Gas Hydrates on the Amazon submarine fan, Foz do Amazonas Basin, Brazil.

Maira Damião Tanaka, Universidade Federal Fluminense – Lagemar, Maira@igeo.uff.br.
Cleverson Guizan Silva, Universidade Federal Fluminense – Lagemar, cleverson@igeo.uff.br.
Michael Ben Clennell, Universidade Federal da Bahia.

Copyright 2003, SBGf - Sociedade Brasileira de Geofísica

This paper was prepared for presentation at the 8th International Congress of The Brazilian Geophysical Society held in Rio de Janeiro, Brazil, 14-18 September 2003.

Contents of this paper were reviewed by The Technical Committee of The 8th International Congress of The Brazilian Geophysical Society and does not necessarily represents any position of the SBGf, its officers or members. Electronic reproduction, or storage of any part of this paper for commercial purposes without the written consent of The Brazilian Geophysical Society is prohibited.

Abstract

Gas hydrate occurrences were previously reported on the Amazon Deep Sea Fan, covering an area of 28,000 km^2, in water depths ranging from 600 m to 2,800 m. In this study, these occurrences were identified based on the seismic signature of the bottom simulating reflectors (BSR) and evidence of blanking within the gas hydrates stability zone.
The gas hydrates stability zone is situated in water depths ranging from 900 to 3000 m within the upper 400 m of the sedimentary column. Two different types of hydrate occurrences were determined: one in heavily deformed substrate, in association with mud diapirs and growth faults, and other in a more gentle topographic setting associated with non-deformed to partially deformed substrate. Evidences of abrupt changes on the depth of the BSR over the diapirs, indicates the possibility of geothermal changes, which can be regarded, at least partially, to a thermogenic origin for the hydrates.

Introduction

The occurrence of gas hydrates on the Brazilian southern and equatorial margins was reported previously by Fontana and Mussumeci (1994), and Sad et al. (1998) in two large regions: the Rio Grande deep sea fan, and the Amazon deep sea fan, respectively on the southern and equatorial Brazilian continental margins.
The Foz do Amazonas Basin, on the equatorial margin of Pará and Amapá States, evolved since the Triassic, initially with the first rift stage (Brandão and Feijó, 1994; Coward, 1999) and subsequently with the thermal subsidence stage, when the passive margin sequence developed (Brandão and Feijó, 1994). The basin morphology is dominated by an extensive continental shelf and the Amazon deep-sea submarine fan, a prominent depositional feature, where more than 12.000 Km of sediments were deposited through the Amazon Submarine Canyon. The submarine fan evolved mainly after the Medium to Upper Miocene, when the uplift of the Andes resulted on the inversion of the Amazon sedimentary input towards the Equatorial Atlantic (Hoorn, 1995).
Foz do Amazonas Basin is one of the new Brazilian hydrocarbon exploration frontiers, where increasing interest started since the end of the state monopoly for hydrocarbon exploration and the initial lease of exploratory blocks during the late nineties.
Besides the interest on gas hydrates as a potential source of energy, its occurrence also poses several technological problems associated with the stability of the seabed and difficulties related to plugging of the production lines and pipelines. In this sense, the investigation of the gas hydrate occurrences on the Foz do Amazonas Basin will bring new insights to the exploration and production activities in this new frontier basin.

Methods

The gas hydrate occurrences were recognized on multi-channel seismic sections usually by the presence of distinctive parameters such as the Bottom Simulation Reflectors (BSR's) and blanking.
The location of geological and structural features, previously mapped by other authors (Brandão and Feijó, 1994; Silva et al, 1999) was associated with the hydrate occurrences, helping in the interpretation of the geological conditions controlling the hydrate formation.
The determination of the hydrates stability zone was approached using the water temperature and salinity information near the sea-bed for different depths and borehole temperatures compiled from ODP sites (Marin, 1995).

Results and Conclusions

Gas hydrates on the Foz do Amazonas Basin occur in water depths ranging from 900 to 2.500 m (Figure 1) on the upper 400 m of sediments below the seafloor. The hydrates stability zone for these depths is associated with water temperatures ranging from 10 to 20^o C for the average local geothermal gradients.
In general the identification of the hydrates on multi-channel seismic sections is clearly defined by the presence of BSR and blanking especially in areas deformed by growth faults and mud diapirs, such as in the northwest of the Amazon Canyon (Figure 2).
In slightly deformed or non-deformed strata, the seismic visualization of the hydrates is less evident, represented by a subdued BSR, cross-cutting the low-angle strata within the gas hydrate stability zone (Figure 3).
The occurrence of collapse structures on the present seabed and abrupt changes on the top of the BSR in areas of mud diapir deformation were interpreted as gas escape features probably associated with thermogenic gas migrating through the flanks of the diapiric structures towards the sea floor. More homogeneous hydrate occurrences in non-deformed strata might be related to

widespread biogenic gas formation and accumulation on the upper layers within the hydrates stability zone.

Acknowledgments

PGS do Brasil kindly contributed with the multi-channel seismic sections used on this study. The Brazilian agency CAPES sponsored the scholarship to the first author.

References

Brandão, J.A.S.L. & Feijó, F.J., 1994. Bacia da Foz do Amazonas. Boletim de Geociências da Petrobrás, v.8(1), 91-99.

Coward, M.P.; Purdy, E.G.; Ries, A.C. And Smith, D.G.; **1999**. The distribuition of petroleum reserves in basins of the South Atlantic Margins. In Cameron, N.R., Bate, R.H. & Clure, V.S.(eds) – *The Oil and Gas Habitats of the south Atlantic*. Geological Society, London, Special Publications, 474 p.

Fontana, R.L., and Mussumeci, A., 1994. Hydrates Offshore Brazil, In: Inter. Conference on Natural Gas Hydrate - Annals of the New York Acad. of Sciences, Vol. 175, 106-113.

Hoorn, C.; Guerrero, J.; Samiento, G.A.; Lorente, M.A., 1995. Andean tectonic as a cause for chandeing drainage patters in Mioceno northern south America. Geology, Vol.23(3), 237-240.

Marin, J.A., 1995. Proceedings of the Ocean Drilling Program, Vol. 155, Initial Reports Amazon Fan,. Lag . Texas A&M University. 1233 p.

Sad, A.R. E.; Silveira, D.P.; S.R.P; Silva, R.R. Maciel, Machado, M.A.P., 1998. Marine Gas Hydrate Along the Braziliam Margin, AAPG, International Conference and Exhibition, Rio de Janeiro, Brazil, 146-147.

Silva, S.R.P.; Maciel, R.R. E Severino, M.C.G., 1999. Cenozoic Tectonics of Amazon Mouth Basin. GeoMarine Letters, 18: 56 – 262.

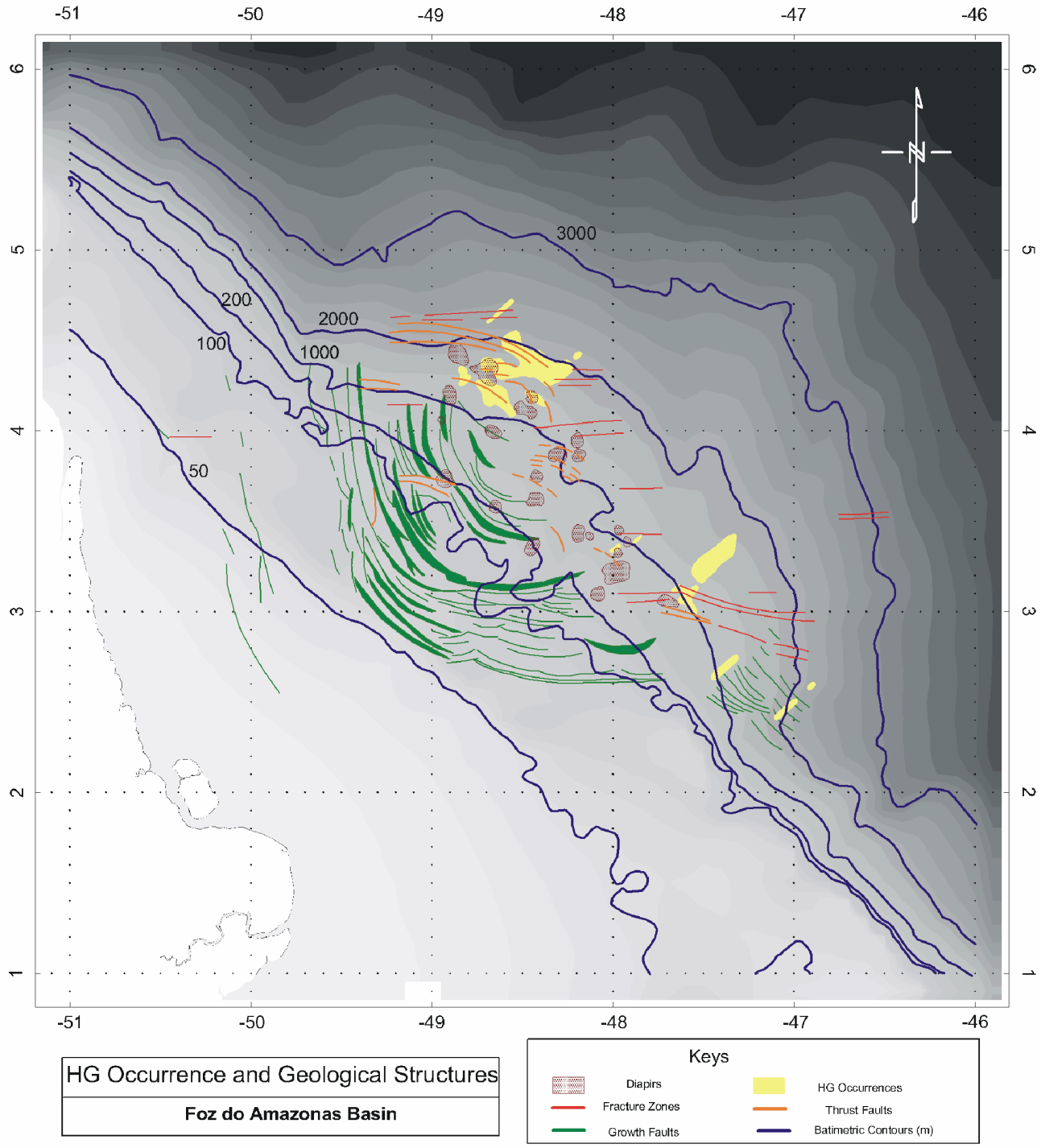

Figure 1 - Gas hydrate occurrences on the Foz do Amazonas Basin. Geological structures compiled from Brandão e Feijó (1994) and Silva et al. (1999).

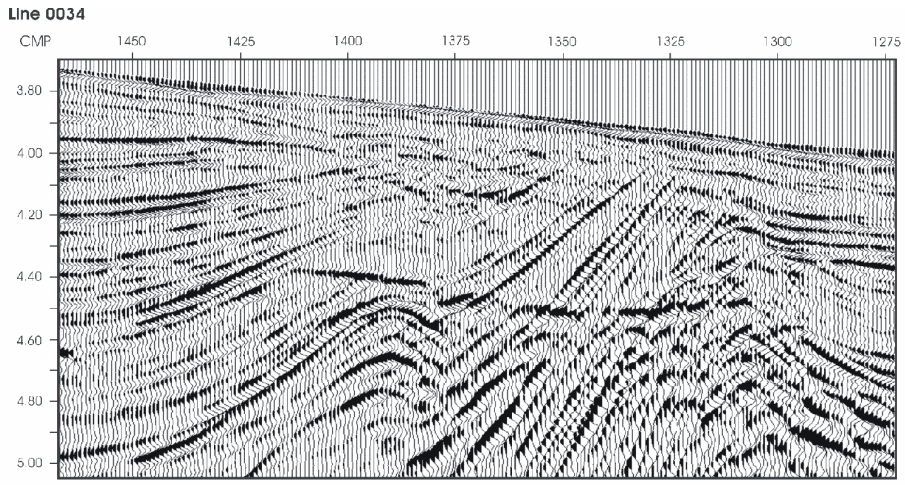

Figure 2 - Gas hydrate occurrence, denoted by the BSR, in association with a large mud diapir on the western half of the Amazon deep sea fan.

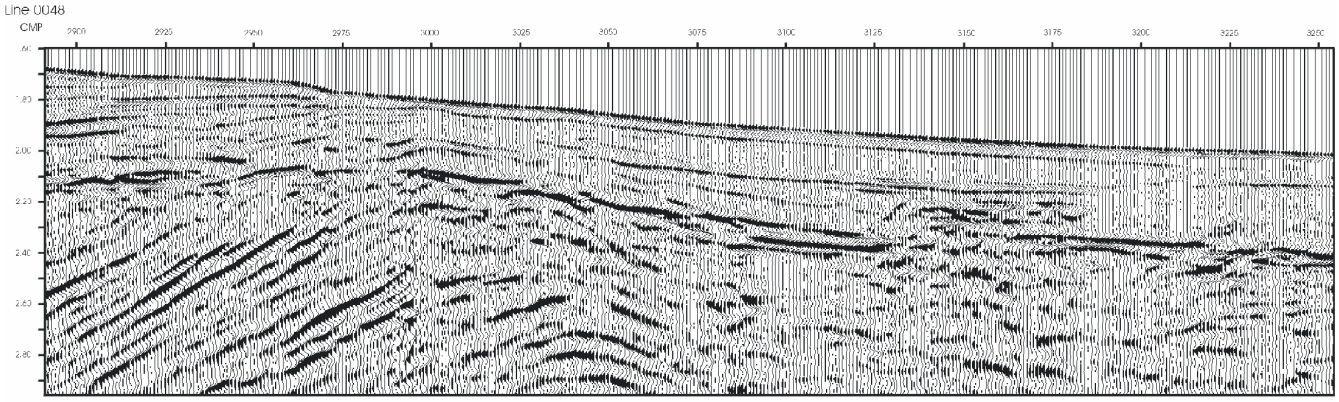

Figure 3 - Gas hydrate occurrence in the eastern half of the Amazon deep sea fan in an area partially deformed by a mud diapir. The visualiztion of the BSR is difficult in the upper continuous reflectors.