SUBSIDENCE AND CRUSTAL FLEXURE EVOLUTION OF THE NEOGENE CHACO FORELAND BASIN (BOLIVIA)

Laurent COUDERT(1), Thierry SEMPERE(2),
Michel FRAPPA(1), Claude VIGUIER(1), and Rafael ARIAS(3)

(1) Laboratoire d'Études et de Recherche en Géotechniques et Géophysique Appliquée, 351 Cours de la Libération, 33405 Talence, France.
(2) Orstom (UR 1H), Convention YPFB-ORSTOM, Santa Cruz, Bolivia. Present address: Département de Géologie sédimentaire (LGTE), case 119, Université Paris VI, 75252 Paris cedex 05, France.
(3) YPFB-GXG, cc 1659, Santa Cruz, Bolivia.

RÉSUMÉ: L'évolution de la subsidence dans le bassin du Chaco (Bolivie) est étudiée à l'aide de sismique réflexion, de gravimétrie et de diagraphies différées. Les courbes de subsidence depuis le Miocène supérieur mettent en évidence trois étapes tectoniques avec des taux de subsidence compris entre 0,1 et 0,4 km/Ma. L'application d'un modèle de flexion, avec une rigidité de flexion de 10^{23} N.m et une épaisseur de la croûte de 30-31 km, permet de décrire l'évolution de la géométrie et de la topographie du bassin depuis 10 Ma.

KEY WORDS: Bolivia, foreland basin, crustal flexure, tectonic subsidence, geophysics, model.

INTRODUCTION AND GEOLOGICAL SETTING

During the last decade, important progress has been made in understanding the subsidence mechanisms of foreland basins. Several modelling studies in continental regions have shown that the flexural response to tectonic loading can be represented by an elastic plate overlying a weak fluid (Turcotte and Schubert, 1982; Flemings and Jordan, 1989). The purpose of this paper is to quantitatively estimate the evolution of tectonic subsidence and crustal flexure in the Chaco basin of Bolivia (lat 19°-20°S) through study of geological, seismic reflexion, gravity and log-welling data (mostly unpublished and borrowed from the Bolivian State Oil Company YPFB).

The study was carried out in the Subandean belt of southern Bolivia (Río Grande-Parapetí area; lat 19°-20°S and long 62°-63°S; Fig. 1). The Subandean belt is bounded in the west by the Main Frontal Thrust (CFP, "Cabalgamiento Frontal Principal"), and the Subandean deformation dies out toward the east into the Chaco plain (Hérail et al., 1990; Baby et al., 1992). During the Neogene, the width of the foreland basin has

apparently varied from 100 to 120 km in general. The basin is filled by late Oligocene to recent sediments reactivation of the CFP system; Sempere, unpublished). Future precisions on the ages of these reflectors may obviously lead to modifications of some of the results presented hereafter.

In order to approach the effects of subsidence, the "back-stripping" method (Steckler and Watts, 1978) was used. The effect of compaction was incorporated for computation of tectonic subsidence. Paleobathymetry and sea-level changes were neglected because the depositional environment remained fluvial.

The porosity of argillaceous sands and mudstones as a function of depth was deduced from sonic tool (BHC) and density tool (FDC) using the matrix parameters and assuming a linear relation between porosity and well logs (Steckler and Watts, 1978).

Three stages were identified (Fig. 3). During stage T_4-T_3 (≈10-≈7.5 Ma), the tectonic subsidence rate was ≈0.4 km/Myr. During stage T_3-T_1 (≈7.5-≈1 Ma), this rate decreased to ≈0.1 km/Myr. Stage T_1-T_0 (from ≈1 Ma to the present) apparently shows an increase in subsidence rate to ≈0.4 km/Myr (Coudert, 1992).

Marshall, L.G., Sempere, T., and Gayet, M. 1993. The Petaca (late Oligocene-middle Miocene) and Yecua (late

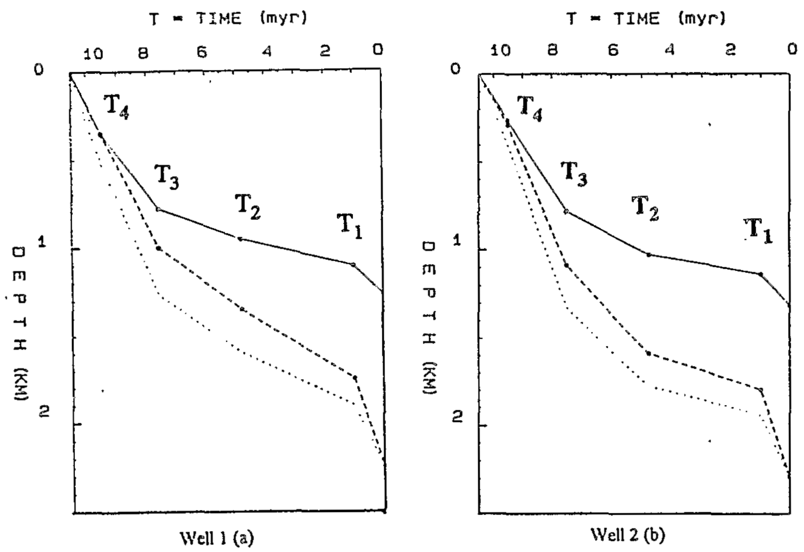

Fig. 3 — Tectonic subsidence curves since 10 Ma for wells 1 and 2. Dashed line: