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Interplay between slab dynamics and upper plate structure for localizing magmatism in continental arcs

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In continental magmatic arcs both deformation and magmatism can be strongly localized in time and space. Compilation and spatial analysis of >200 Ar-Ar and U/Pb ages from the Copiapo-Vallenar segment of the Mesozoic Costal Cordillera batholith of northern Chile reveals that during the Cretaceous the locus of magmatism swept across the arc from west to east at an average rate of ∼500 m/Myr. In detail, this migration was discontinuous; elongate plutonic complexes were fixed and grew adjacent to one strand of the arc-parallel Atacama-Tigrillo fault system over ca. 3 Myr periods and then magmatism jumped 5 to 15 km to the east to be captured by the next strand. This growth-jump-growth cycle was repeated six times between 170 and 90 Ma over an arc-normal distance of ∼50 km. In the Coastal Cordillera, the arc-normal component of deformation during the Cretaceous was extensional with an increasing component of margin-parallel sinistral strike-slip. The observed eastward migration of magmatic activity is difficult to reconcile with upper plate extension, which is thought to be driven by slab roll back/trench retreat or upper plate retreat with a fixed or free slab. To resolve this we explore several possible interactions between slab motions, flow in the mantle wedge, upper plate deformation and reactivation of pre-existing arc-parallel faults. For example, it is possible that migration and emplacement of magmas is tied to the geometry of extension in the upper plate and flow in the asthenospheric wedge and not to retreat of the subducting plate. Alternatively, localization of magmatism and the pattern of migration may be consequences of complex slab dynamics and upper-crustal fault reactivation.