MID-CRETACEOUS CRUSTAL SHORTENING, UPLIFT AND EXHUMATION: EVIDENCE FROM A REGIONAL-SCALE DUCTILE SHEAR ZONE IN THE COASTAL RANGE OF CENTRAL CHILE (32ºS)

Gloria ARANCIBIA (1)

(1) Departamento de Geología . Universidad de Chile. Casilla 13518, Correo 21, Santiago, Chile. (gloarancibia@123.cl)

KEYWORDS: Mid-Cretaceous crustal shortening, shear zone, Coastal Range, central Chile

INTRODUCTION

Previous studies indicate a complex tectonic evolution of the Coastal Range of Central Chile during the Cretaceous. The following regional tectono-magmatic events have been documented between the 27º and 33ºS: 1) Widespread volcanism associated with extensional volcanosedimetary intra-arc or back-arc basins developed during the Lower Cretaceous (*e.g*. Vergara *et al*., 1995); 2) an extensive very low-grade metamorphism, coeval with basins closure (*ca.* 93-94 Ma), which affected the Upper Jurassic and Lower Cretaceous stratified rocks (*e.g.* Aguirre *et al.,* 1999); and 3) the first stages of the Coastal Range formation and uplift during mid-Cretaceous, associated with a marked increase in the exhumation/erosion rate (*e.g.* Vergara *et al*., 1995; Parada and Larrondo, 1999; Gana and Zentilli, 2000). These three events indicate a major change from a mainly extensional tectonic regime, associated with Lower Cretaceous volcanism, to contractional regime associated with the closure of the Lower Cretaceous basins, uplift, and increase of the exhumation/erosion rate in the Coastal Range during mid Cretaceous time. However, no Cretaceous contractional shear zones compatible with crustal shortening have been documented to date. In this study, we first document a regional-scale, reverse ductile shear zone (the Silla del Gobernador Shear Zone, SGSZ), whose geometry, kinematics and timing are consistent with mid-Cretaceous crustal shortening.

THE SILLA DEL GOBERNADOR SHEAR ZONE (SGSZ)

The SGSZ is a NNE-striking shear zone located in the western border of the present-day Coastal Range in central Chile (Fig. 1). This shear zone consists of: (a) NS-striking micaceous mylonite belts with moderately-

dipping foliation to east, subvertical mineral/stretching lineation and reverse-slip kinematic indicators; and (b) NE-striking cataclastic belts with subvertical foliation and oblique lineations (striae) with dextral-reverse and reverse-dextral kinematic indicators. Mylonitic and cataclastic fabrics are consistent with a regional transpressive regime (predominantly reverse) resulting from EW to NWW shortening; with a small dextral shear component. Thermodynamic and microstructural data indicate deformation temperatures between 300º and 400ºC. Mesoscopic fabric and microstructure are strongly controlled by the protolith rheology. The best estimate for the absolute age of mylonitic deformation, obtained through *in situ* ^{40}Ar-^{39}Ar laser ablation on neophormed micas from high strain mylonites zones, is 108 ± 12 Ma (Arancibia, 2002) (Fig. 1).

DISCUSSION AND CONCLUSIONS

The increase in the erosion rate during mid-Cretaceous times is based on the presence of Upper Cretaceous coarse grain deposits, interpreted as a consequence of fast erosion rates of the Jurassic to Cretacic volcanosedimetary units (*e.g*. Las Chilcas Formation, Vergara *et al.,* 1995). This event is coeval with a fast exhumation (fission track ages) of the Paleozoic, Jurassic and Lower Cretaceous plutons forming the bedrock of the Coastal Range between the 27º to 34ºS. These data suggest that the plutonic rocks crossed the 80º-125ºC zone at 110-90 Ma ago (Parada and Larrondo, 1999; Gana and Zentilli, 2000). Pre-Cretaceous plutonic rocks, in turn, were probably located at a shallow crustal level as far back as the Middle Jurassic.

The increase in the erosion/exhumation rates documented for the mid-Cretaceous can be interpreted as coeval with the onset of uplift of the Coastal Range (*e.g*. Gana and Zentilli, 2000). This also is compatible with a major change from a predominantly extensional regime in which the Lower Cretaceous basins opened (Fig. 2a), to another more compressional regime coeval with the closure of these basins and the peak of the very low-grade metamorphism which affected the Lower Cretaceous rocks (Fig. 2b). The ^{40}Ar-^{39}Ar age of 108 ± 12 Ma, the calculated 300 - 400ºC deformation temperature and the geometry and kinematics of the ZFSG, suggest that the increase in the erosion/exhumation rates is coeval with crustal shortening and uplift during this time and is a clear evidence of a switch on the regional tectonic regime (Fig. 2b).

ACKNOWLEDGMENTS

This work is part of the author Ph.D. Thesis and was funded by a FONDECYT PROJECT 2000011 and a CONICYT Scholarship. Reynaldo Charrier (University of Chile) is thanked for field work and discussions.

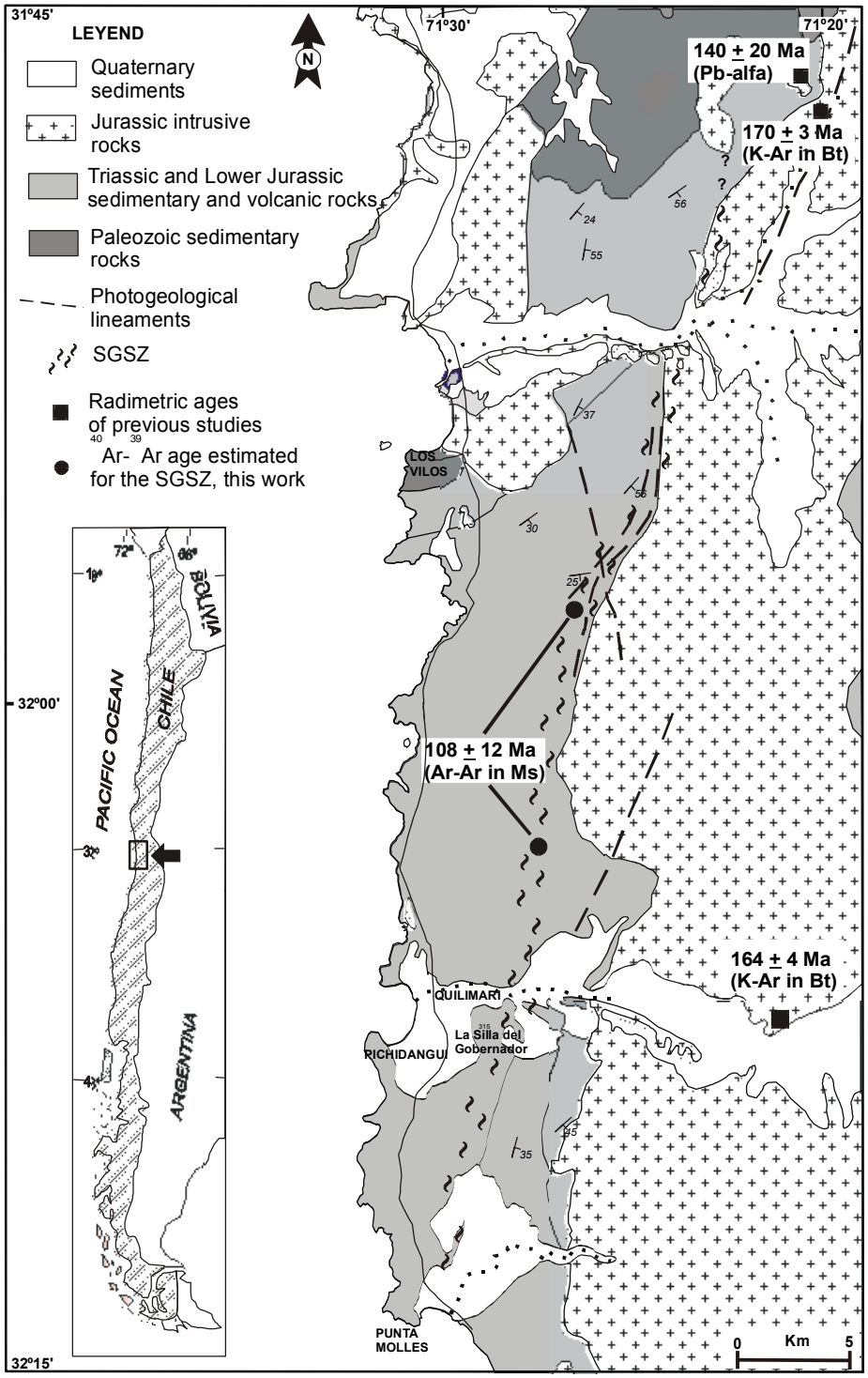

Figure 1. Simplified geological map of the Silla del Gobernador Shear Zone (SGSZ) (modified from Rivano *et al*., 1993) and location of study area (lower-left).

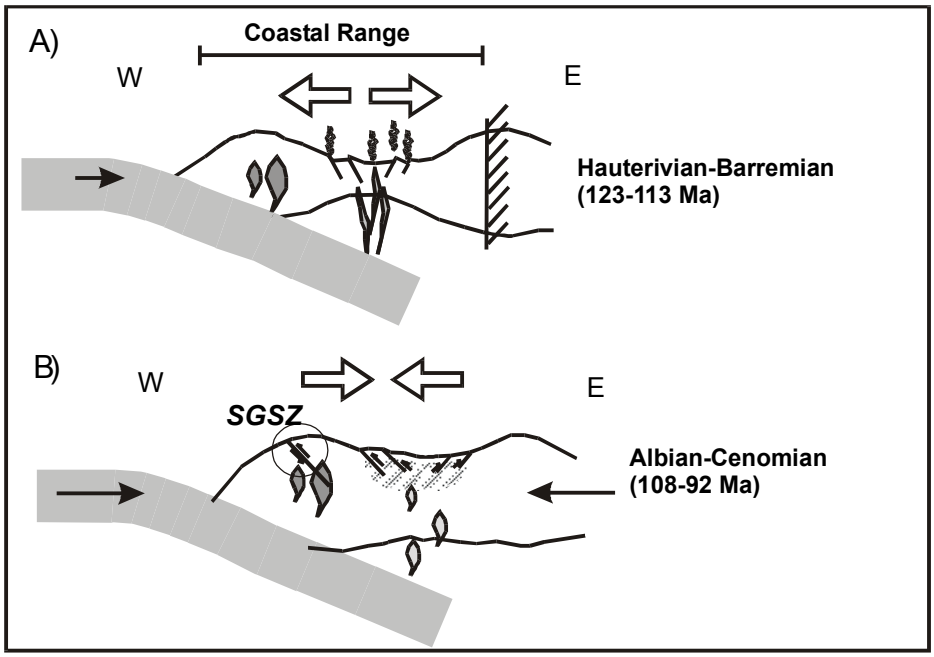

Figure 2. Schematic tectonic W-E section in the Coastal Range at 32ºS. A) Predominantly extensiona in which the Lower Cretaceous basins were opened (123-113 Ma). B) More compressional regime with the closure of these basins and the peak of the very low grade metamorphism (108-92 M SGSZ suggest that the increase in the erosion/exhumation rates is coeval with crustal shorten uplift during middle Cretaceous and is a clear evidence of a switch on the regional tectonic

REFERENCES

Aguirre, L., Fëraud, G., Morata, D., Vergara, M., Robinson, D. 1999. Time interval between volcanism and burial metamorphism and rate of basin subsidence in a Cretaceous Andean extensional setting. Tectonophysics, 313: 433-447.

Arancibia, G. 2002. Geometría, cinemática, condiciones y edad de la deformación milonítica en rocas volcánicas. El caso de la Zona de Falla Silla del Gobernador, Chile central (32ºS). Unpublished Ph.D. Thesis, Departamento de Geología, Universidad de Chile.

Gana, P., and Zentilli, M. 2000. Historia termal y exhumación de intrusivos de la Cordillera de la Costa de Chile central. In: IX Congreso Geológico Chileno, 2: 664-668.

Parada, M., and Larrondo, P. 1999. Thermochronology of the Lower Cretaceous Caleu Pluton in the coast range of central Chile: Tectonostratigraphic implications. In: 4th ISAG, Göttingen, Germany, 563-566.

Rivano, S., sepúlveda, P., Boric, R., Espiñeira, D. 1993. Hojas Quillota y Portillo, Servicio Nacional de Geología y Minería, escala 1:250.000.

Vergara, M., Levi, B., Nyström, J., Cancino, A. 1995. Jurassic and Early Cretaceous island arc volcanism, extension, and subsidence in the Coast Range of central Chile. Geological Society of America Bulletin, 107 (12): 1427-1440.