare-up events, there is an increase in Sm/Yb, indicating deeper melting, and a decrease in εNd_i, suggesting a higher degree of crustal assimilation. Geochemical scatter also increases during the initiation of flare-up events. Plate kinematic data provide a means of evaluating mantle heat input. The correlation between plate convergence rate and magmatic accretion varies for each sector, suggesting that different flare-ups or lulls likely reflect variable combinations of processes.

Keywords: Magmatism, continental arc, Cordilleras, geochronology, geochemistry, plate motions, Paleozoic, Mesozoic, Invited Centennial article