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THE ROLE OF THE ATACAMA FAULT SYSTEM IN THE POST-LATE PALEOZOIC EVOLUTION OF NORTH CHILE: IS IT A TERRANE BOUNDARY?

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The Atacama Fault System (AFS) is situated within the Coastal Range of North Chile (Figure 1), along the active continental margin of the South American plate. The AFS has been interpreted to represent a trench-linked strike-slip system developed in the overriding plate as a result of oblique subduction (see references in Brown et al., 1992). In addition, Ramos (1988) suggested that the AFS is a boundary between the Chañaral Displaced Terrane and the Chilenia Terrane. By contrast, paleomagnetic data for southern South America suggest only limited post-late Paleozoic accretion and terrane displacement throughout much of the Central Andes (e.g. Beck et al., 1991). However, the data do allow tectonic rotations within the forearc in northernmost Chile.

The AFS transects intrusive and volcanic rocks of the Jurassic-Cretaceous magmatic arc (Figure 2). The distribution of sedimentary, volcanic and intrusive rocks of various ages along and across the AFS implies that different structural levels are exposed as a consequence of fault displacement. South of El Salado (Figure 2), Jurassic and older intrusive rocks, and Upper Paleozoic metasedimentary basement rocks, are exposed along the western side or within the AFS. Younger rocks (including Cretaceous plutonic and volcanic rocks) are exposed east of the AFS, which implies a vertical east-side-down component of displacement within the AFS. North of Quebrada Pan de Azucar, volcanic and sedimentary rocks are exposed west of the AFS and plutonic igneous rocks are exposed to the east (Figure 2), which implies a downthrow to the west. Downthrown Cretaceous volcanic rocks within the AFS are in fault contact with Jurassic supracrustal rocks (west) and with plutonic rocks (east), interpreted to represent a negative flower structure by Brown et al. (1982). The superficial complexity in map distribution of rock units obscures a continuity of post-late Paleozoic geology across the AFS.

South of Quebrada Pan de Azucar, the AFS contains three major faults characterized by brittle deformation which has overprinted strong ductile fabrics (Brown et al., 1992). The western fault juxtaposes Jurassic diorite/tonalite (west) and Cretaceous tonalite/granodiorite (east). Within the zone of ductile deformation along the western fault a variety of kinematic indicators consistently suggests that ductile movement was dip-slip, east-side-down. This ductile deformation occurred during upper amphibolite facies P-T conditions. The mylonites typically show annealing microstructures (Brown et al., 1992). In Quebrada del Saladito, sheets of Cretaceous tonalite intrude across the mylonitic foliation. Some sheets are nearly concordant and penetratively foliated. Other sheets are discordant and undeformed. Emplacement of this Cretaceous tonalite was clearly syn- to post-kinematic with respect to ductile dip-slip movement.

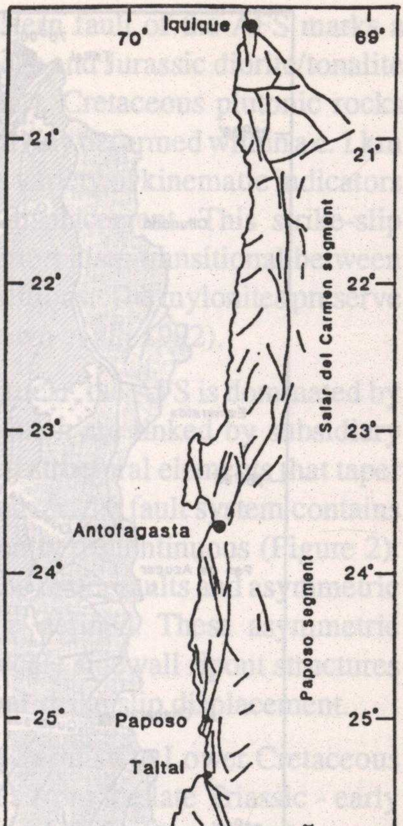

Fig. 1: The Atacama Fault System in Northern Chile.

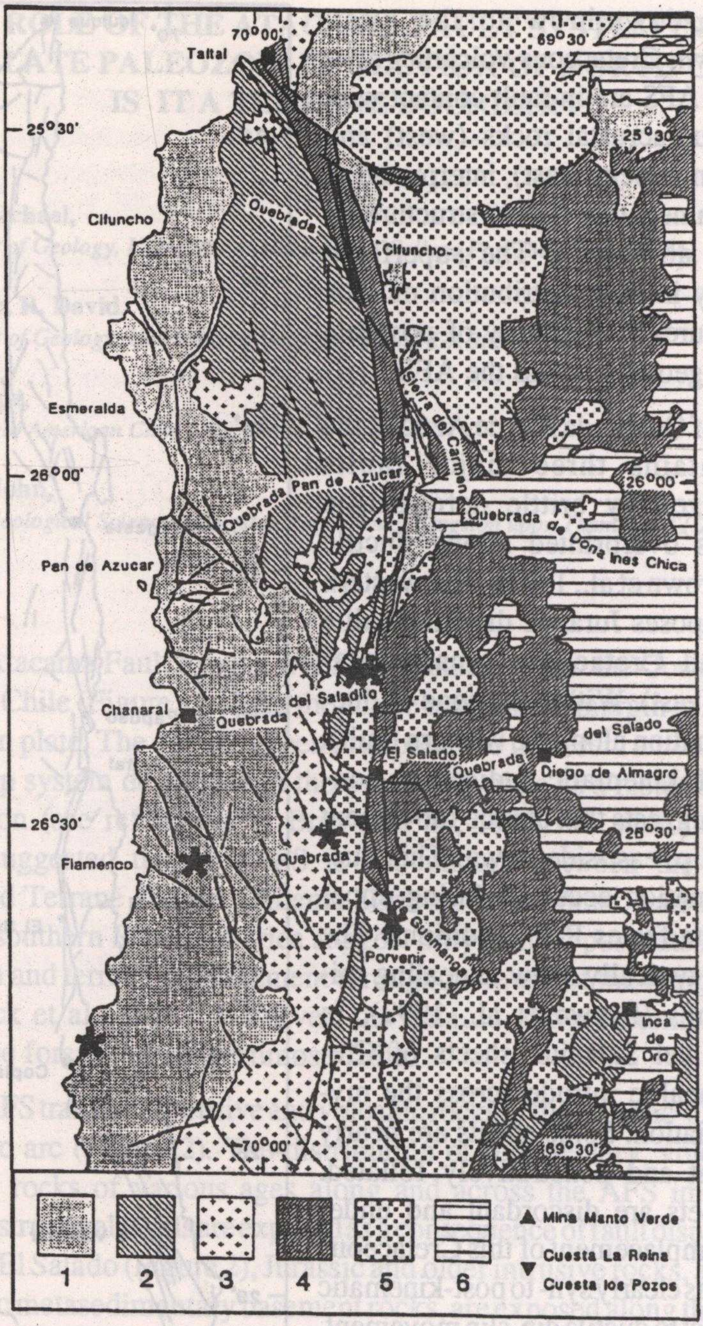

Fig. 2: The Atacama Fault System between 25°20'S and 27°00'S. 1. Paleozoic metasedimentary basement and Permian - Triassic and Triassic - early Jurassic plutonic complexes. 2. Jurassic volcanic and sedimentary rocks. 3. Jurassic plutonic complexes. 4. Cretaceous volcanic and sedimentary rocks. 5. Cretaceous plutonic complexes. 6. Atacama gravels. * = sample locations for $^{40}Ar/^{39}Ar$ hornblende dating.

South-south-east of Manto Verde, the eastern fault of the AFS marks a boundary between Cretaceous volcanic rocks and Jurassic diorite/tonalite (west) and Cretaceous tonalite/diorite (east). Cretaceous plutonic rocks adjacent to the brittle fault trace are penetratively deformed within a c. 1 km wide zone of easterly-dipping mylonites. A variety of kinematic indicators signify a consistent sinistral strike-slip displacement. This strike-slip ductile deformation occurred during metamorphism transitional between amphibolite and greenschist facies P-T conditions. The mylonites preserve evidence of dynamic recrystallization (Brown et al., 1992).

Between Taltal and Quebrada Pan de Azucar, the AFS is dominated by two, subparallel major faults (Figure 2) which are linked by subsidiary faults that define asymmetric fault-bounded structural elements that taper to the north. South of Quebrada Pan de Azucar, the fault system contains major faults which overlap and are apparently discontinuous (Figure 2). Northwest-trending subsidiary faults link the major faults and asymmetric fault-bounded structural elements may be defined. These asymmetric features are interpreted to represent large-scale sidewall ripout structures (Brown et al., 1992) which indicate sinistral strike slip displacement.

Plutonic rocks of the Coastal Range are Permian to Lower Cretaceous in age. Three tonalite/granodiorite samples from the late Triassic - early Jurassic arc to the west yield $^{40}Ar/^{39}Ar$ hornblende plateau and isotope correlation ages of c. 190 Ma, which are interpreted to date post-magmatic cooling through temperatures required for intracrystalline retention of argon within constituent hornblende grains. Hornblende within Cretaceous tonalite, exposed between the west and central branches of the AFS in Quebrada del Saladito, records a $^{40}Ar/^{39}Ar$ hornblende plateau and isotope correlation age of c. 127 Ma, also interpreted to date post-magmatic cooling. Mylonitic Jurassic diorites (dip-slip sense of movement) from two localities along the western part of the fault system yield $^{40}Ar/^{39}Ar$ hornblende plateau and isotope correlation ages of 132-130 Ma, which are interpreted to date the last cooling through those temperatures required for intracrystalline retention of argon in constituent hornblende grains following amphibolite facies annealing. By contrast, mylonitic Cretaceous diorite (strike-slip sense of movement) located along the east branch of the AFS (south-south-east of Manto Verde) yields a $^{40}Ar/^{39}Ar$ hornblende plateau and isotope correlation age of c. 126 Ma, interpreted to date closure to loss of intra-crystalline argon in constituent hornblende grains following dynamic recrystallization under transitional amphibolite-to-greenschist facies metamorphic conditions. The age data confirm that ductile sinistral strike-slip displacement along the eastern fault was younger than east-side-down ductile displacement along the western fault.

Global paleogeodynamic reconstructions suggest that south-east directed subduction of an oceanic plate occurred beneath the active continental margin of North Chile during the Jurassic-Cretaceous. The breakup of the southern continents resulted in the eventual separation of South America from Africa. The resultant response along the western margin of the South American continent was a change from extension to compression. The change from Lower Cretaceous dip-slip movement to Lower Cretaceous strike-slip movement across the AFS in the ductile regime may reflect this westward migration of South America as the South Atlantic Ocean Basin opened. Subsequently, the compression resulted in structural inversion of the Mesozoic marginal basin developed east of the Jurassic-Cretaceous plutonic arc in the Coastal Range. Transition from ductile to brittle sinistral strike-slip within the AFS may have occurred in the Cretaceous as a consequence of exhumation and cooling; however, the age of the brittle deformation is not well constrained. Between Quebrada Pan de Azucar and Taltal, intensely ductilely deformed rocks are generally absent, although they occur north of Taltal (between Paposo and Antofagasta). This gap is due to sinistral offset of more than 70 km by a brittle fault system. Armijo and Thiele (1990) interpreted active displacements on the AFS near Antofagasta as both sinistral strike-slip and extensional. Thus, it is possible that the major brittle, sinistral strike-slip displacements within the AFS were of late Tertiary/Quaternary age.

The AFS records Lower Cretaceous to Recent ductile and brittle sinistral strike-slip displacements. However, the continuity in the post-late Paleozoic geology across the AFS suggests lateral transport only locally within a continental arc system. This suggests that no truly exotic terrane elements are present. Thus, the AFS is not a boundary which separates different tectonostratigraphic terranes.

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