NORTH-SOUTH STRUCTURAL EVOLUTION OF THE PERUVIAN SUBANDEAN ZONE

Willy GIL R. (1), Patrice BABY (2), René MAROCCO (1), Jean François BALLARD (3)

(1) IRD, Apartado 18-1209 Lima 18, Peru. ird@chavin.rcp.net.pe
(2) IRD. Apartado 17-10-7019, Quito, Ecuador. pbaby@pi.pro.ec
(3) ELF EP, Av. Larribau, 64000, Pau, France. Jean-Francois.Ballard@elf-p.fr

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INTRODUCTION

The Peruvian Subandean zone corresponds to a foreland fold and thrust belt, whose structural geometry varies drastically from north to south. It constitutes the transitional zone between the Eastern Cordillera and the foreland basins of the Peruvian Andes (Marañon, Ucayali and Madre de Dios basins), and extends southward in Bolivia and northward in Ecuador (Fig. 1).

The northern part of the Peruvian Subandean zone (between lat. 4°S and 8°S) is formed by the Santiago and Huallaga Neogene basins. Its central part (between lat. 9°S and 11°S) comprises the Pachitea Neogene sub-basin, which prolongs to the south with the Ene basin. The southern Peruvian Subandean zone (between lat. 11°S and 14°S) extends from the southern extremity of the Ucayaly Basin to Bolivia.

This paper illustrates the north-south geometric evolution of the Peruvian Subandean zone and shows how the Paleozoic and Mesozoic paleogeographies have controlled the style of deformation. Serial balanced cross-sections construction has been possible due to field works, seismic reflection data and drilling information provided by petroleum industry.

DEFORMATION GEOMETRY AND KINEMATICS

In the northern part of the Peruvian Subandean, the section involved in deformation consists of metamorphic Precambrian rocks, and Triassic to Recent sedimentary rocks. The Santiago and Huallaga basins are deformed by diapirs, thrust sheets and tectonic inversions (Figs. 2A-2B). The diapirs and the décollement of the thrust system developed in the Upper Triassic evaporites of the base of the Pucara Group. Thrust structures are locally deformed by deep positive inversions of Upper Triassic-Lower Jurassic normal faults. In the Huallaga Basin, horizontal shortening increases and the frontal fault

(Tarapoto Thrust) 30km overthrusts the Marañon Basin, which is deformed by wrench tectonics (flower structures) as the Oriente Basin of Ecuador (Baby et al., 1999). Apatite fission track analysis (Alemán and Marksteiner, 1997) shows that the uplift of the thrust belts which limit and deform the Santiago basin started at 10 Ma.

The central part corresponds to the Pachitea basin (Fig. 2C) which pinches out to the east on the Shira High limited by basement faults. The Hinterland (Subandean internal zone) is deformed by an important thrust system developed in a thick series of Paleozoic and Lower Mesozoic sediments. The main detachment is located in the base of the Upper Permian shales (Ene Fm.). A total horizontal shortening of 50% has been calculated in the internal Subandean zone from balanced cross-section construction (Fig. 2C). Neogene continental sediments are overthrusted and do not present strong thickness variations, which seems to show a very young age of the deformation (Gil, 1997).

The southern Subandean zone comprises the southern part of the Ucayali Basin and the north-western border of the Madre de Dios Basin which extends to Bolivia. It is deformed by a thrust system developed in a thick and continuous Paleozoic series (Figs. 2D-E). Total horizontal shortening is also of about 50%. The external zone is deformed by fault propagation folds, whereas the internal zone is structured by blind duplexes and Neogene piggyback basins, similar to the Alto Beni piggyback basin studied by Baby et al. (1995) in the northern Subandean zone of Bolivia.

PALEOGEOGRAPHIC CONTROL

Balanced cross-sections show that some Paleozoic and Mesozoic units wedge out to the east or despair abruptly in the thrust sheets of the hinterland. These drastic changes controlled the style of Subandean deformation.

Deformation of the northern Peruvian Subandean zone (Figs 2 A-B) was controlled by the inversion of an Upper Triassic-Lower Jurassic rift (Pucara Group) which extends to the north in the Oriente Basin of Ecuador (Baby et al., 1999). The presence of evaporites in the base of the Pucara Group induced the development of diapirs and an important detachment. Its pinching out to the east stopped the detachment propagation and provoked the formation of the Santiago Basin frontal triangle zone (Fig. 2 A).

In the central Subandean zone, the development of the hinterland thrust system was controlled by the appearance of the Permo-Triassic shales (Ene Fm.), which formed the sole thrust (Fig. 2 C). To the east, the Ene Fm. disappears and the deformation is characterised by thick-skin tectonics and basement uplift (Shira High).

The southern part (Figs. D-E) is deformed exclusively by thin-skin tectonics. The thick and almost continuous series of Paleozoic sediments permitted the development of various detachments and duplexes in the internal zone. Similar paleogeography and thrust system geometry are known moreto the south in the northern Bolivian Subandean zone (Baby et al., 1995).

CONCLUSIONS

The Peruvian Subandean foothills is a transition zone where from north to south thick-skin tectonics is progressively replaced by thin-skin tectonics. This north-south evolution was controlled by the Triassic-Jurassic setting, which leaded rift systems oblique to the chain and a strong erosion of the Paleozoic sedimentary series. In the northern part, Triassic and Jurassic rift systems are inverted and their NNE-SSW orientation (oblique to the plate convergence) induced transpressive deformations. In the southern part, the Paleozoic series is poor eroded and permitted the development of thin-skin tectonics with 50% of horizontal shortening.

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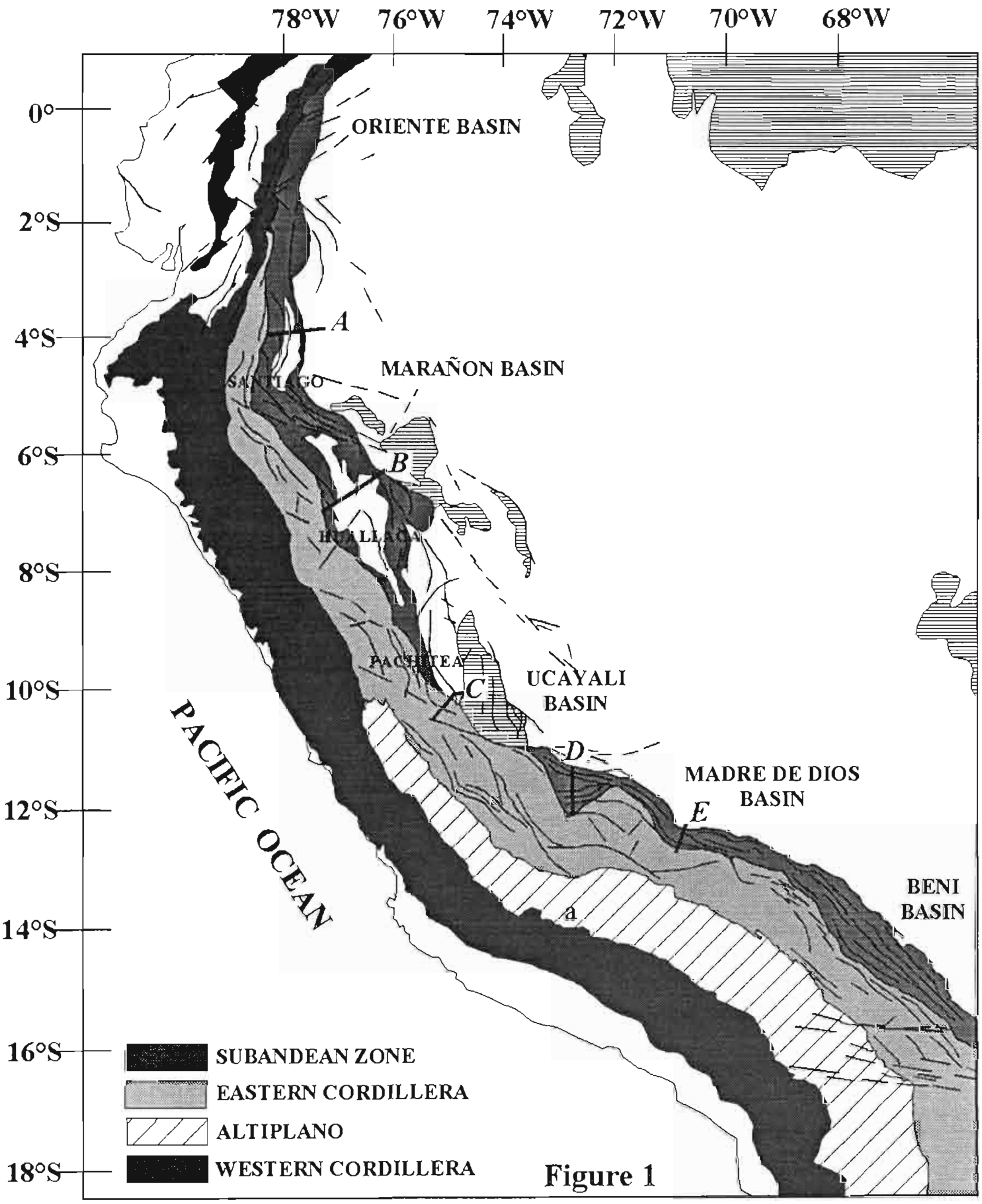
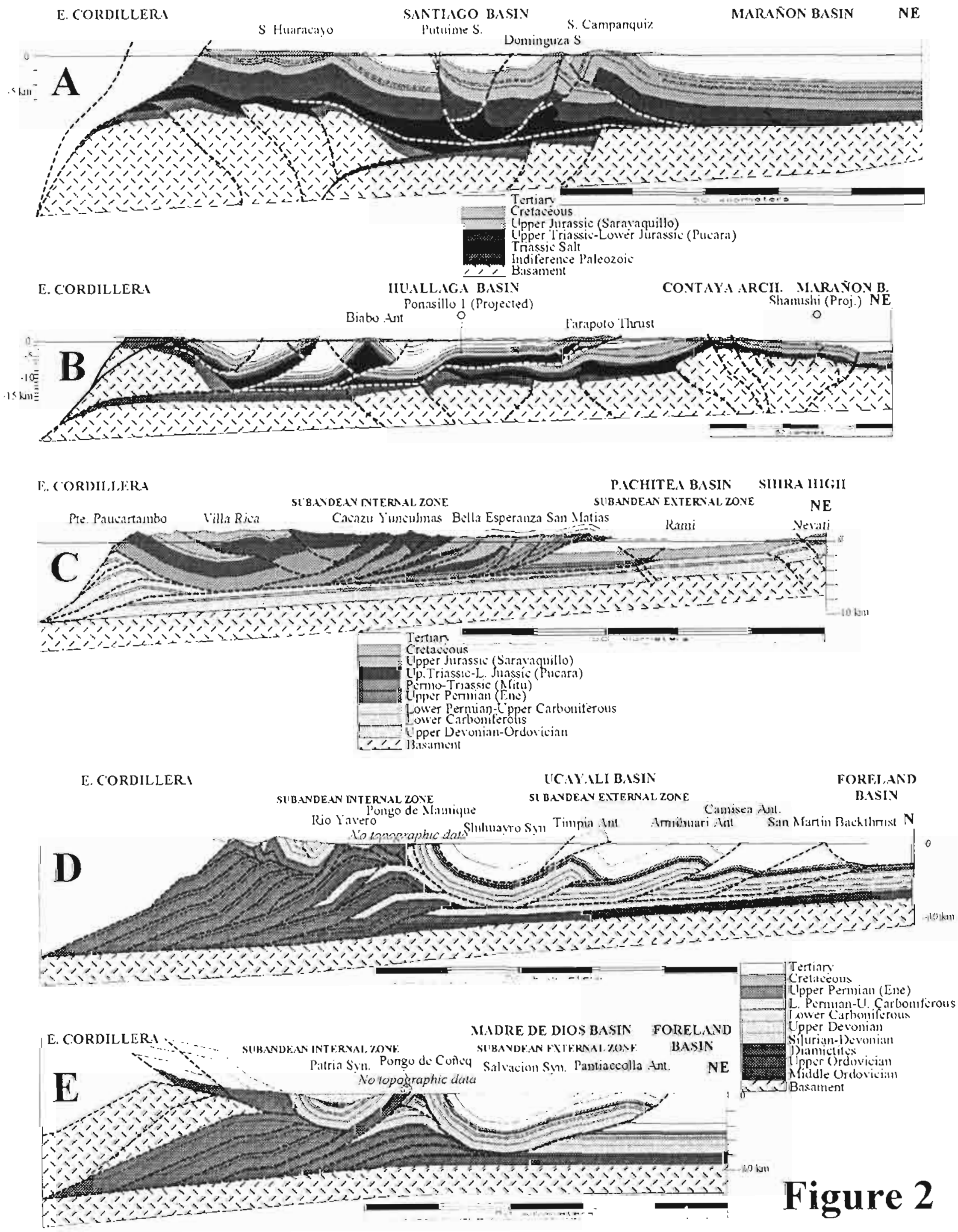

78°W
76°W
74°W
72°W
70°W
68°W
0°
2°S
4°S
6°S
8°S
10°S
12°S
14°S
16°S
18°S
ORIENTE BASIN
A
MARAÑON BASIN
B
C
UCAYALI BASIN
D
MADRE DE DIOS BASIN
E
BENI BASIN
a
PACIFIC OCEAN
SUBANDEAN ZONE
EASTERN CORDILLERA
ALTIPLANO
WESTERN CORDILLERA

Figure 1



E. CORDILLERA
SANTIAGO BASIN
MARAÑON BASIN
NE
S Huaracayo
Putuime S.
S. Campanquiz
Dominguza S
A
Tertiary
Cretaceous
Upper Jurassic (Sarayaquillo)
Upper Triassic-Lower Jurassic (Pucara)
Triassic Salt
Indiference Paleozoic
Basament
E. CORDILLERA
HUALLAGA BASIN
CONTAYA ARCH.
MARAÑON B.
Ponasillo 1 (Projected)
Shanushi (Proj.)
NE
Biabo Ant
Tarapoto Thrust
B
E. CORDILLERA
PACHITEA BASIN
SHIRA HIGH
SUBANDEAN INTERNAL ZONE
SUBANDEAN EXTERNAL ZONE
NE
Pte. Paucartambo
Villa Rica
Cacazu
Yuncullmas
Bella Esperanza
San Matias
Rami
Nevati
C
10 km
Tertiary
Cretaceous
Upper Jurassic (Sarayaquillo)
Up.Triassic-L. Juassic (Pucara)
Permo-Triassic (Mitu)
Upper Permian (Ene)
Lower Permian-Upper Carboniferous
Lower Carboniferous
Upper Devonian-Ordovician
Basament
E. CORDILLERA
UCAYALI BASIN
FORELAND BASIN
SUBANDEAN INTERNAL ZONE
SUBANDEAN EXTERNAL ZONE
Pongo de Mainique
Rio Yavero
Camisea Ant.
No topographic data
Shihuayro Syn
Timpia Ant
Armihuari Ant
San Martin Backthrust
N
D
Tertiary
Cretaceous
Upper Permian (Ene)
L. Permian-U. Carboniferous
Lower Carboniferous
Upper Devonian
Silurian-Devonian
Diamictites
Upper Ordovician
Middle Ordovician
Basament
E. CORDILLERA
MADRE DE DIOS BASIN
FORELAND BASIN
SUBANDEAN INTERNAL ZONE
SUBANDEAN EXTERNAL ZONE
Patria Syn.
Pongo de Coñeq
No topographic data
Salvacion Syn.
Pantiacolla Ant.
NE
E
10 km

Figure 2