The Tectono-Sedimentary Evolution of the Amazon Fan Across the Central Transect, Foz do Amazonas Basin, Brazil*

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Search and Discovery Article #30213 (2011)  
Posted December 12, 2011

*Adapted from poster presentation at AAPG International Conference and Exhibition, Milan, Italy, October 23-26, 2011

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Abstract

The problems of the tectono-sedimentary evolution of the Foz do Amazonas Basin have been addressed by integrating a broad set of geophysical and well data onto one regional seismic section. Two different hypotheses were considered in the interpretation of gravitational tectonics affecting the Brazilian equatorial margin, exceptionally developed in this basin due to the thick sedimentary loading of the Amazon Fan. The first hypothesis contemplates thin skinned tectonics, while the second implies the presence and activity of deep direct faults displacing the basement.

In order to discriminate which of the two hypotheses is the most reliable, the restoration of the central transect of the fan, 265 km long, was performed. The data on the depth of the basement, obtained by gravimetric and magnetic modeling, was also considered.

The first hypothesis envisages a deformation with loss of volume that, in order to be justified, requires removal of large amounts of sediments by erosion. The second hypothesis reduces the need of processes difficult to verify, and therefore is preferable.

Thanks to the high resolution of a proprietary 3D seismic survey covering the critical area of the slope, it was possible to analyze in detail the syndepositional tectonic features of the most important seismostratigraphic units of the fan in relation to the development of gravitational tectonics. The existence of at least two different levels of detachment were identified. From seismic evidence and well data these levels can be interpreted as overpressured clays. These levels induced the detachment and deformation of the overlying sediments in at least two distinct tectonic phases, locally recorded by unconformities. In fact, fold and thrust belts that are sealed by Tortonian unconformities have been identified.

The tectono-sedimentary evolution is characterized by a system of faults that is not related to a single event of gravitational collapse. This evolution differs from the reconstruction published in the literature for the possibility that the extension, due to a system of normal faults at the shelf break, is not completely transferred to the thrust in the shortening zone through the identified
levels of detachment. It is hypothesized that a part of the extension observed may have been balanced during the sedimentation of the fan, from a temporary reactivation of deep crustal faults, originated during rifting of the continental margin of South America.
The Tectono-Sedimentary Evolution of the Amazon Fan across the Central Transsect (Foz do Amazonas Basin, Brazil)

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SUMMARY

Some of the open questions posed by the reconstruction of the Foz do Amazonas Basin tectonic-sedimentary evolution have been addressed through the geophysical integrate modeling of a significant regional seismic section. Two different hypotheses were considered in interpreting the gravitational tectonics, observed along the Brazilian equatorial margin, exceptionally developed due to the sedimentary loading of the Amazon Fan. The first hypothesis contemplates a thick-skinned tectonic model only, while the second postulates the presence of the activity of stress faults deep-seated in the basement. In order to discriminate between the two hypotheses, the restoration of the 205 km long central transect of the Amazon fan was performed. Also the data on the depth of the basement, obtained by gravimetric and magnetic modeling, was considered.

The Central Transsect

The Foz do Amazonas Basin is affected by an exceptionally developed gravitational tectonics resulted from three major episodes (Silva et al. 1999, Perovano et al. 2009), involving the activation of different stratigraphic levels of clay in overpressure conditions.

The extension in the platform area, during each event was partly balanced, under the mid-lower slope, by fold and thrust belts and high angle reverse faults. Thus, this area became a source area of gravitational flows, resedimented oceanward.

The deposition of the Amazon Fan has greatly enhanced the last tectonic phase, locally still active.

The shallowest level of detachment at the basin scale is represented by the "Mio-Mid" and the extensional settlement tectonic of the Fan lies on its top.

CONCLUSIONS

The solution according to the first hypothesis, envisages a deformation with a substantial volume loss, which requires, in order to be justified, the removal of large amounts of sediments by erosion.

The solution according to the second hypothesis, instead, implies that great part of the observed extension may have been compensated, during the sedimentation of the Fan, by the reactivation of deep crustal faults (see Fig. 7b), originally developed during the rifting of the South America continental margin and only in part by the thin-skinned tectonic.

In the shortening areas, during the last event of collapse, high-angle reverse faults displaced the whole stratigraphy of the Fan and the underlying old system of folds and thrusts, without reactivating them. Locally, the compressive structures appear as clay diapirs (see Fig. 7b). It is believed that the oceanside propagation of these structures was arrested by a loss of efficiency in the level of detachment, in its turn.

ACKNOWLEDGMENTS

I thank my supervisor, Dr. Alessandro Moscardini Maggiora and Prof. Carlo Ingallina, for their helpful support during the development of this work and Dr. Alessandro Barnola for encouraging the writing of this paper. I am grateful to the Exploration & Production Division, ENI, for access to data disclosed in this paper, the exploration of data from international scientific support. I especially thank Marco Medici, Giuseppe Vincenzo, Antonio Schirra, Laura Vai, Roberto Marinari, Vincenzo Mazzolli, Giuseppe Barbier, Carlo Bigi, Roberto Longoni, Cristiano Magistroni, Claudio Feuchting, Ornello De Rold, Sergio Nardelli, Antonio Condoluci.

BIBLIOGRAPHY

-Figure 7. Location Map showing the seismic transect across the Amazon fan depression. The data are from the INGEGHINI et al. 2000, and processed according to the INGEGHINI and ALESSANDRONI 2001.

-Figure 8. Line 1: Location and geometry of the Foz do Amazonas Basin. The location of the seismic transect and the potential path of the Amazon River through the Basin is shown. The Central Transsect is marked by the black line.

-Figure 9. Line 2: Depth conversion and restoration of the central transect of the Foz do Amazonas Basin. The data are from the INGEGHINI et al. 2000, and processed according to the INGEGHINI and ALESSANDRONI 2001.

-Figure 10. Magnetic data. The contour lines show the magnetic anomaly map with a magnetic anomaly unit of 0.05 nT. The anomaly is due to the magnetic basement, which is located beneath the fan and may be associated with the basement. The magnetic basement is located beneath the fan and may be associated with the basement.