Influence of the Nazca ridge subduction on the Amazonian foreland basin deformation: Preliminary analyses

Patrice Baby (1), Nicolas Espurt (1, 2), Stéphane Brusset (2), Wilber Hermoza (3), Pierre-Olivier Antoine (2), Martin Roddaz (2), Joseph Martinod (2), & Rolando Bolaños (3)

(1) IRD, Convenio IRD-PERUPETRO, Lima, Pérou; pbaby@ird.fr
(2) LMTG UMR 5563, 14 avenue Edouard Belin, F-31400 Toulouse, France; espurt@lmtg.obs-mip.fr, brusset@lmtg.obs-mip.fr, mroddaz@lmtg.obs-mip.fr, martinod@lmtg.obs-mip.fr, poa@lmtg.obs-mip.fr
(3) PERUPETRO, Convenio IRD-PERUPETRO, Lima, Pérou; whermoza@perupetro.com.pe, rbolanos@perupetro.com.pe

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INTRODUCTION

Foreland basin evolution is classically related to fold and thrust belt propagation. The Amazon basin – the world's largest Cenozoic fluvial basin (Räsänen et al., 1992; Molinier et al., 1996) – is actually an atypical foreland basin whose geometry is not fitting with classical models (DeCelles and Giles, 1996). In western Amazonia, the foreland basin is divided into two subsiding sub-basins delimited by a structural/morphologic arch (the Fitzcarrald Arch), which develops perpendicularly to the Central Andes (Fig. 1). This foreland basin pattern must be explained by another geodynamic process than simple orogenic loading.

In this paper, we present a preliminary analysis of this problem based on geomorphic and foreland basin deposits observations.

GEOMORPHIC AND GEODYNAMIC ANALYSES

The western part of the modern Amazon foreland basin extends from northern Bolivia to Ecuador and is related to Central Andes geodynamics. It comprises two main subsiding sub-basins: the Pastaza-Marañon basin in the north (Roddaz et al., in press), and the Beni-Mamore basin in the south (Baby et al., 1999). These two flexural sub-basins, driven by thrust-sheet loading, are actually separated by the NE-SW Fitzcarrald Arch, which corresponds to a widespread dissected relief of Neogene deposits. As shown in Figure 1, this structural Arch (1100 x 900 km) extends in southern Peru and western Brazil and constitutes a major geomorphic feature of the Amazon foreland basin. It superimposes perfectly on the reconstruction of the eastern subducted portion of the Nazca Ridge proposed by Hampel (2002) from updated plate motion data obtained by a revision of the geomagnetic time scale. Given the scale and the geometry of the Fitzcarrald Arch, the horizontal subduction of the Nazca ridge seems the better process to explain the western Amazonian uplift.

TIMING ANALYSIS

The timing of the Fitzcarrald Arch uplift can be easily correlated to the 900 km horizontal subduction history of the Nazca Ridge. In the Madre de Dios basin, seismic reflection profiles show an onlap of late Neogene deposits (probably Mio-Pliocene) on the southern flank of the arch (Hermoza, 2004), which recorded an incipient uplift. In the same area, recent studies on Neogene outcrops show a Miocene tide-influenced sea environment (Hovikoski, J. et al., 2005), similar to the Pebas environment described more to the north in the Iquitos region (Hoorn, 1993; Räsänen et al., 1995; Gingras et al., 2002). During this period, marine incursions have been controlled by the flexural subsidence of the Amazon foreland basin (Roddaz, 2004). These observations are consistent with the migration history of the Nazca Ridge proposed by Hampel (2002). Ridge subduction began ~ 11.2 Ma ago at 11°S below the Peruvian coast, and probably deformed the Amazon basin in the last 5 Ma, prior to reach its present-day position below the Fitzcarrald Arch. The consequent Pliocene uplift of western Amazonia transformed radically the foreland basin landscape inducing the end of marine incursions.

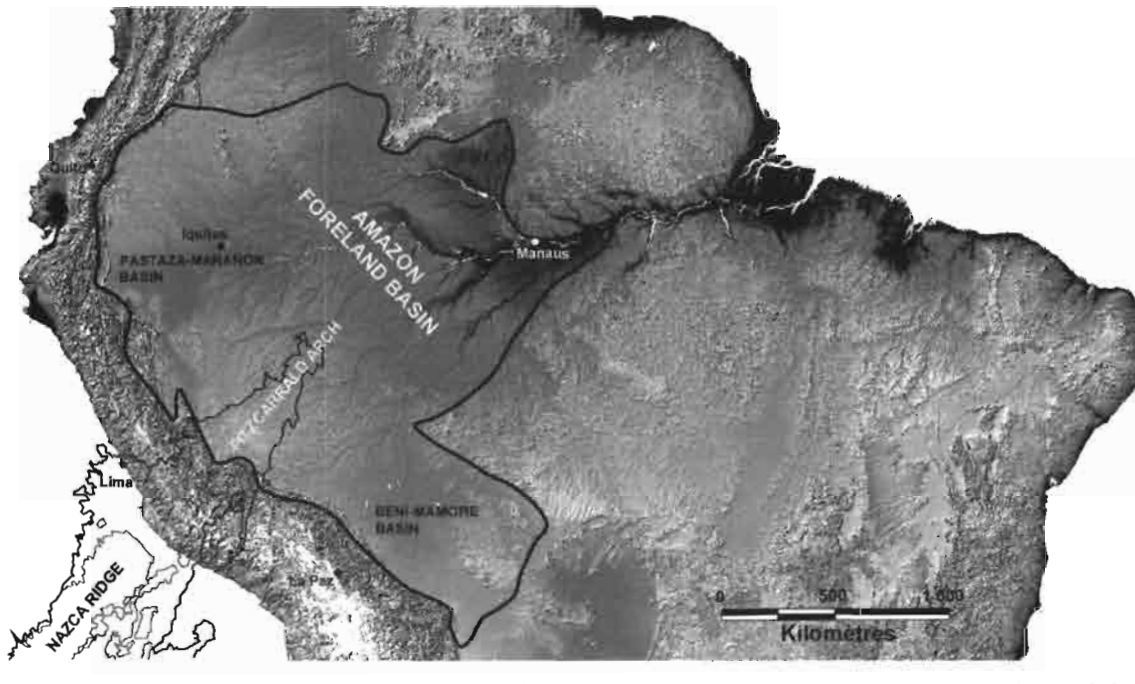

Fig. 1 – The western part of the Amazon foreland basin is actually divided into two mean subsiding sub-basins (Pastaza-Marañon to the north and Beni-Mamore to the south) separated by the Fitzcarrald Arch, which superimposes on the reconstruction of the eastern subducted portion of the Nazca Ridge proposed by Hampel (2002) (DEM from NASA SRTM data).

CONCLUSIONS

The geometry and the location of the widespread Fitzcarrad Arch uplift in the foreland Amazon basin show it can be related to the 900 km Nazca Ridge subduction. Late Neogene deposits in the eastern flank of the arch recorded its incipient uplift. In the same area, Miocene sediments correspond to tide-influenced sea deposits of a flexural foreland basin. The Fitzcarrald Arch uplift, as a result of the Nazca ridge subduction, is probably responsible for the late Neogene foreland evolution from this tide-influenced sea to the modern incised fluvial basin drainage network. This sudden environmental change might be one of the decisive factors, which led to the

very high biodiversity growing in the Amazon basin during the Neogene (Hooghiemstra and Van der Hammen, 1998).

In view of the complex consequences that could induce the Nazca Ridge subduction on the Amazon foreland basin environment, a multidisciplinary research project is launched on the Fitzcarrald Arch. It consists in sedimentological and geomorphological basin analyses coupled with palaeontological/palaeoenvironmental studies for the Neogene of the Western Amazon basin.

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