LATE JURASSIC RIDGE-TRENCH COLLISIONS AND DEVELOPMENT OF GULF OF CALIFORNIA-TYPE BASINS ALONG THE ANDEAN CORDILLERA

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Résumé

De nouveaux résultats des prospections géologiques et géochimiques de La Géorgie du Sud, qui fait partie déplacée du bassin marginal des "Rocas Verdes" des Andes, suggèrent que le bassin s'est formé dans un milieu ressemblant celui du Golfe de la Californie. En conséquence, il se peut que des collisions entre une système de dorsales et une fosse océanique aient dirigé l'orogenese des Andes d'une façon non reconnu jusqu'à présent.

Key Words: Andean orogenesis, marginal basin, strike-slip

The tectonic evolution of the Andean Cordillera is intimately related to long-lived subduction of Pacific and proto-Pacific oceanic lithosphere beneath the South American margin during both the Mesozoic and Cenozoic. Although broadly a convergent margin, repeated continental lithospheric extension has resulted in intra-arc and back-arc basin formation. Basin evolution is generally related to variations in subduction parameters; namely: convergence rate; roll back; age and hence thermal characteristics of the subducting oceanic slab; and subduction zone angle. Surprisingly, one parameter rarely considered in Andean orogenesis is the role of ridge-trench collision, notwithstanding the current collision between the Chile Rise and Peru-Chile trench and consequent formation of the Golfo de Penas-Taitao basin (Forsythe and Nelson, 1985). It is likely similar collisions occurred during the Mesozoic and may have been an important, previously unrecognized control on Andean orogenesis and ensialic marginal basin formation.

Although the Late Jurassic to Early Cretaceous Rocas Verdes ensialic marginal basin system in the southern Andes (Fig. 1) is generally considered to be a subduction-related back-arc basin, its tectono-magmatic evolution has also been compared with the Gulf of California. New field mapping, structural data and an integrated trace-element and Nd isotopic study on the Larsen Harbour Complex on South Georgia (Fig. 1), a displaced part of the Rocas Verdes, suggest basin formation resulted from oblique spreading in a transform system due to intersection of a spreading ridge with a trench (Alabaster & Storey, in press). Magmas produced during the early stages of continental lithospheric attenuation were derived by varying degrees of partial melting and fractional crystallization from a low-ENd lithospheric mantle source enriched in large ion lithophile elements (LILE) during an earlier phase of subduction-related calc alkaline magmatism. Petrogenesis of these magmas does not require contemporaneous subduction-related hydrous melting in the mantle source and consequently we suggest the basalts were not generated in a supra-subduction zone setting. Interestingly, basalts generated during the early stages of rifting both from the Rocas Verdes and the Gulf of California are essentially indistinguishable geochemically. Moreover, in both areas, magmas produced during later stages of rifting were derived from a high-ENd asthenospheric mantle source similar to N-type MORB, unaffected by earlier LILE-enrichment.

Additionally, we have discovered geochemically unusual pre-ophiolitic continental high-magnesium andesite (CHMA) dykes on South Georgia and CHMA lavas on the once contiguous Antarctic Peninsula. Studies based on the occurrence of Early Miocene age CHMA lavas in Baja California and of Middle Miocene age in the Setouchi volcanic belt, Japan (Saunders et al., 1987, Tatsumi and Maruyama, 1989) suggest CHMA form in response to high geothermal gradients associated with atypical subduction. These conditions may, in part, be generated by encroachment of a spreading center upon a trench and subduction of newly created, hot, oceanic lithosphere.

Structural data from a one kilometre wide ductile shear zone that dissects the island of South Georgia indicates a major component of strike-slip displacement. Strike-slip and oblique faults have also exerted an important control on Andean tectonics (Dala Solda and Franzese, 1987).

We propose a model for the formation of the Rocas Verdes basin which involves cessation of subduction along an oblique-slip margin as a result of ridge-trench collision, and the migration of a ridge-trench-fault triple junction forming a growing transform boundary (Fig. 2). The change from subduction to strike-slip tectonics allowed local transtension and upwelling of hot asthenospheric mantle. Opening of the marginal basin may have resulted from instability in the triple junction due to an embayment along the coast. This instability could have resulted in the transform boundary migrating inland from the continental margin and the carving off of a continental slice by oblique spreading in a transform system. The present- day orocline in southern South America may be, at least in part, an original feature that caused the triple junction instability and opening of the basin. The basin was subsequently infilled by volcanic detritus derived from an inactive remnant arc, whereafter subduction resumed resulting in basin inversion and uplift.

The extent to which ridge-trench collision influenced the formation of elongate basins of Late Jurassic to Early Cretaceous age along the entire length of the Andean Cordillera is, however, unknown. Interestingly, Atherton and Webb (1989) have suggested that formation of the Huarmey Basin in the western part of the Mesozoic Peruvian Trough was not subduction-related, but formed in response to crustal extension similar to that postulated for the Gulf of California. It is therefore possible to conclude that the tectonic evolution of the Andean Cordillera has been influenced by oblique tectonics, migrating triple junctions and ridge-trench collision; a scenario which has important implications for Andean-type orogenesis, continental lithospheric extension and ophiolite formation along convergent margins.

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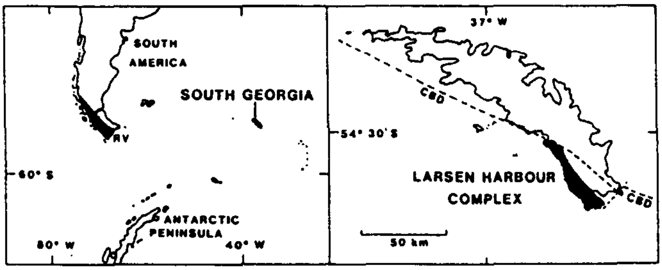

Figure 1. Location map showing position of south Georgia relative to Rocas Verdes (RV), South America and Antarctic Peninsula. Map of South Georgia showing the ophiolitic rocks of the Larsen Harbour Complex and the strike-slip fault zone (Cooper Bay dislocation zone, CBD).

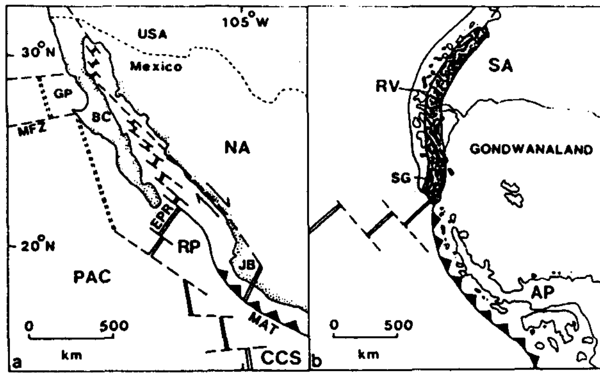

Figure 2. a, Present-day tectonic setting of Baja California (BC). NA, North America plate; PAC, Pacific plate; GP, Guadalupe plate; RP, Rivera plate; CCS, Cocos plate; JB, Jalisco block; MAT, Middle American Trench; EPR, East Pacific Rise; MFZ, Molakai Fracture Zone. b, Proposed reconstruction for part of the proto-Pacific margin of Gondwanaland during Late Jurassic times, illustrating a Gulf of California type model for the Rocas Verdes basin (stippled, RV). AP, Antarctic Peninsula; SA, South America; SG, South Georgia.