QUATERNARY BRITTLE DEFORMATION IN THE CALDERA AREA, NORTHERN CHILE (27°S)

Carlos MARQUARDT(1) and Alain LAVENU(2)

(1) SERNAGEOMIN Chile, Av. Santa María 0104, Santiago (cmarquar@sernageomin.cl)
(2) IRD, casilla 53 390, correo central, Santiago1, Chile (alavenu@dgf.uchile.cl)

KEY WORDS: Neotectonics, extensional deformation, uplift, marine terrace.

INTRODUCTION

Even though evidence of young brittle deformation is well preserved in several localities of the coastal belt south of Caldera (27°-27°15'S), the only reference available regarding faulting in the area is found in Mortimer (1969), who describes a Neogene reverse fault followed by normal reactivation SE of Morro Copiapó (figure 1). Deformation is characterised by variously oriented high angle normal faults. They show centimeter to meter long displacements in sedimentary layers associated to Quaternary marine terraces and, occasionaly, originate scarps that may be well distinguished from marine cliffs.

We thus infer the normal faults present in the southern part of the area based on the fact that they cut old beach-ridges and other shorelines, specially those more oblique to the fault traces. A second criterium we have applied considers the fact that, in contrast to marine cliffs, the base of fault scarps shows a variable elevation, refered to sea-level.

Two case studies have been selected in order to better describe the geometry, kinematics and age of these faults : the Calderilla and Bahía Inglesa localities.

CALDERILLA

One N10°E and three N60°E trending normal faults outcrop in the area between Caldera and Bahía Inglesa. Fault planes are well exposed only in the major one from the second set, whose base scarp varies from sea level up to 45 m above it. In figure 2 we describe the following three profiles, located in figure 1, along this fault :

Profile A.- two normal faults are exposed at a elevation of 9 m, one km inland northeast from Bahía Inglesa. They offset both the base of the sedimentary cover and erosional unconformities within littoral and continental unconsolidated sediments with an age range from Neogene to Quaternary. These N72°E/66°N and N81°E/64°N trending faults suggest an hemigraben related to NNW-SSE extension. The small western antithetic normal fault in the hanging wall may reflect minor rigid block rotation.

Deformation took place after deposition of the sedimentary cover, whose age is given by that of the marine terrace (Qm), formed at 125 kyr (Marquardt *et al.*, 1999).

Profile B.- a branched normal fault that crops out at 13 m a.s.l. displaces at least 3 m the base of the Quaternary shallow marine sediments (outside from figure 2B). The fault seems to be sealed by eolian and aluvial deposits, yet the development of a superficial scarp favours their involvement in the deformation.

The NE-SW trend of this fault suggests a NW-SE extensional deformation. As shown in the same figure, 10 m southeast of this structure a set of four small reverse faults may be related to footwall rigid rotation.

Profile C.- 2.5 km northeast of the previous profile and 10 m southeast from the main fault trace (figure 2C); we recognise two secondary SE dipping normal faults. A small NW dipping reverse fault is associated to one of them. Because no scarp is preserved in the loose overlying sands, faulting seems to have displaced only the marine deposits, assigned here to the 220 kyr (I.S. 7) marine high stand. Their offset is less than a meter and their trend once more suggests a NW-SE extensional deformation.

Age of deformation may here be somewhat older than in profile 2A, considering the age assigned to the only markers clearly displaced.

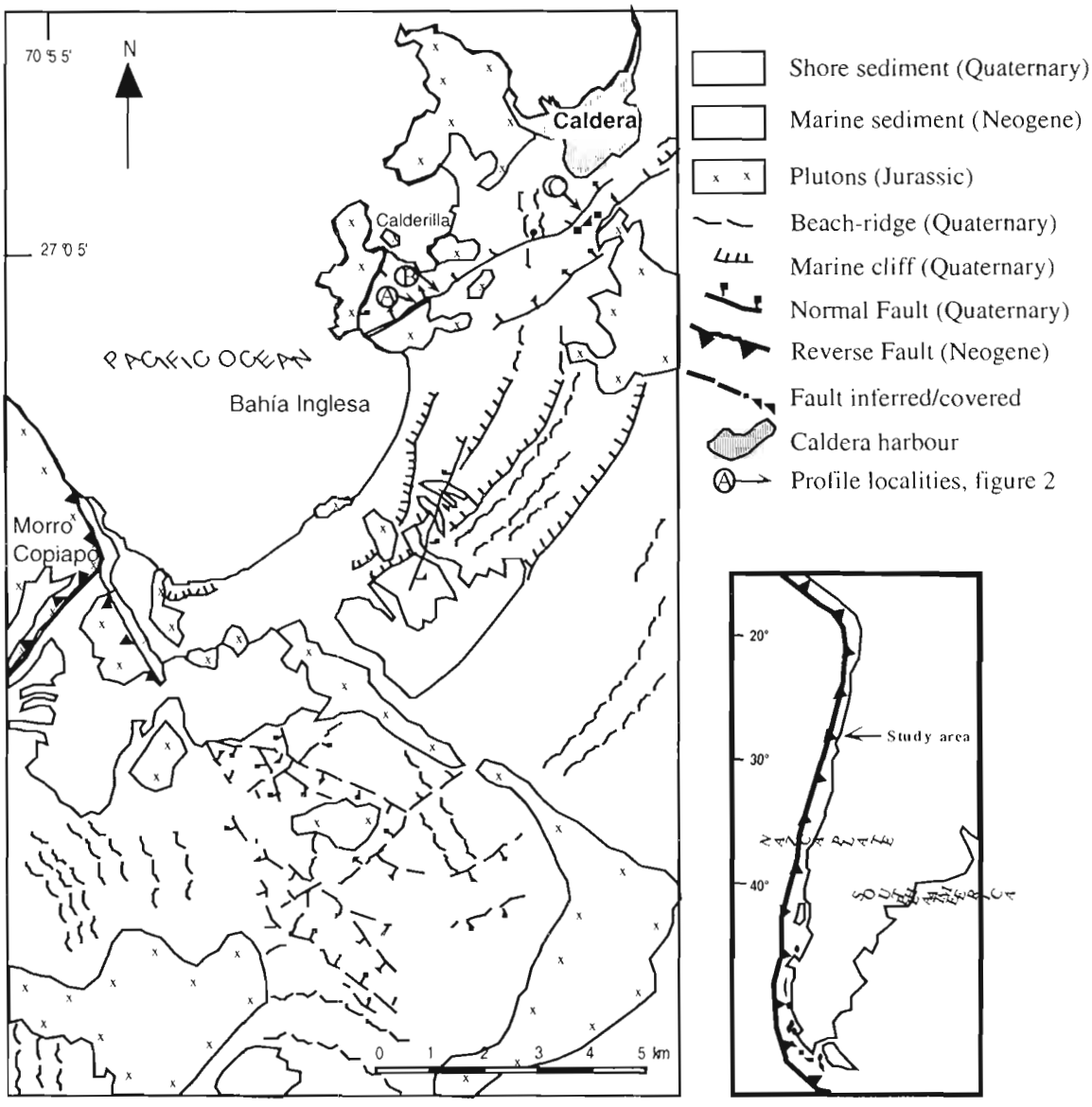

Figure 1.- Geologic sketch map showing the main structure of the coastal south Caldera harbour.

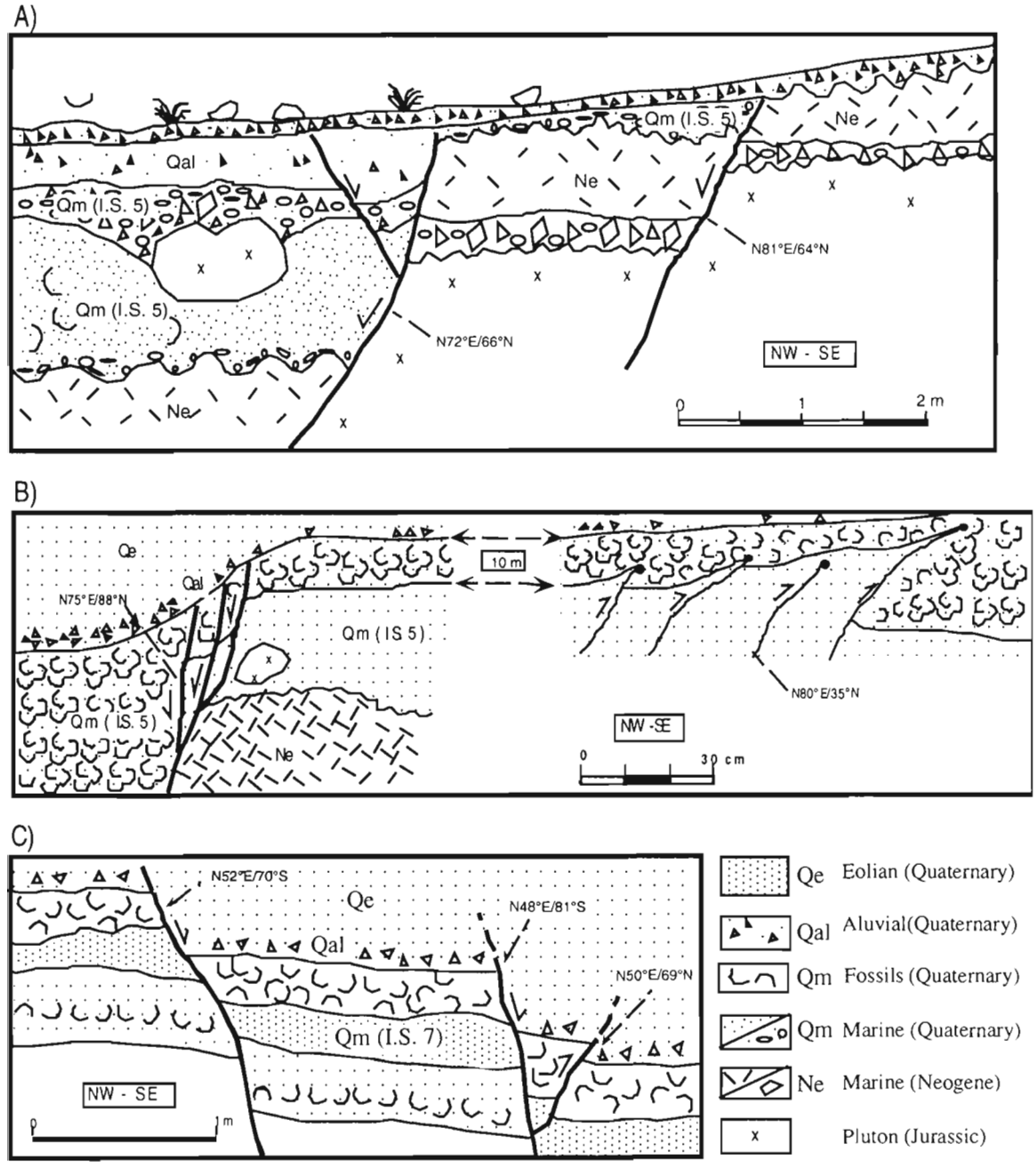

Figure 2.- Profile along the same normal fault scarp, inland Calderilla.

BAHIA INGLESA

A NNE-SSW trending normal fault scarp, subparallel to a marine cliff whose base lies at 30 m a.s.l., develops 2 km east of Bahía Inglesa.

The fault scarp faces westward in its northern half and eastward in the southern one, showing that the structure corresponds to a scissor fault (figure 3). A small graben is developed westward of the northern section. Vertical offsets range from 4 m down to half a meter in the vertical dipping central zone. A WNW-ESE extensional deformation, younger than 125 kyr (age of the displaced marine sediments) may be infered for this structure.

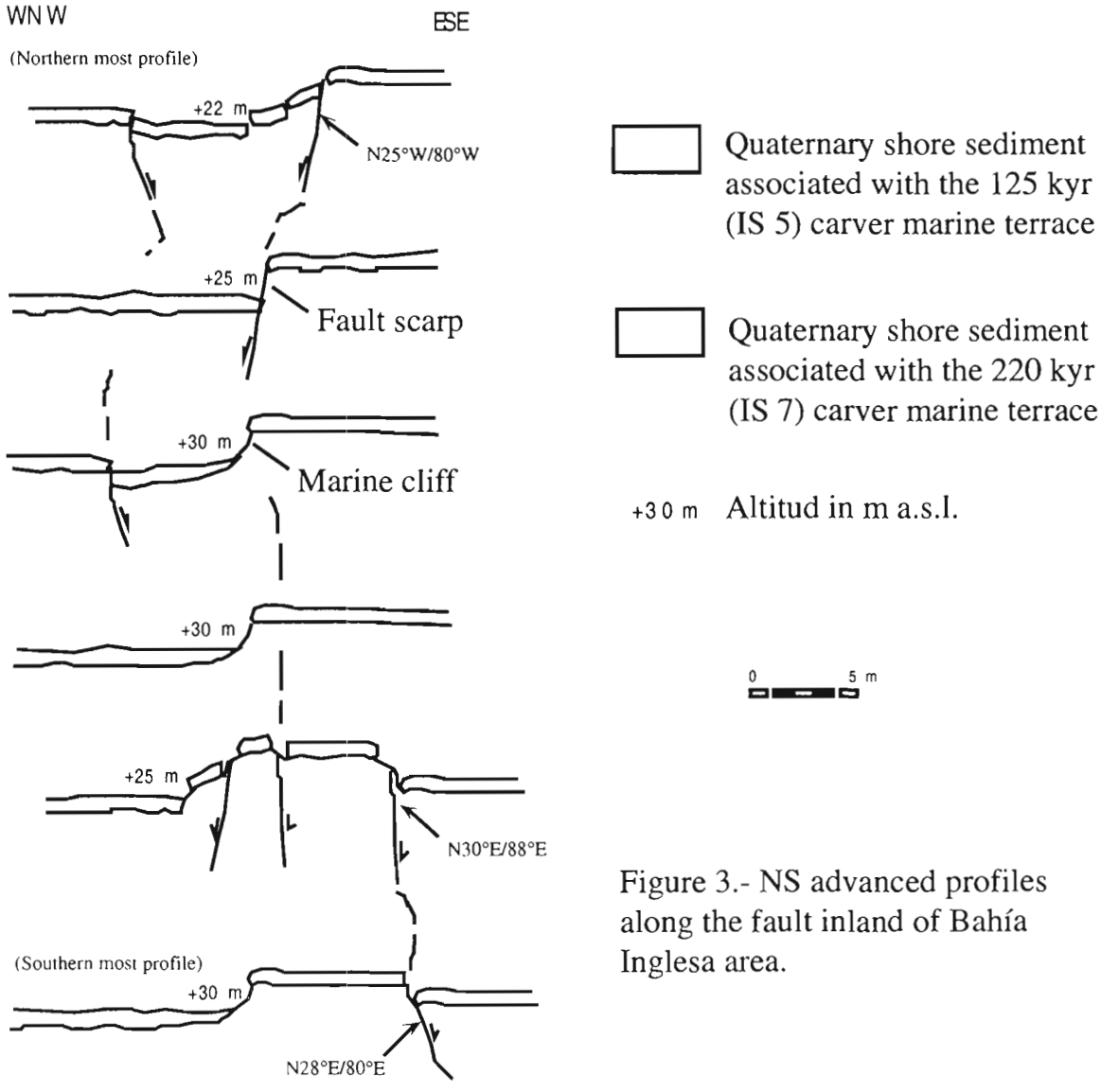

Figure 3.- NS advanced profiles along the fault inland of Bahía Inglesa area.

CONCLUSIONS

In the coastal belt between 27° and 28°S evidence of neotectonic activity is recorded by :

- Quaternary marine terraces uplifted at various heights under 200 m a.s.l.
- brittle deformation found in the terrace sediments close to Caldera (27°00' to 27°15' S).

The brittle deformation is recorded by probably coseismic normal faults that may be related to reactivation of preexistent structures. Based on their trend and the age of the sediments involved in the deformation, we propose that extensional deformation took place after 220 kyr
(most likely after 125 kyr), with a WNW-ESE to NNW -SSE trend. Extension may have resulted from uplift and trenchward migration of the coast.

The "major" faults show a maximum vertical displacement of 4 m. Normal and reverse cm scale faults, associated to rigid block rotation, are recognized in both their foot and hanging walls.

ACKNOWLEDGEMENTS

This study was supported by the chilean Servicio Nacional de Geología y Minería, as a part of its "Geological Mapping of the Atacama Fault System and Coastal Belt between 26° and 28°S", a project carried out with Estanislao Godoy , to whom we acknowledge his help in both field work and discussion of the text.

REFERENCES

Marquardt, C., Ortlieb, L., Guzmán, N. and Lavenu, A., 1999. Recent Vertical Motions and Quaternary Marine Terraces in the Caldera Area. (This Simposium).

Mortimer, C., 1969. The Geomorphological Evolution of the Southern Atacama Desert, Chile. A thesis submitted to the University of London for the Degree of Philosophy. Departament of Geology, University College London.