An integrated geological-geophysical profile across northwestern Venezuela

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INTRODUCTION

The 250-km-long integrated profile here discussed is located across the northwestern part of Venezuela (Falcón range), between Cabo San Román and Barquisimeto city, following a N15ºW direction (**Figure 1**). This profile integrates surface geology, oil-prospection seismics, gravity and magnetic data. It runs north of the major active dextral Boconó fault and south of the Colombo-Venezuelan subduction zone, crossing two different tectonic domains (Bellizzia, et al., 1976; Stephan, 1985): the Caribbean nappes and the Oligo-Miocene Falcón basin. The southward transport of nappes occurred from Paleocene to Eocene onto the Cretaceous-Paleocene passive margin of northern South America, previous to a major orogenic collapse responsible for the Falcón basin. The Falcón basin anticlinorium, inverted from the Middle Miocene, follows an ENE-WSW direction, perpendicular to the maximum horizontal stress (σ_1). In addition, the Oca-Ancón fault –a major active east-west dextral fault running from the Colombian border and joining the San Sebastian fault to the east–, crosses the Falcón range, offsetting its axis in as much as 33 km and presenting a "transtensional jog" geometry in the central part of the Falcón range (Audemard, 1993; Audemard et al., 1994).

The Falcón basin depositional history started during the late Eocene, being older units lying above the Caribbean allochthonous, and contemporary to a main extensional period responsible for a "horst and graben" generalised geometry (Audemard, 1993). Muessig (1984) suggests that this geometry could be associated to a "pull-apart" deformation related to the Oligocene Oca-Ancón fault activity. However, Audemard (1993) and Audemard and Giraldo (1997) conclude that dextral deformation occurred only during the last 17-15 Ma, during compressive phases such as the one currently active.

Since a "rifting" period has preceeded during Oligocene-Early Miocene time to compressive phases (Audemard, 1995), very important variations in thickness and paleo-geographic conditions (Paraiso, Pecaya, San Luis and Churuguara Formations) during this extensional episode have been well documented (González de Juana et al., 1980). Besides, basaltic intrusions of Early-to-Middle Miocene age have been interpreted as derived from the upper mantle/continental lithosphere boundary (McMahon, 2001) and associated to this intraplate "extensional" process responsible for the early structuration of the Falcón basin (Audemard, 1993). The northern part of the profile images WSW-ENE-trending "horsts" and "grabens", interpreted from seismic lines, affecting both the Caribbean allochthonous and the Miocene sediments.

BOUGUER ANOMALY AND MAGNETIC DATA

The database comprises 1833 gravity and 491 magnetic measures, of which 205 and 299 were acquired for this study (Rodríguez and Sousa, 2003). The Bouguer anomaly map shows a preferential N70°E direction ranging between - 40 and 60 miligals. This last value correlates well with the ultramafic rocks outcropping in the northern edge of the profile (Cerro de Santa Ana). In the central part a maximun value of 45 mgal can be correlated with the Early Miocene intrusions. The value of -30 mgal in the southern part can correlate with the Siquisique Ophiolitic Complex (pillowlavas and metagrabros; Bartok et al., 1985).

The magnetic field ranges from 34,200 to 35,500 gamma. The maximun values are located in the northern edge (Cerro de Santa Ana ultramafic rocks) and in the central part of the Falcón basin (35,500 gamma) correlating well to the Miocene intrusions and also suggesting a thinned crust. The minimum value of 34,200 gamma – between the Oca-Ancón and Boconó faults, in the southern part of the section- has been correlated with the metamorphic rocks of the Caribbean allochthonous.

DISCUSSION

The Falcón range can be interpreted as part of a much longer Oligocene basin, later inverted during Middle Miocene to Holocene times. According to geophysical modelling, the thickest part of the basin corresponds to a dramatic crustal thinning from 40 km to 20 km, located in the central part of the profile coinciding with the Miocene intrusions alignment (**Figure 2**). From several attempts of gravimetric and magnetic modelling along the entire profile, the best-fit model that integrates available geological-geophysical data corresponds to a shallow (incipient) flat subduction having a south vergence (**Figure 3**). Therefore, this is partly in agreement with the flat slab subduction model of anomalously thick oceanic Caribbean plate under South American plate, proposed by Van der Hilst and Mann (1994), although differing in the amount of slab subducted.

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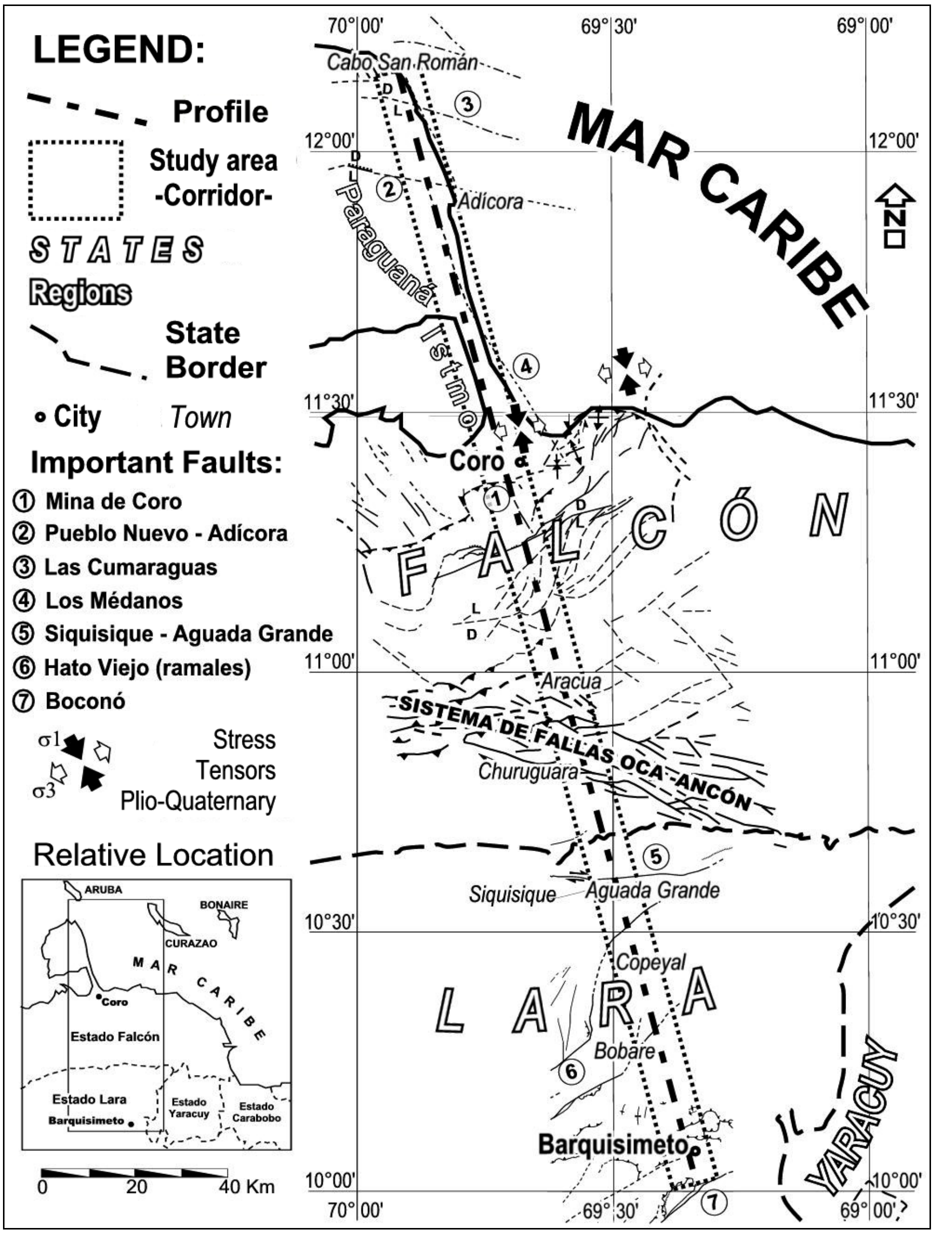

Figure 1. Profile location (Rodriguez and Sousa, 2003)

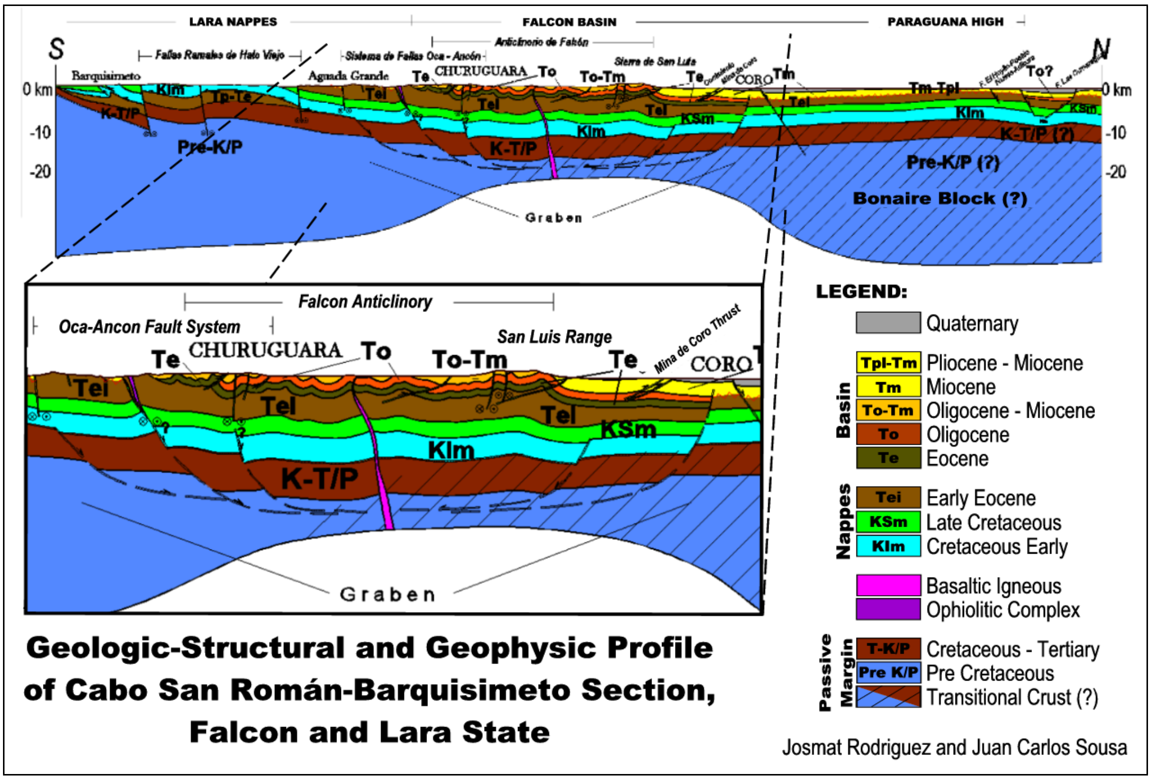

Figure 2. Integrated profile (Rodriguez and Sousa, 2003)

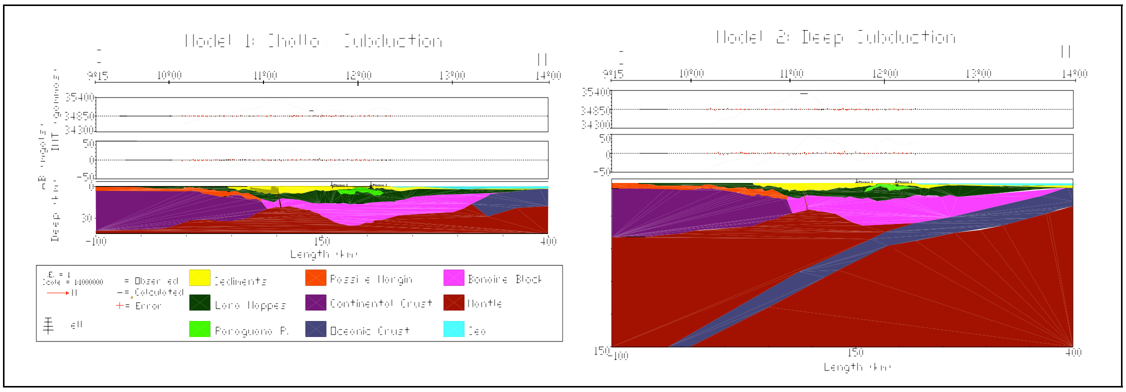

Figure 3. Geophysical modeling (Best fit = Shallow subduction -left-, Rodriguez and Sousa, 2003)