TECTONIC CONTROLS ON MESOZOIC ARC MAGMATISM IN NORTH CHILE

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RESUMEN: Complejos plutonicos Jurasicos (*c.* 190 Ma and *c.* 153-138 Ma) se ubican escencialmente al oeste del Sistema de Falla Atacama (SFA), emplazados en el basamento metasedimentario y los complejos plutonicos anteriores. El SFA corresponde a una zona de fractura a escala cortical con una larga y compleja historia de desplazamientos desde el Jurasico-Cretacico (*c.* 158 Ma, *c.* 132-126 Ma) al Reciente. Complejos plutonicos Cretacicos se urbican a lo largo (*c.* 127 Ma) y al este (*c.* 106 Ma) del SFA emplazados en volcanitas andesiticas Cretacicas, ya que durante el Cretacico, el foco de la actividad magmatica migro hacia el este.

KEY WORDS: Ar ages; dip-slip faulting; Mesozoic arc magmatism; strike-slip faulting; syn-kinematic plutonism; transtension.

INTRODUCTION

One perplexing feature of arc systems relates to the relationship between the apparently continuous nature of subduction processes and the episodicity of regional magmatic events. Such episodicity suggests that the rates of tectonic processes must be relatively rapid. Also, the relationship between arc-related strike-slip faults and magmatism is uncertain. Arc-parallel trench-linked strike-slip faulting is common along convergent margins and is particularly important in continental arc systems. As a result, fore-arc slivers typically are stranded between strike-slip faults and trenches. Trench-linked strike-slip faults, in addition to accommodating the horizontal component of oblique subduction, cut and may localize arc intrusions and volcanic rocks. One major question is whether relative thermal 'softening' within an evolving magmatic arc is required for development of strike-slip fault systems or whether development of strike-slip fault systems facilitates the ascent and emplacement of arc-related magma? One aim of our ongoing research

GEOLOGICAL SETTING

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magma emplacement. Thus our precise $^{40}Ar/^{39}Ar$ dates also reflect crystallization ages. Peaks of activity occurred in the Lower Permian (LP), the Triassic (T), the LJ, the UJ and the LC. Using the $^{40}Ar/^{39}Ar$ method, we have determined precise emplacement ages of individual plutonic complexes both along strike and across strike within each of the Mesozoic arcs. On the west side of the Coastal Range, $^{40}Ar/^{39}Ar$ hornblende isotope correlation ages of *c.* 190 Ma characterize the LJ arc suite along more than 1° of latitude. Ages of 153, 139 and 138 Ma have been determined on hornblende from samples W to E across the UJ arc suite, and ages of *c.* 127 and 106 Ma have been determined on hornblende from localities across the LC suite. These ages indicate that as the locus of magmatic activity stepped successively E, each previous arc cooled. Furthermore, whole rock $^{40}Ar/^{39}Ar$ ages of 156 and 154 Ma from calc-alkaline basaltic andesite dikes indicate emplacement of the earliest magmas of the UJ suite in an extensional environment.

The geochemical features of granitoid (> 63% SiO_2) samples from the LJ, UJ and LC plutonic complexes from the Coastal Range include enrichment in Rb, Th, U and K and depletion in Ba, Ta, Nb, Sr, P and Ti, characteristic features of continental margin granitoids, and relative enrichment in the LREE relative to the HREE. Normalized values for Y of *c.* 5 suggest shallow magma sources. For the expanded range of compositions, K/Rb and Rb/Sr do not change dramatically with increasing SiO_2 until very high SiO_2 contents, features that are consistent with fractional crystallization as the dominant control of the chemical variation. The low on average Ba/La ratios exhibited by the rocks suggest low alkali earths in the source region and argue for limited subduction zone enrichment within the mantle wedge. This is confirmed by low Ba/Nb ratios at low SiO_2 contents.

THE ATACAMA FAULT SYSTEM

In the El Salado segment, the AFS transects intrusive and volcanic rocks of the Upper Jurassic and Lower Cretaceous magmatic arcs. At El Salado, and for 20 km to the S, the AFS contains three principal fault zones where distinct brittle faults have reworked rocks that display an earlier record of penetrative ductile strain. For much of its length, the western fault zone juxtaposes Jurassic diorite/tonalite to the W with Cretaceous tonalite/granodiorite to the E. This brittle fault contact is located within a *c.* 800 m wide ductile shear zone which appears to have initiated during upper amphibolite facies conditions. A variety of kinematic indicators all indicate east-side-down displacement (Brown *et al.*, 1993). Because field relations constrain at least an early Lower Cretaceous age for ductile displacement, the AFS could have initiated within a fault system responsible for Jurassic - Lower Cretaceous subsidence in the Mesozoic marginal basin to the E. Jurassic plutonic rocks exposed west of the main shear zone are cut by small-scale shear zones which again display amphibolite facies mineral assemblages, and which may have formed during the early stages of development of the AFS. The eastern fault zone of the AFS

deformation during strike-slip displacement on the AFS.

The upper amphibolite facies, east-side-down shear zones along the west fault of the AFS are interpreted to have formed in the wall-rocks of Lower Cretaceous intrusions during emplacement. The shear zones dip steeply at the surface but may become low-angle at depth. Ductile deformation was promoted by heat supplied from the arc plutons which were emplaced at dilational jogs in this extensional shear zone system. The east fault of the AFS represents a boundary to the extensional domain. The mylonites were reworked by successively lower temperature, sinistral strike-slip ductile-to-brittle faults.

CONCLUSIONS

Our preliminary $^{40}Ar/^{39}Ar$ data on plutonic complexes suggest that arc magmatism is partly episodic. A significant time gap exists between the Lower Jurassic plutonic complexes and Upper Jurassic plutonic complexes. Smaller, possibly significant time gaps occur within the Upper Jurassic and Lower Cretaceous plutonic complexes.

The Atacama Fault System likely was initiated *c.* 160 m.y. ago and was characterized by extension until *c.* 130 Ma. Since plate kinematic reconstructions suggest south-east directed subduction during this interval, due to the expansion of the Pacific Ocean Basin while South America remained essentially static in a mantle reference frame, it is likely that the AFS represents a transtensional fault during the Upper Jurassic. The outcrop shape of plutonic