THE EVOLUTION OF THE AYSEN BASIN, AN EARLY CRETACEOUS EPICONTINENTAL INTERIOR SEAWAY IN SOUTHERNMOST SOUTH AMERICA

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INTRODUCTION

The Aysen Basin is a north-south elongated basin (Fig. 1) in which over 1200 m of shallow marine sediments accumulated in a narrow, epicontinental sea parallel to the continental margin in the southern Andes during early Cretaceous times (Suárez and De la Cruz, 1994). The basin formed in a back-arc setting as a thermal sag during a period of volcanic and tectonic quiescence. It was linked to the Magallanes Basin to the south. The sediments were derived from the continental San Jorge Basin in the east.

TECTONIC SETTING

Extensive marine and continental sedimentary basins developed on the continental crust of southernmost South America during the Mesozoic and Cainozoic. The early Cretaceous evolution of these basins (Fig. 1) was controlled by two major tectonic events, one on either side of the continent. In the west, subduction of an oceanic plate produced a magmatic arc parallel to the continental margin. At the same time, in the east, the split-up of the Gondwana supercontinent and the opening of the South Atlantic Ocean resulted in the development of an extensive passive margin. The basins are of great economic significance as they enclose the petroleum provinces of Chile and Argentina.

Early stages of basin development during mid-Jurassic to earliest Cretaceous times were associated with extensional rifting of the continental crust. Subsequently, during the Lower Cretaceous, the dominant tectonic style over most of the area was a slow, gentle and broad subsidence, probably related to thermal sagging. There is little evidence in the sedimentary record for syndepositional tectonic or magmatic activity related either to the subduction in the west or the extension in the east. A foreland basin, associated with a western fold and thrust belt, only started to develop in the Magallanes Basin in the southern part of the region in the uppermost Cretaceous.

The sedimentary basins are floored with metasedimentary continental basement rocks, some of which were probably the product of terrane accretion. These are unconformably overlain by a

widespread succession of late Jurassic subaerial volcanic rocks. By early Cretaceous (Berriasian) times broad subsidence and downwarping had resulted in the development of two major NW-SE trending sedimentary basins (Fig. 1). In the north-east between 45°and 47°S was the east-west elongated San Jorge Basin. This was separated by the uplands of the Deseado Massif from the larger Magallanes Basin to the south (Riccardi, 1988). The San Jorge Basin was filled with predominantly lacustrine and fluvial continental sediments and the Magallanes Basin with pelitic marine sediments. The evidence from prograding sequences identified by seismic stratigraphy (Biddle et al., 1986; Fitzgerald et al., 1990) indicates that most of the sedimentary infill of both the San Jorge and the Magallanes basins was derived from the north and north-east. The Somuncurá Massif was the source of sediments in the San Jorge Basin and the Deseado Massif provided clastic debris to the Magallanes Basin.

AYSEN BASIN

Linking the San Jorge and Magallanes Basins in the west, and probably cut off by an inactive segment of a magmatic arc from the Pacific Ocean farther to the west, was the north-south elongated Aysen Basin (Suárez and De la Cruz, 1994). Although most of the clastic debris which fills this basin was derived from the erosion of volcanic rocks, there is little direct evidence for contemporaneous volcanic activity in the form of interbedded pyroclastic deposits or lava flows. A lack of soft-sediment deformation structures, mass flow deposits and turbidites suggests that the area was tectonically stable during the accumulation of the sediments.

Marine sedimentary rocks of the Coyhaique Group (Table 1) infilled the Aysen Basin. Limestones, sandstones and pyroclastic rocks of the Toqui Formation form the base of the succession. They were deposited as reefs and beaches during a marine transgression across the rocky shores of active silicic volcanoes. Deepening of the seas to form a large, sheltered marine embayment, resulted in the deposition of a thick succession of carbonaceous black shales of the Katterfeld Formation. Fossil fauna assemblages indicate that the Aysen basin was linked to the Magallanes Basin to the south. The fossils also suggest that the basin was isolated from basins to the north. The black shales are overlain, with a sharp and probably regionally significant contact, by rippled sandstones and shales of the Apeleg Formation. Sandstone lithologies and paleocurrents in the Apeleg Formation indicates that the sediments were derived from rivers flowing westward from the continental San Jorge Basin (Fig. 2).

The thick successions of well-sorted, fine-grained sandstones and mudstones, together with abundant plant debris, indicate that the sediments of the Coyhaique Group were derived from densely-vegetated areas of low relief with a warm, humid climate. The Katterfeld Formation was deposited in a large restricted marine embayment produced by flooding of the continental shelf from the south. Subsequent opening up of this embayment to the influence of tidal currents sweeping through the narrow seaway, produced the Apeleg Formation, characterised by the deposition of large, low-relief offshore tidal sandbars in a shallow shelf sea. The sea level rises which produced the initial flooding and subsequent opening of the embayment may have been related to global sea level rises of Valanginian and Hauterivian times (Vail et al., 1977),

The Aysen Basin developed in a back-arc position between an active continental margin and an undeformed continental platform (Fig. 1). Despite this setting it does not display the sedimentary characteristics of a foreland basin (Allen and Homewood, 1986). The area was apparently tectonically stable and the sediments show no evidence of eastwards thinning or fining successions. The paleocurrents indicate derivation from the continental landmass to the east rather than from a magmatic arc or a fold and thrust belt in the west.

Marine sedimentation in the Aysen Basin ended with a minor and localised episode of deformation, uplift and erosion in Barremian to Aptian times. These events were followed by extensive Aptian-Albian calc-alkaline subaerial volcanic activity which produced the unconformably overlying sedimentary and silicic volcanic rocks of the Divisadero Formation. This late Cretaceous volcanic activity was associated with a major phase of plutonic activity in the Patagonian batholith (Fig. 1).

CONCLUSIONS

The epicontinental Aysen Basin of southern Chile and Argentina formed during early Cretaceous times as an interior seaway between an volcanically and tectonically quiescent segment of a subduction-related active continental margin in the west and a passive margin in the east.

Sedimentary basins in southernmost South America record a variety of distinctive tectonic histories. Cretaceous thermal subsidence in the Aysen and San Jorge Basins was followed by Tertiary uplift and erosion (Fitzgerald et al., 1990). By contrast the northern part of the Magallanes Basin evolved from an early Cretaceous continental thermal sag, with sediment derived from the northeast, into a late Cretaceous and Cainozoic foreland basin, with sediment derived from a fold and thrust belt in the west (Biddle et al., 1986; Ramos, 1989). Farther south, in the south of the Magallanes Basin, the Rocas Verdes back-arc basin, which opened as a narrow ophiolite-floored sea in the late Jurassic or earliest Cretaceous, became filled with deep marine sediments during the early Cretaceous. This basin was uplifted and deformed in the late Cretaceous (Dalziel, 1981). The distinct magmatic, structural and sedimentary evolution of each of these adjacent areas reflects the segmentation resulting from variations in the geometry of sections of the downgoing oceanic slab.

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		Age	Succession or event	Interpretation
Divisadero Formation		Aptian-Albian	Subaerial calc-alkaline volcanism	Magmatic activity in western arc
~~		Barremian-Aptian	Local unconformity. Deformation and uplift	Minor folding and thrusting
Coyhaique Group	Apeleg Formation	Hauterivian-Aptian	Rippled sandstones and shales	Tidal sandbars in narrow seaway
	Katterfeld Formation	Valanginian-Hauterivian	Fossiliferous black shales	Embayment with restricted circulation
	Toqui Formation	Berriasian	Limestones, sandstones and pyroclastics	Marine transgression across active volcanoes
Ibañez Formation		Mid to Upper Jurassic	Subaerial silicic volcanism	Magmatic arc in west, crustal extension in east
~~		Early Mesozoic	Regional unconformity	Uplift and erosion
Metasedimentary basement		Late Proterozoic to Palaeozoic	Continental basement rocks	Possible Paleozoic terrane accretion

Table 1. Stratigraphy of the Aysen Basin

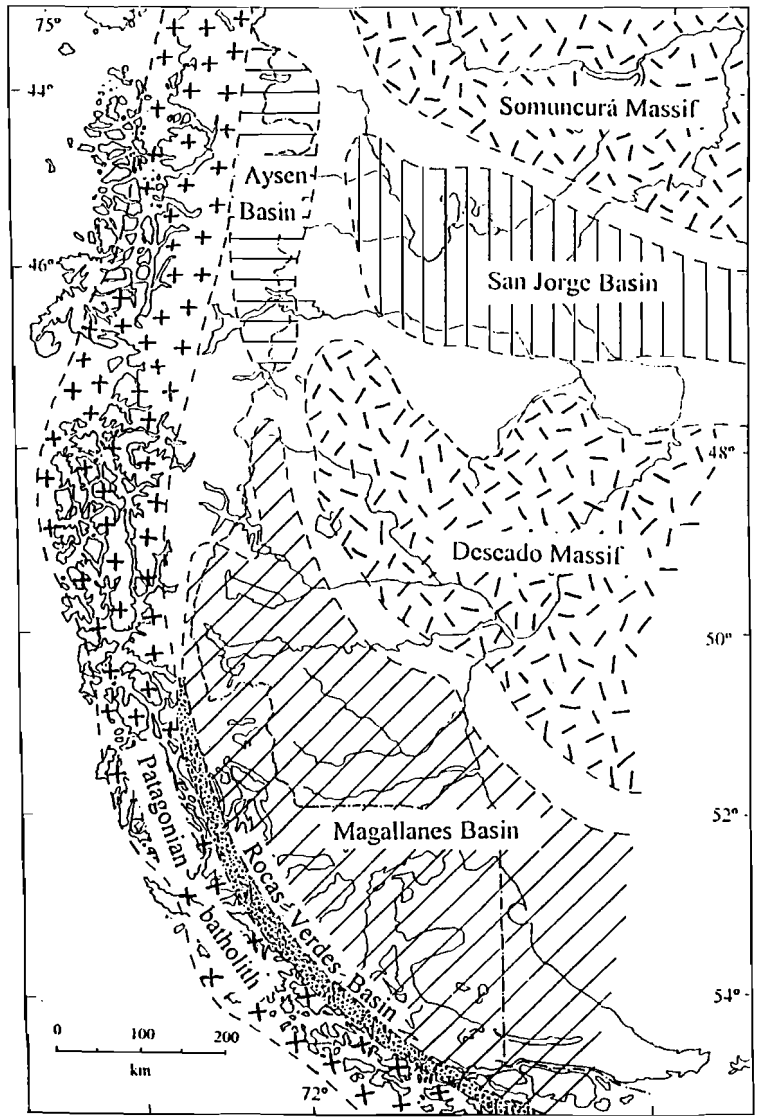

Fig. 1. Distribution of early Cretaceous sedimentary basins in southernmost South America.

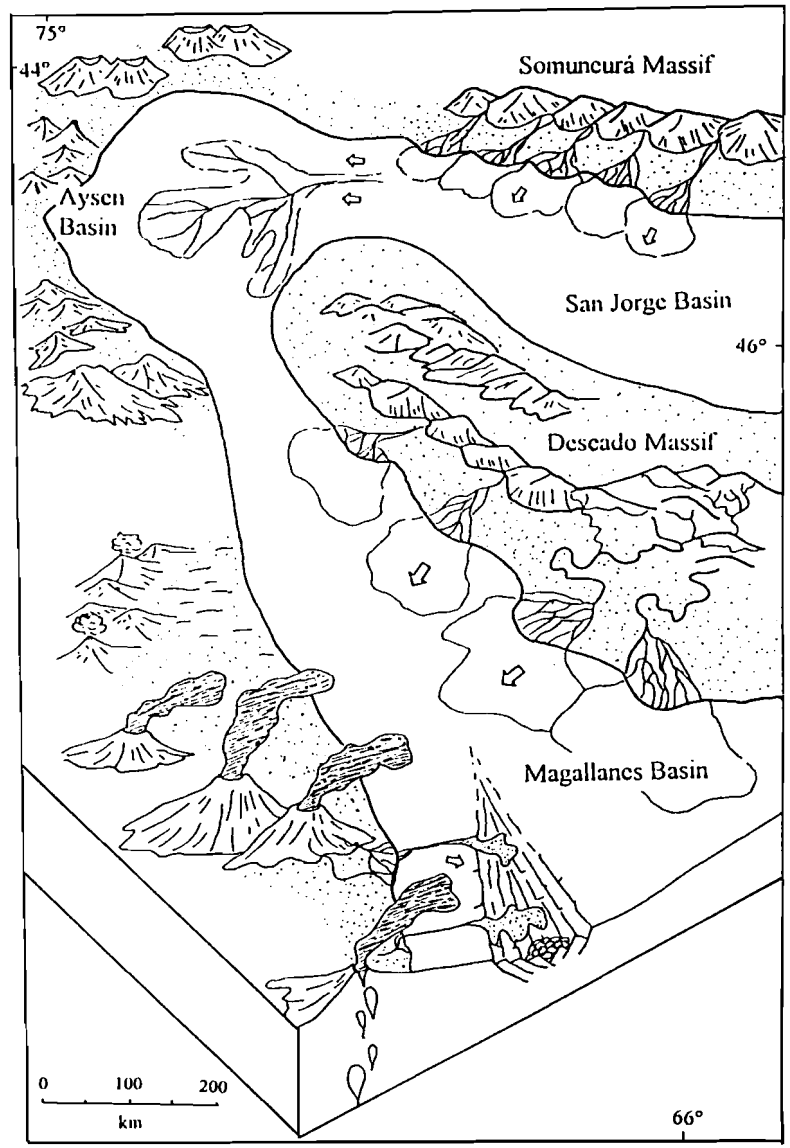

Fig. 2. Palcogeography of southern South America during the early Cretaceous.