6th International Symposium on Andean Geodynamics (ISAG 2005, Barcelona), Extended Abstracts: 273-276

Exhumation and uplift of the western Main Cordillera between 33° and 34°S

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KEYWORDS: Central Chile, Andes, Apatite fission-track ages, Neogene mountain building

INTRODUCTION

In this paper we discuss the control of major structures in the exhumation of Cenozoic rocks and surface uplift in the Andean Main Cordillera based on new apatite fission tracks age analysis and the study of geological cross -sections.

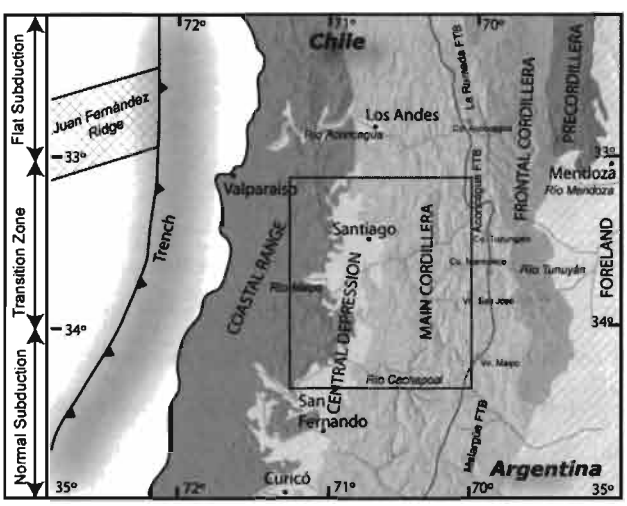

Fig. 1: Principal morphostructural Units. The box shows de Study Region

The study area is segmented in the following N-S oriented morphostructural units (Fig. 1), from west to east: Coastal Cordillera, Central Depression, Western and Eastern Main Cordillera (WMC and EMC, respectively), and Frontal Cordillera. The Coastal Cordillera consists mainly of volcanic and sedimentary Mesozoic rocks, the Aptian – Albian Las Chilcas and Maastrichtian Lo Valle formations and Late Mesozoic intrusive bodies (Sellés and Gana, 2001), which are in contact with Cenozoic rocks through west vergent thrust faults located in the Central Depression and the western border of the WMC. The Central Depression corresponds to a basin rooted by Eocene to Early Miocene rocks: the Cordón de los Ratones Beds (Sellés and Gana, 2001) and the Abanico Formation (Sellés and Gana, 2001), filled by Pleistocene (?) – Holocene alluvial, fluvial and pyroclastic deposits. The WMC consists mainly of extensional basin-related deposits of the Abanico Formation (Late Eocene to Early Miocene) overlain by the Miocene volcanic Farellones Formation (Thiele, 1980; Charrier et al, 2002). In the eastern boundary of the WMC, the Abanico Formation thrusts westwardly Mesozoic marine and continental series that form the bulk of the EMC (Fig. 2).

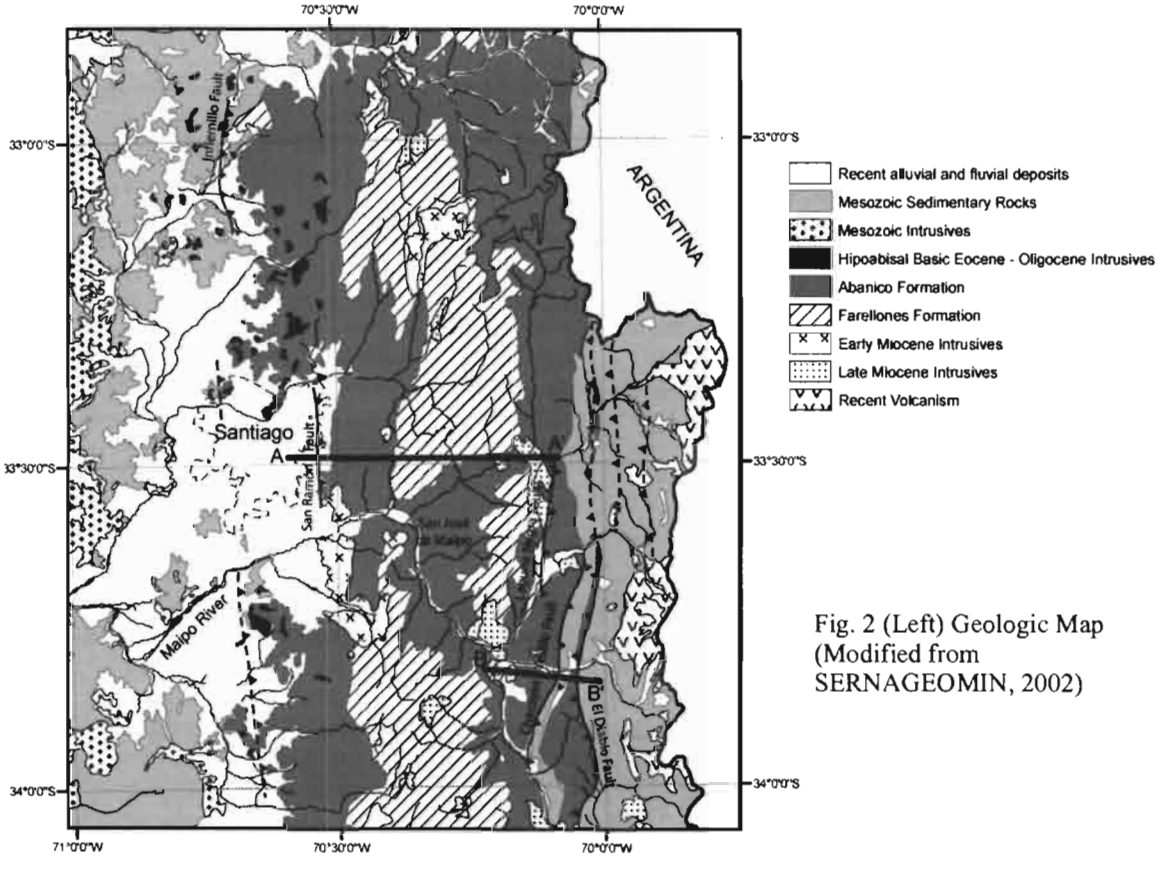

Fig. 2 (Left) Geologic Map (Modified from SERNAGEOMIN, 2002)

STRUCTURE

The boundary between the Coastal Cordillera and the Central Depression in the northern part of the Santiago basin is controlled by a west-vergent thrust-fault (e.g. Infiernillo fault). Similarly, the boundary between the Central Depression and the WMC is controlled by a west-vergent thrust (San Ramón Fault System) forming a 2500 m escarpment (see fig. 3, cross section A-A'), that could be responsible for the deformation of the Abanico Formation along this boundary (Rauld, 2002).

In the central part of the WMC, the deformation consists mainly of open folds showing eastward growth strata. Close to the eastern boundary of the WMC, the deformation increases, exhibiting tight, overturned folds and west-vergent faults (e.g. Chacayes – Yesillo Fault). The boundary between the WMC and EMC is characterized by a major east-vergent fault (El Diablo Fault) that thrusts the Abanico Formation over the Mesozoic succession (cross section B-B'). The origin of the west-vergent thrust system has lengthy been discussed (Palma, 1991; Baeza, 1999; Bustamante, 2001; Charrier et al., 2002, Charrier et al., 2005). We present here a discussion about the possible mechanism that caused this deformation and provide additional apatite fission tracks age determinations that shed new light on this problem.

From the analysis of Fig. 3 (cross section BB') it is possible to deduce the following hypotheses for the development of this fault system: (1) The major east-vergent El Diablo fault would corresponds to an inverted normal fault that induced the eastward development of the Aconcagua Fold-and-Thrust belt (ATFB). Thus, the west-vergent system would correspond to a back-thrust on the rear part of the east-vergent ATFB; (2) The El Diablo fault on the back of the ATFB is an (east-vergent) out-of-sequence thrust of the Aconcagua Fold-Thrust

belt developed further east and the west-vergent faults corresponds alike as in the hipothesis to a back-thrust.

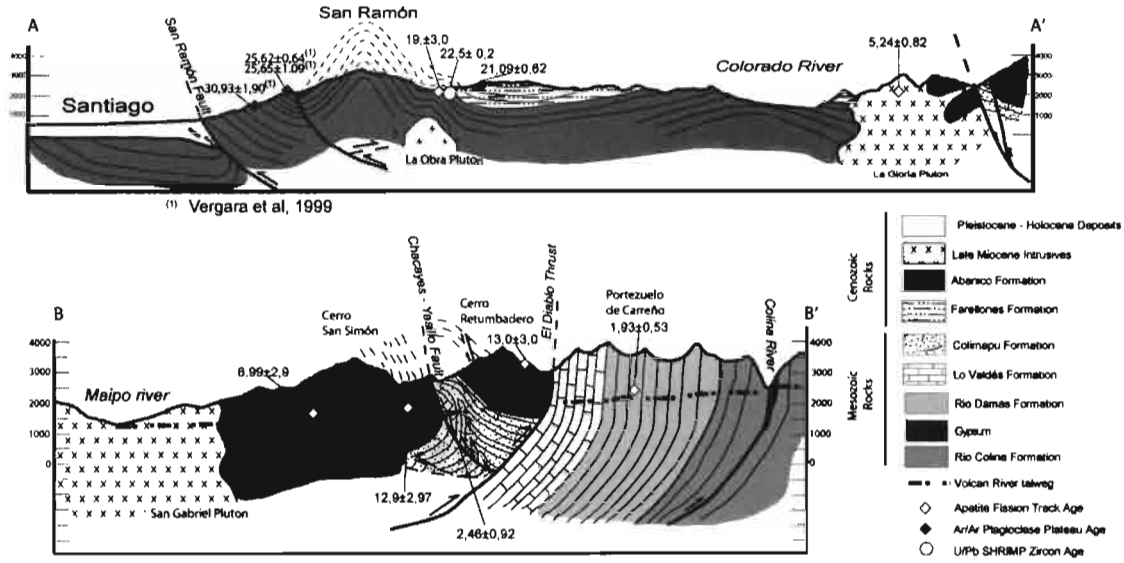

Fig. 3 : Geologic cross sections. For location see Fig. 2

DEFORMATIONAL HISTORY

Between 33° S and 34° S, apparently two main deformation stages can be recognized during an apparently countinous process of tectonic inversion. The first one took place in Late Oligocene and Early Miocene times (Kurtz et al., 1997; Godoy et al., 1999; Charrier et al., 2002). Most of the deformation occurred on the basins borders, enclosing a new basin where the Farellones Formation was deposited, forming a continuos sucession with Abanico Formation and exhibiting locally evidence for syn-tectonic depositation. The second stage took place in Late Miocene – Pliocene times, coeval to the main stage of surface uplift of the Andean Main and Frontal Cordillera between 33° - 34°S (Skewes y Holmgren, 1993; Giambiagi et al., 2003; Maksaev et al., 2003).

EXHUMATION AND UPLIFT OF THE WESTERN MAIN CORDILLERA

14 new apatite fission tracks (AFT) ages were obtained from samples collected in the Abanico Formation, Late Miocene Plutons (WMC) and Mesozoic Rocks (EMC), showing complex a process of deformation, exhumation and mountain building across the Main Cordillera at this latitude during Late Cenozoic (Fig. 1).

In the western flank of the WMC, the AFT ages agree with the depositional ages of the Abanico sucession according to new U/Pb SHRIMP and $^{40}Ar/^{39}Ar$ ages. Therefore, the burial of these rocks was not enough to warm and reset the AFT, confirming a similar conclusion of Maksaev et al. (2003) for the La Obra Pluton (cross section A-A'). In the central part of the WMC, near to San José de Maipo, the AFT ages obtained in the stratigraphically lowest levels of Abanico Formation are ca. 10 Ma, but 500 m above, the AFT ages coincide with the depositional age (corroborated by new U/Pb SHRIMP age and the available $^{40}Ar/^{39}Ar$ ages in the literature). The boundary between WMC and EMC exhibits a more complex situation. According to three AFT ages obtained in the Abanico Formation in different locations along an east-west oriented section (see cross

section B-B'), the lowest and easternmost stratigraphic levels of the Abanico Formation were cooled before the upper and western stratigraphic levels, suggesting that the west-vergent thrust system might have dragged upward the Abanico Deposits west of El Diablo Fault. This situation would support hypothesis 1, that El Diablo Thrust is an inverted normal fault. On the other hand, AFT exhumation ages on Mesozoic rocks are constrained to Late Pliocene and Early Pleistocene times.

CONCLUSIONS

AFT ages suggest that burial in the basin was greater to the east of the WMC than to the west, coinciding with the similar conclusion of Zurita (1999) for the Las Leñas River at 34° 15' S. This probably indicates that El Diablo Fault corresponds to the eastern basin bounding fault. Inversion of the El Diablo Fault induced the development of the Aconcagua FTB as well as the west vergent deformation. A probable reactivation of this structural system ocurred in Late Pliocene based on very young AFT ages from the Mesozoic units, explaning present day shallow seismicity and high rates valley incision (Farías et al., this symposium).

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