TECTONIC EVOLUTION OF THE CHILEAN MAIN CORDILLERA BETWEEN 33 AND 35 SOUTH LATITUDE

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Resumen

Las unidades (Jurásico a Presente) se acumularon en una cuenca de tras-arco en el Mesozoico y en sucesivos arcos volcánicos desplazados hacia el este en el Cenozoico. Existen cinco pisos estructurales cuyo plegamiento se debió a fenómenos compresivos asociados a episodios de tectónica global.

Key words: Central Andes, Chile, Stratigraphy, Paleogeography, Tectonics, Structural Geology.

Introduction

This area is located in the southern part of the Central Andes, inmediately S of the flat-slab subduction segment (Fig. 1). It is one of the most studied areas in Chilean Andes and is representative for the Main Cordillera in central Chile. It, thus, provides a good basis to understand the evolution of this andean region.

We summarize the geology and stratigraphy of the area and discuss the paleogeography, tectonic setting and deformation mechanisms for each of its evolutionary periods.

Stratigraphy

The stratigraphic record (Fig. 2) consists of rock units ranging in age from Middle Jurassic to Present. The age of the mainly sedimentary mesozoic part is well constrained on the basis of the ammonite content of the marine intercalations. The age of the cenozoic continental mainly volcanic units is based on isotopic determinations. A strong and widespread low temperature alteration of the volcanigenic units precludes a more precise chronology of the cenozoic units.

Paleogeography

During the evolution of this area two basically different paleogeographies were recognized: 1. a back-arc domain with the development of a strongly subsident mainly marine basin during Mesozoic, and 2. arc domains with the development of intra-arc basins or small continental back-arc basins, or arc domains located in graben depressions during Cenozoic.

The back-arc deposits accummulated during two transgression-regression cycles: 1. Late Liassic-Bajocian to Kimmeridgian, and 2. Tithonian to Neocomian. The basin was located to the east of an emmerged and active volcanic arc and seems to have been connected through narrow openings in the arc with the paleo-Pacific Ocean. The presence of the arc caused an eastward decrease in grain coarseness and volcanigenic content in the back-arc deposits. The development of carbonatic platforms on the west margin of the basin during Callovian and Tithonian-Neocomian was considerably inhibited by the abundant detritic material supplied by the arc. Neocomian volcanism in this area has a calc-alkaline nature.

Exept for a possible marine intercalation from the Atlantic side in the lower Abanico=Coya-Machalí Fm., which is suspected to be of Maastrichtian-Danian age, the Andean domain was totally emmerged during the Cenozoic. The volcanic cenozoic units are located in regions that formerly were part of the back-arc domain. They correspond to at least three volcanic arcs, respectively shifted to the east of the previously existent arc. The eastward migration of volcanism and of the batholitic bodies in this area is a characteristic feature of the Chilean Andes. Cenozoic volcanism is bimodal and of calc-alkaline nature.

Tectonic Evolution and Interpretation

The development of a strongly subsident back-arc basin in the Mesozoic was interpreted as the result of a weak coupling of

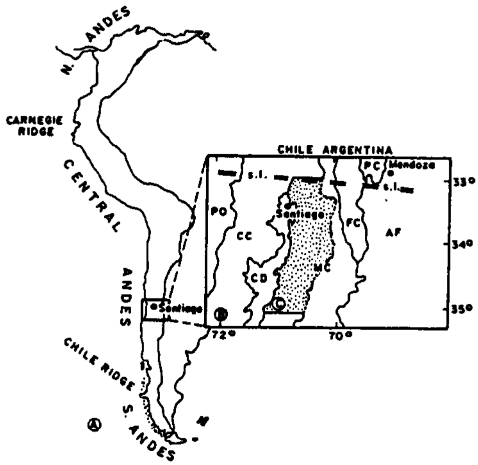

Fig. 1. Location map. a. Main subdivision of the Andes. b. Morphostructural units between 33-35 S. c. Studied area (stippled). PO: Pacific Ocean, CC: Coastal Cordillera, CD: Central Depresion, MC: Main Cordillera, FC: Frontal Cordillera, PC: Precordillera, AF: Andean Foreland. s.l.: approximate limit of flat-slab subduction segment.

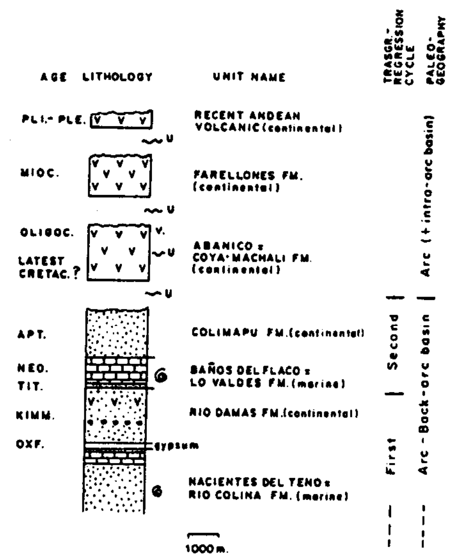

Fig. 2. Stratigraphic column of the studied area with indication of the marine transgression - regression cycles and main paleogeographies developed. U: unconformity; V: vertebrate fossils.

the colliding plates due to steep-slab subduction. This could have caused an extension tectonic regime in the back-arc domain. The absence of a well developed back-arc basin during Cenozoic was interpreted with a similar reasoning as the result of a more flat subduction (Chilean-type).

Deposition during the Mesozoic was continuous. An unconformity between mesozoic and cenozoic deposits was only mapped at 34o 30'S. During Cenozoic at least three unconformities separate the continental volcanic and detritic units (Fig. 2).

The transgression-regression cycles during Mesozoic do not coincide with global sea-level fluctuations. They can rather be interpreted as the result of global diastrophic episodes like variations in sea-floor spreading rates and the different stages of the openning of the S-Atlantic.

The kimmeridgian deposits form a thick wedge that interrupts the marine sedimentation. The absence of unconformity between both marine cycles and the existence of an important jurassic magmatic activity to the W suggests a thermally induced uplift of the continental margin, possibly with the beginning of subduction during the rift stage of the S-Atlantic. This episode caused no folding of the back-arc deposits. The back-arc domain maintained an extensional regime during Mesozoic. The "middle" Cretaceous regression is a generalized phenomena in the Andean back-arc basin. An increase of the spreading rate, related to the break-up of Gondwana, occurred at this time in the S-Atlantic. It is debated if this episode caused a compressive phase. The tectonic style of the mesozoic deposits is, however, very different to that of the overlying units suggesting, if not distinct deformational episodes, at least different mechanical behaviours.

The unconformable superposition of the cenozoic units and the distinct upwards decrease of deformation demonstrates diastrophic origins for these unconformities.

Based on the amount of deformation and style, five tectonic stages were differentiated: I. Recent Andean Volcanism, II. Farellones Fm., III. Abanico=Coya-Machalí Fm. (two stages?), IV. Gypsum (Nac. Teno Fm.), Rio Damas, Baños del Flaco=Lo Valdés, Colimapu Fms., and V. lower Nac. Teno Fm.

Stage I is not folded. The differently folded II and III stages are competent multilayers deformed by buckling and flexural-slip mechanism. Stage IV, which rests on oxfordian gypsum, forms to the W a W-dipping homoclinal, while to the E, it forms a thrust-fold belt (TFB) with E-vergent tectonic scales formed by tight, almost concentric synclines, some of them recumbent, separated by reverse faults and diapiric gypsum. Deformation of stage V seems to be the response of the same stresses that affected stage IV. Although deformation was attenuated by the oxfordian gypsum, some deformation occurred during décollement along some pelitic levels.

The style of this TFB differs strongly from the flats and ramps style described by for its E part. Thisa difference may tentatively be explained by the existence of thicker and more competent units in this proximal area of the back-arc basin and a thicker evaporitic level below these rock units.

Conclusions

The geological history of this area is the result of a complex paleogeographic, tectonic and magmatic evolution, which seems to have its explanation in global tectonic processes like changes in ocean spreading rates and the break-up of Gondwana. Global sea-level changes had no major influence.

Folding is the result of compressive stresses. The different tectonic styles are the result of a combination of factors like composition and thickness of the multilayers, presence of low viscosity levels (gypsum) and age of the folded units.