Canal do Varador, Amapá, Brazil – Saturated gas sediments as seen on high resolution shallow seismic.

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Abstract

Propagation of acoustic waves in sediments using high-resolution seismic surveys, is strongly influenced by gas. Therefore, high resolution seismic provides evidence for gas accumulation within shallow seafloor sediments. The aim of this work is present patterns of sediments saturated with gas. The data were obtained in Canal do Varador, Amazon shelf at the Estação Ecológica Maracá-Jipioca (EEMJ). The survey carried out with a subbottom profiler using the frequency range of 0.5-6 kHz and the results shown two pattern of gas accumulation: acoustic turbidity; and acoustic curtain.

Introduction

According to Davis (1992) since the fifties, anomalies presented on echosounder and sidescan sonar records, was interpreted as indicative of gas escaping at the seabed, and the integration of the high resolution seismic provided more conclusive evidence for gas accumulation within the shallow seafloor sediments.

In Amazon shelf, evidences of shallow gas on seismic were shown by Figueiredo Jr *et al* (1996) in their study about Gas-charged sediments in Amazon submarine delta.

On the coastal zone, Silveira (1998) observed gas accumulation in a vibracore hole on the north margin of the Cassiporé river.

In the Canal do Varador a seismic record was described by Silveira (1998) as gas charged and in this paper identified as acoustic turbidity.

The propagation of the acoustic waves in sediments, with the frequency used in the high-resolution seismic surveys, is strongly affected by the presence or absence of gas (Wilsen & Richardson, 1998). Furthermore, the attenuation of the acoustic wave energy is significant even on small gas concentrations (FU *et al*., 1996).
The aim of this work is to present patterns of gas saturated sediments in Canal do Varador.

Study Area

The Estação Ecológica Maracá-Jipioca (EEMJ) is a conservation unit inserting in the north of Brazil, locate in the Amapá City in the State of Amapá. The EEMJ has an area of 2000 km² and is compose by the islands of North Maracá and South Maracá, Canal do Varador and Canal do Turluri, the Flexal river's mouth and the Atlantic Ocean (SANTOS, 2016a) (Figure 1).

The Canal do Varador which separates Maracá islands from the continent, is located on north of Amazon River's mouth, on the interface between Amazon Coast and Amazon Shelf (Figure 1). According to Geyer et al. (1996) the Amazon shelf is subject to energetic forcing, including semi-diurnal tides, large buoyancy flux from the Amazon River discharge, wind stress from the northeasterly Trade Winds and an along-shelf flow associated with the North Brazil Current. These characteristics providing an extremely dynamic environment.

Method

The data used in this study was collected during a survey conducted in July 2016 on Canal do Varador in the vicinity of Maracá Island, Amapá State. The seismic lines (SL) were planned along the Canal do Varador, in order to cross paleodrenages observed on the Maraca Island and the continental region (SANTOS *et al*, 2016c). Three seismic transversal lines (STL) to the channel was used for control (Figure 1B). The seismic data were collected in continuous mode using a SB512i Subottom Profiler System integrated to two floats fixed to the tow vehicle distanced 12 to 16 meters from the ship. The frequency ranges during acquisition was 0.5-6 kHz and chosen after numerous field tests (SANTOS *et al*, 2016c). A GPS Garmin 60CSx was connected to the seismic data recording system, in order to locate the seismic lines, and a GARMIM echosouder to evaluate the depths recorded by the Subbottom Profiler.

Before mounting the system, the vessel was docked, following the methodology indicated in NORMAN 25 of the Directorate of Hydrography and Navigation of the Brazilian Navy (2014).

Field navigation was performed in real time on the planned lines and using a processed Landsat 7 ETM+ satellite image. Ten seismic lines were collected, totaling approximately 85 km of profiles.

The data were processed using the Software Reflex Win 8.1 (SANDMEIIER, 2014) and the flow was composed by five steps: importing the *.JSF data; remove header gain; time cut; deconvolution; and average XY-filter. The

purpose of this processing was to preserve and correcting distortions in the seismic profile, attenuating noises from external sources that may interact with the acoustic pulse.

The interpretation was based on seismic signature of evidence for presence of gas (DAVIS, 1992).

Results

Considering the seismic signature, on macroscale features, were mapped occurrence and gas accumulation along the Canal do Varador.

The most common gas accumulation in Canal do Varador, on high-resolution seismic profiles, were acoustic turbidity. Acoustic turbidity or gas masking are patches on seismic data where reflections are absent, this effect refers to absorption of acoustic energy by a body of trapped gas in sediment (DAVIS, 1992). According to Frazão and Vital (2007) that gas occurrence gives an enhanced superior reflector and masking the underlying strata (Figure 2A).

The lateral extension of these gas accumulation, in the seismic data collected on Canal do Varador, has a range from 130 m to 4300 m. In seismic profile SLT 02, an acoustic turbidity, with approximately 550m of lateral extension, masking the underlying limits of a feature which we interpreted as a paleochannel, was observed (Figure 2A). The acoustic turbidity was found in the seismic profiles near the North Maracá.

Another form of seismic manifestation of gas, found in Canal do Varador, were acoustic curtain (Figure 2B). Taylor (1992) describes acoustic curtain as a feature with convex or chevron-shaped upper boundary and masking completely the underlying seismic record (Figure 2B).

The acoustic curtain found, had lateral extensions between 13 m e 78 m, near the Ponta da Pescada in the Maracá Norte and near Igarapé Tijolo. This type of accumulation is similar to the mushroom or inverted U-shaped type of Karisiddaiah *et al.* (1993), curtains of Taylor (1992), acoustic curtains of Garcia-Gil *et al.* (2002) and gas curtain of Baltzer *et al.* (2005), in the marine environment.

The Canal do Varador is a favorable environment for the occurrence of gas, due to the high concentration of organic matter in the area and muddy sediments from the Amazon River. As, according to Fleischer *et al.* (2001) areas with rapid accumulation of fine-grained muddy sediments, rich in organic matter provide an ideal environment for the formation of biogenic methane.

Conclusions

In this work were presented the results of the survey and processed of the seismic profiles, collected in an area with high concentration of organic matter and muddy sediments from the Amazon River.

The high-resolution 2D seismic data, acquired with a Subbottom Profiler System and processed using REFLEX WIN, shown two pattern of gas accumulation in Canal do Varador: acoustic turbidity; and acoustic curtain. These results corroborate the importance of using the high resolution seismic technique in mapping of sedimentary environments.

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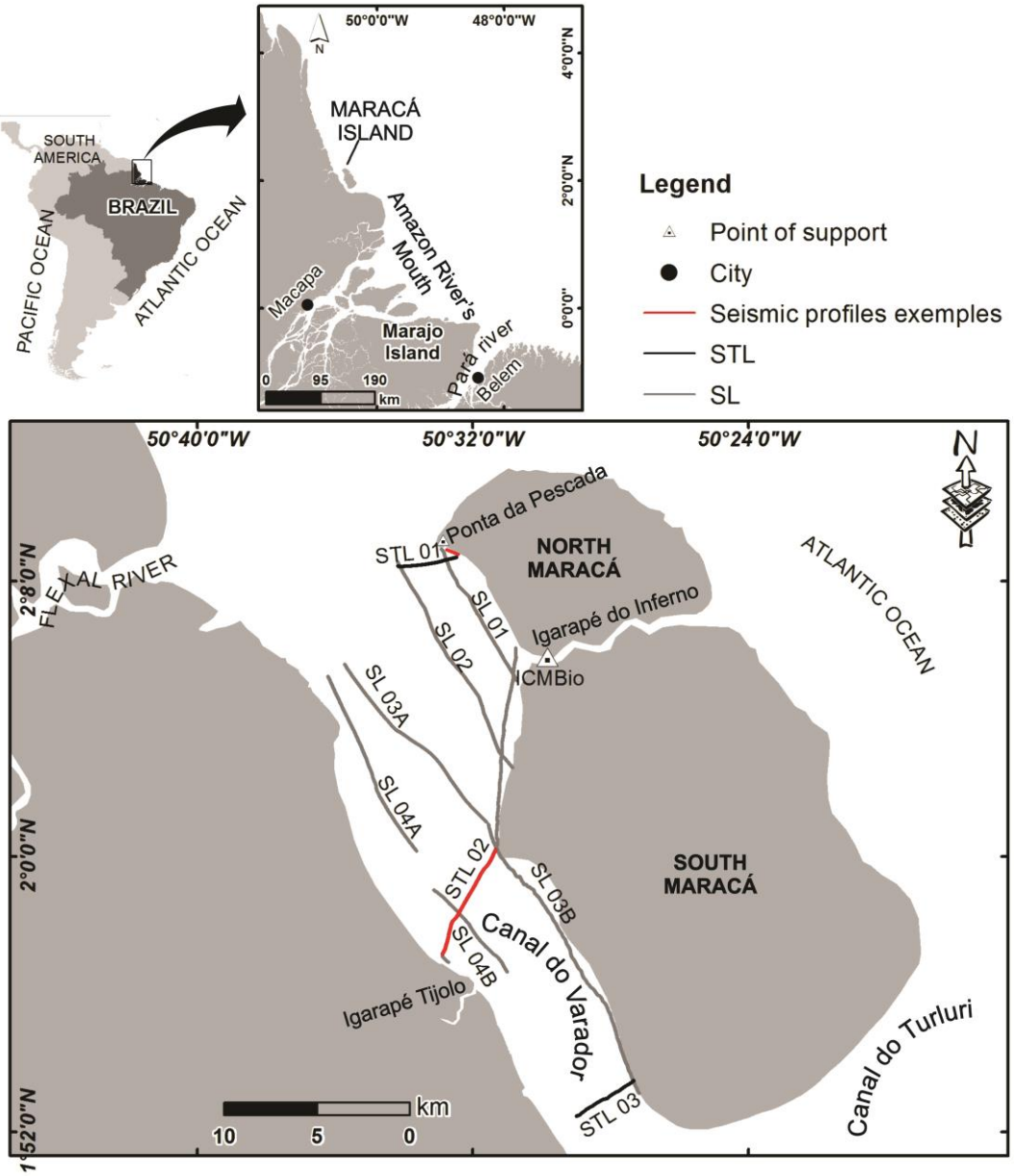

Figure 1: Map of study área showing the location of seismic profiles in Canal do Varador and position of the seismic profiles (red lines) used as exemples of gas charged sediment pattern. [Data source: SANTOS et al., 2016b; Position of seismic lines from GPS data survey].

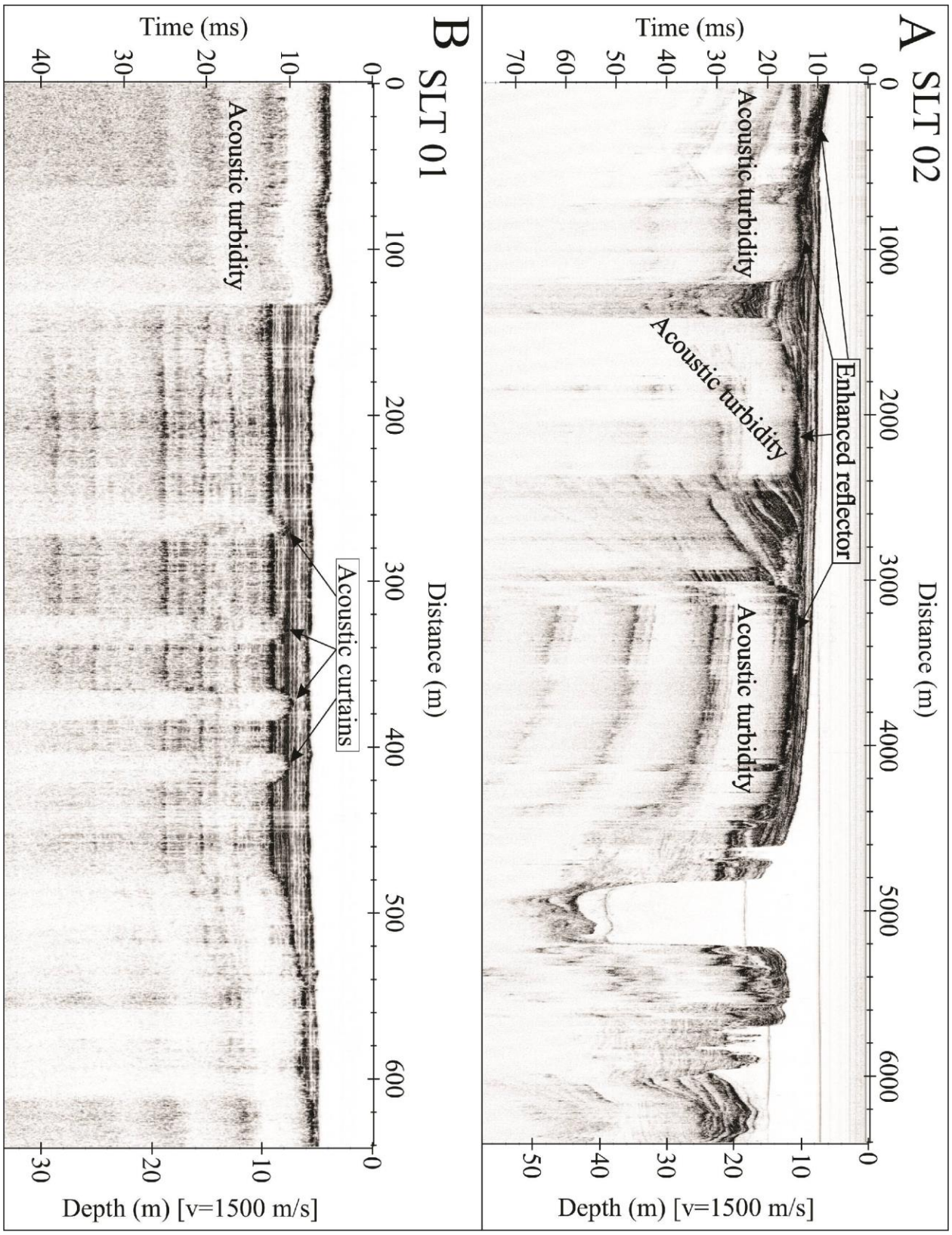

Figure 2: Seismic sections showing gas charged sediments in Canal do Varador: (A) Acoustic turbidity; and (B) Acoustic turbidity and acoustic curtains.