LATE CARBONIFEROUS TO TRIASSIC MAGMATISM IN THE CENTRAL AND SOUTHERN ANDES: THE CHANGE FROM AN ACCRETIONARY TO AN EROSIVE PLATE MARGIN MIRRORS THE PANGEA HISTORY

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Resumen

En los Andes Centrales y Australes, el cambio del margen activo de la placa suramericana de un tipo acrecionario a un tipo erosivo durante el lapso Carbonífero Superior - Triásico está acompañado por un fuerte magmatismo parcialmente extensional. Así, la evolución andina refleja la formación y destrucción de Pangea.

Key words: Andean magmatism, Carboniferous-Triassic, subduction-to-rift trend, reflection of Pangea development

Outline

At least since the Late Proterozoic, the region of the Central and Southern Andes was in a marginal position with respect to the Gondwana (later South American) plate. Accordingly, a longstanding and complex history of this active continental margin is documented. Until the Late Carboniferous, accretionary subduction prevailed, giving way to a general westward migration of the magmatic arc activity and a westward growth of the continental plate. The situation changed fundamentally with the beginning of the Jurassic, when an erosive subduction setting was established and the loci of arc magmatism began to migrate eastward into the continent. The change from the accretionary to the erosive type of continental margin is marked by an intense magmatic activity, which will be the focus of this paper.

Among the Pre-Jurassic magmatic rocks of the Central and Southern Andes, outcrops of Late Paleozoic to Triassic, mainly siliceous volcanoplutonic complexes are a prominent feature. In the High Andes of Chile and Argentina between 19° and 42°S these are Carboniferous intrusions followed by thick Permotriassic volcanosedimentary successions (Choiyoi Group) and associated high-level intrusions. Comparable to this, in the Eastern Cordillera of Peru and Bolivia, between 6° and 16°S, magmatic activity is documented by ?Upper Devonian-Carboniferous intrusions and the following Permotriassic volcanosedimentary rocks of the Mitu Group with associated intrusions. Investigations on

these rocks show that the magmatic evolution displays a trend from a 'normal' subduction setting with calc-alkaline magmatism during Carboniferous times to a tensional setting during the Permian-Triassic, which gave rise to (calc-) alkaline and locally peralkaline magmas (Carlier et al. 1982, Kontak et al. 1985, Parada 1988, Rapela & Kay 1988, Breitkreuz et al. 1989, Mahlburg Kay et al. 1989).

Results from Northern Chile

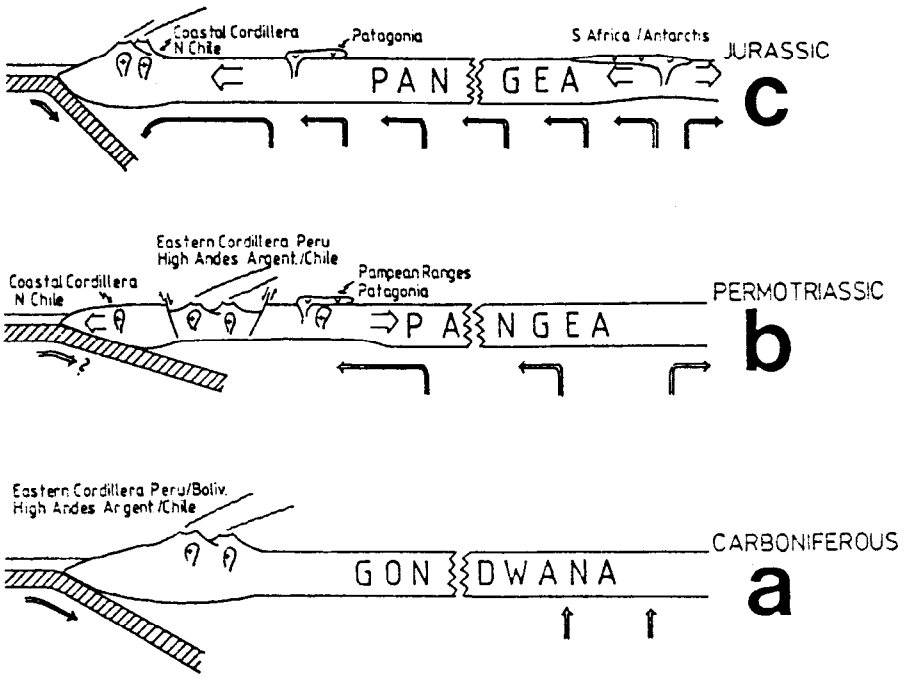
The Late Carboniferous to Triassic volcanosedimentary successions in the north Chilean Andes between 19° and 25°S, studied by the author, consist of calcalkaline to slightly alkaline, predominantly siliceous volcanic rocks and sedimentary intercalations (Breitkreuz et al. 1989). The geochemical features of the volcanic rocks display a clear volcanic arc affilation with a weak within-plate tendency. This is also true for the associated intrusions (Baeza & Pichowiak 1988). It is important to note that the north Chilean volcanism already started in the Late Carboniferous as indicated by radiometric ages and fossils (Davidson et al. 1985, Helmdach pers. comm.). This is somewhat earlier than the commence of the Choiyoi volcanism in the Permian (Mahlburg Kay et al. 1989).

Caldera eruption seems to have been an important volcanic activity in north Chile as indicated by the predominance of thick ignimbrite sheets, frequent intraformational volcanotectonic tilting, and in places the close outcrop association of volcanic and high-level intrusive rocks (see also Davidson et al. 1985). At least during the Latest Carboniferous, an extended depression existed in Northern Chile, which developed on thick, previously deposited volcanic successions. Alluviolimnic sedimentation in this basin was accompanied by basic alkaline volcanism. For that time, the geotectonic setting is supposed to consist in an extensional arc graben as it was the case for the Peruvian Mitu volcanism (Carlier et al. 1982)(Fig. B). A recent equivalent represents the Transmexican Volcanic Belt (see Busby-Spera 1988).

Andean development: mirror of the Pangea history

From the Late Proterozoic to the Carboniferous, the Pacific margin of South America was of an accretionary type, growing by 'normal' arc magmatism and terrane collision (see e.g. Ramos et al. 1986, Breitkreuz et al. 1989)(Fig. A). Likewise, Gondwana was growing along the other parts of its active continental margin during that time.

When Pangea was assembled in the Permian, continental insolation led to an enhanced radial mantle convection away from the centre of the supercontinent (Anderson 1982)(Fig. B). The mantle convection induced a tensional regime in the overlying continental plate (Gurnis 1988). This continent-wide tension could first provoke extension in the Andean continental margin, because, in contrast to the inner parts of Pangea, this marginal area was structurally weakened and heated up by the previous, Carboniferous arc magmatism. In the Southern Andes melting of recently accreted crust leads to important siliceous magmatic activity in a broad zone from the Coastal Cordillera to the Patagonian platform (Mahlburg Kay et al. 1989). In the Central Andes of Peru and northern Chile extension seems to have been more focussed in the High and Eastern Cordillera areas, where extensional arc grabens developed, associated with pronounced rift volcanism in the Eastern Cordillera (Kontak et al. 1985)(Fig. B).



Three plate tectonic sketches of the Central and Southern Andes and of the continental area to the east depicting mantle convection, continental extension and magmatism from the Carboniferous to the Jurassic (for explanation see text).

Siliceous volcanism continued until the Jurassic on the Patagonian platform (Rapela & Kay 1988)(Fig. C). The abrupt westward shift of the main magmatic zone from the High Andes to the Coastal Cordillera at the beginning of the Jurassic is still a puzzling feature of the Andean evolution. Possibly, further enhanced radial mantle convection, which was strong enough to induce basaltic rift volcanism in the inner part of Pangea (S. Africa, Antarctica), bent the subducting oceanic slab westward to a steeper dip. This might have caused the westward shift of the magmatic arc to the Coastal Cordillera and the basic magmatism of that area.

The break up of Pangea accelerated convergence at the Pacific plate margin of South America. As a consequence, a destructive continental margin with subduction erosion was established in the Andes.

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