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The Huallaga foreland basin evolution: Thrust propagation in a deltaic environment, northern Peruvian Andes

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Abstract

The sub-Andean Huallaga basin is part of the modern retroforeland basin system of Peru. It corresponds to a thrust-and-fold belt superimposed on inverted and halokinetic structures and is characterized by Eocene–Pliocene, thick synorogenic series that have controlled the burial history of petroleum systems. Sedimentological analysis and a sequentially restored cross-section based on seismic data and new field studies show three sequences of synorogenic deposits. The Eocene (Lower Pozo member) developed in shoreface environments, when the basin morphology corresponded to a foresag depozone linked to an orogenic unloading period. The Middle Eocene sequence (Upper Pozo member) developed in shallow marine environments and recorded a change in Andean geodynamics and the retroforeland basin system. The basin morphology corresponded to a foredeep depozone linked to an orogenic loading period. This configuration remained until the Middle Miocene (Chambira Formation). The Middle Miocene–Pliocene sequence recorded the onset of the modern sub-Andean Huallaga basin that became a wedge-top depozone. Thrust propagation occurred in a deltaic environment, which evolved progressively to an alluvial system linked to the modern Amazon River.

Keywords: Deltaic and estuarine deposits; Eocene; Foreland basin; Huallaga basin; Miocene; Peru; Petroleum systems; Sub-Andean

1. Introduction

The Huallaga sub-Andean and Amazonian basins of the northern Peruvian Andes (Fig. 1) belong to the retroforeland basin system linked to the Andean orogen. The Huallaga basin is mainly structured by thrust systems such as duplex, fault bend folds, and fault-propagation folds associated with syntectonic sedimentation. Cenozoic foreland deposits are exceptionally thick in this part of the sub-Andean zone (about 8 km) and have never been approached using descriptive sedimentary parameters and modern foreland propagation concepts.

The aim of this article is to present new data about the Cenozoic sedimentary environments observed in the Huallaga basin, interpret paleoenvironmental evolution from a stratigraphic architecture point of view, and propose a sequential restoration of the Huallaga portion of the northwestern Amazonian foreland system.

2. Geological setting

The sub-Andean zone is an active fold-and-thrust belt on the eastern edge of the Andean orogen that constitutes the wedge-top depozone of the Andean retroforeland basin system. In the sub-Andean zone, the Huallaga basin is N160E elongated approximately 400 km long and 100 km wide and located between 76°–77°W and 6°–9°S (Fig. 1). It is bounded to the north by the Santiago basin. To the east,

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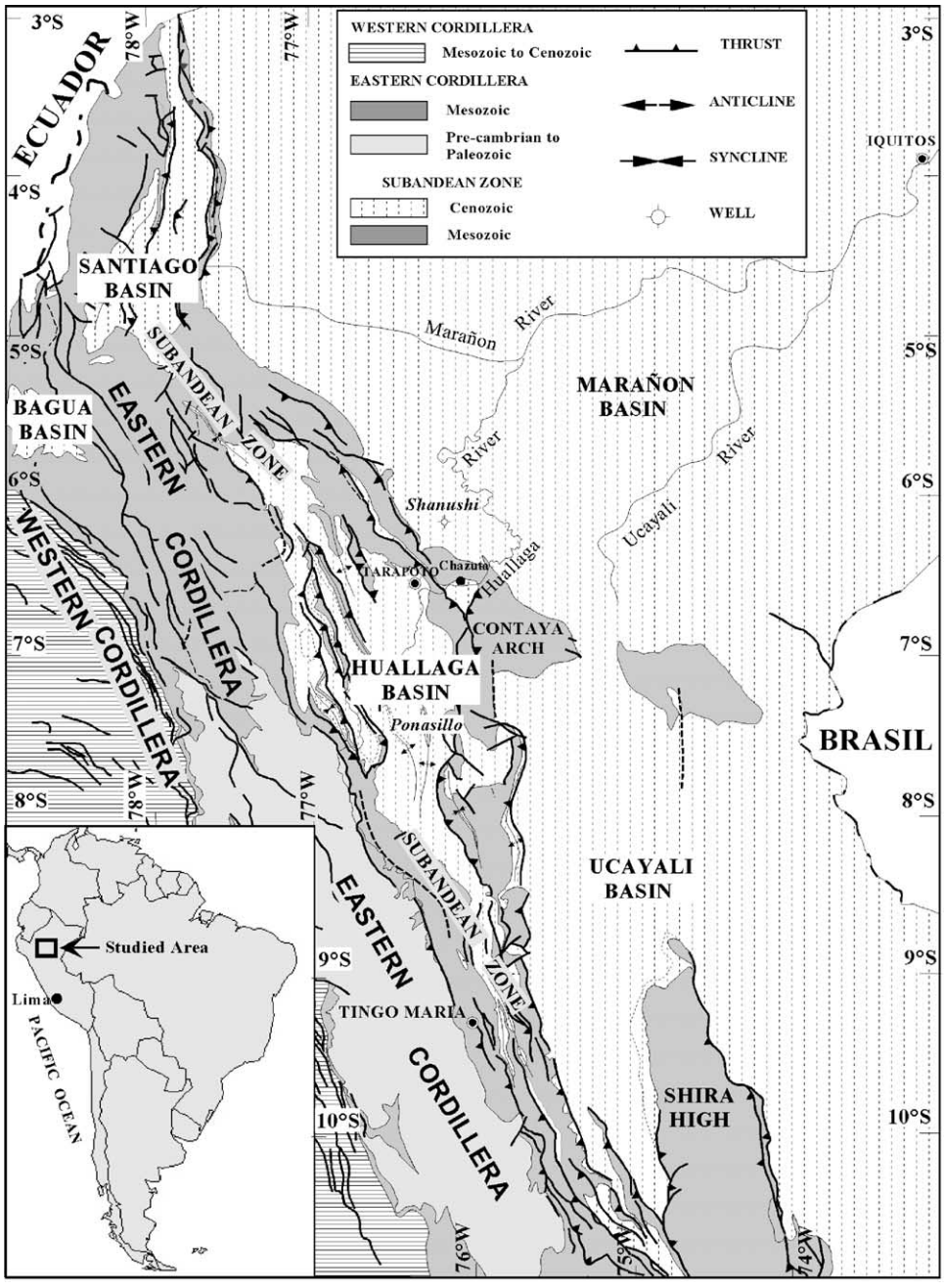

Fig. 1. Structural map of the northern Peruvian Andes, showing the Western Cordillera, Eastern Cordillera, sub-Andean basins (Santiago, Huallaga, and Ucayali), and Amazonian basin (Marañón).

the Huallaga basin is restrained from the Marañón foredeep basin by the NE-vergent Shanusi-Chazuta thrust, which overthrusts the WNW–ESE-oriented Contaya arch (Fig. 1). To the south, the Huallaga basin progressively terminates along the backlimb of the Shira high.

The geological evolution of the Peruvian Andean retroforeland basin is ascribed to the onset of the Nazca subduction, which started in Late Cretaceous times (Peruvian phase; Mégard, 1984) along the western margin of the South American continental lithosphere. In the Ecuadorian Oriente basin, which is the northern continuation of the Peruvian Marañón basin, compressional deformation began in the Late Turonian (Baby et al., 1999; Barragán, 1999). Consequently, two sedimentary successions can be distinguished (PeruPetro, 2002; Fig. 2): (1) the pre-Andean series that consists of Paleozoic–Early Mesozoic deposits (McLaughlin, 1924; Kummel, 1946; Huff, 1949; Jenks, 1951; Rosenzweig, 1953; Zegarra and Olaechea, 1970) and (2) the Andean series that corresponds to Late Mesozoic marine to continental foreland successions (Morán and Fyfe, 1933; Kummel, 1948; Rodríguez and Chalco, 1975; Pardo and Zúñiga, 1976).