Methodological development and identification of Oceanic processes from the Seismic Oceanography in Tropical West South Atlantic.

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Abstract

Seismic oceanography comes as a tool for obtaining thermohaline data using data from the petroleum industry. During seismic processing for the entire oil industry seismic data corresponding to the water column is discarded which corresponds to approximately 25%. of the total data. Seismic processing to obtain thermohaline or oceanic structures conventional processing due to the characteristics of the seismic reflectors already that the differences in acoustic impedance values different from conventional seismic which makes the process more cautious to preserve the seismic signal. This work to map the thermohaline structures from exploratory seismic data and to define an effective methodology for this mapping. The methodology used will be based on the conventional seismic processing but always doing an analysis, which can generate a so that there is no distortion of the signal. use of single-point decomposition for direct wave removal. During processing we can see that Many changes were made mainly in the choice of a correct gain, since the automatic gain was reinforcing the reflectors below the ocean floor and other usual gains were not good. Processing for reflections in the water column was effective and it was possible to observe the thermohalines and internal waves after stacking.

Introduction

Seimic Oceanography promotes the imaging of the oceans column(or thermohalines structures) with a highter resolution than conventinal methods. Based on the difference of acoustic impedance when subjected to a contrast of salinity and temperature. The

Accoording to (Holbrook et al., 2003),(Biescas et al., 2008), and (Wood et al., 2010) increased horizontal resolution is two orders of magnitude compared to conventional methods using profiling CTD (Condutivity,Temperature and Depth) and XBT (Expendable BathyTermograph). Thus, the seismic reflection has emerged as a new tool to study the ocean on a large scale, as the extensive global file of marine seismic data is a major untapped resource for drilling structures in the water column, thereby assisting oceanographers to view and identify the structures in the water column with unprecedented resolution.

The result will be relevant under all Oceanography areas(include Physics, Biology or Chemistry), due to the impacts that these structures have in all oceanic processes, it is also possible to know and determine the sedimentary evolution and dynamics of the basin. The Jequitinhonha basin was chosen as a study area due to its characteristic of being a natural laboratory, has a geological context that is well defined within the continental margin, where it will be possible to study processes of the Quaternary acting.

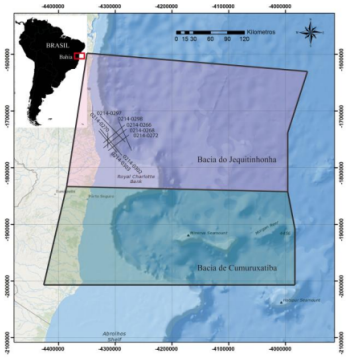


Figure 1: Location of the study area on the Tropical West South Atlantic

In Brazil still is little explored Seismic Oceanography and only (Barão et al., 2017) sought to advance this knowledge to the Santos Basin, which shows an under-utilization of seismic data collected by the oil industry, as to discard the water column during processing about 15 to 30% of the acquired data is deleted.

This study aims to fill this gap. The overall objective of the project is to expand the methodological development of seismic signals and establish a data processing routine in order to increase the resolution and thus characterize oceanographic structures, mesoscale, in the region of Bahia Continental Margin, NE Brazil.

The working hypotheses are:

- The reflection seismic method are capable of detecting variations in the oceans termohalina structure, when analyzed mesoscale;
- Structures thermohaline with currents in oceans, are largely responsible for the transfer of heat and power between the various bodies of water and responsible for the fertilization and carbon assimilation, and can be observed and described using the Oceanography Seismic.

Methodology / Problems Investigated

After the Seismic lines were initially selected from the Exploration and Production Database (BDEP) set by the National Petroleum Agency (ANP) . This set of raw data, unprocessed, are the basis for the initial phase which is the processing and analysis of signals that follows the traditional method of seismic processing with adjustments due to the medium study difference and lower contrasts amplitudes.

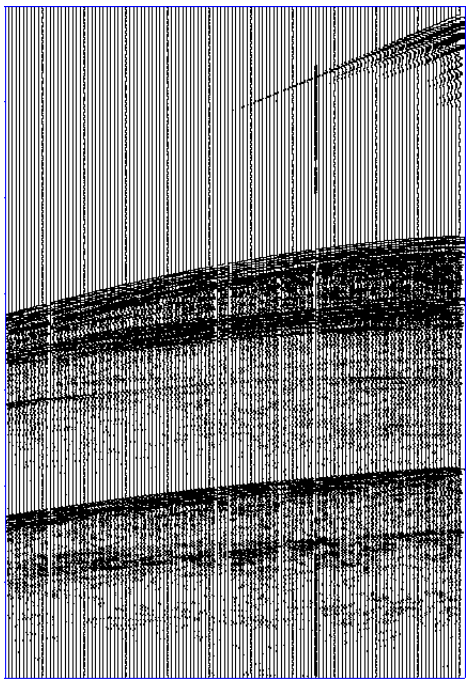


Figure 2: Shot gather record of Line 0214-0266 Jequitinhonha Basin

The seismic data processing was done by software Seismic Unix, which has an open source package developed by Center for Wave Phenomena and using fortran codes to apply method that dont have at Seismic Unix package.

In detail, the processing flow will be:

- Geometry : at this step we Define the coordinates of the source and receives, as well as the coordinates of CMPs (Common Midpoint, Offsets), fundamental mainly to do stacking lines.
- Editing and mute: In this step all the noisy part is removed, like data above the direct wave and receptors or shots with problem, we remove the seismic data below the seabed.
- Gain: Stage responsible for a better visualization of the data, because it corrects the spherical divergence and energy absorption of the wave.
- SVD filtering: Use of the decomposition method in values singular, or simply SVD, used to remove the direct wave and reverberation events from the energy at the water surface. This step is very important for the processing because the data is above the direct wave, so is necessary using a method what keep the closest reflections well.
- CMP organization: In this step the data will be organization from the common mid-point to make the sum of the line amplitudes of the same point under study.
- Velocity analysis: This step is very important so that a good stacking is obtained and thus a good differentiation of the thermohaline layers. seismic data redundancy when the CMPs are and layer speeds are correctly associated factors makes it possible to increase signal-to-noise ratio that facilitates noise reduction random effects.
- NMO correction: Correction made for linearization of the hyperbolic curves obtained through the reflections of the waves,
- Stacking: In this step the arithmetic mean of the traces obtained after the corrections, after this step it is see the layers and their behaviors.

Results and discussions

In the stage of geometry did not occur difficulties, since to identify defective shots and receivers there is not a challenge. For the mute stage and editing there was no difficulty, it was only necessary to observe where the ocean floor begins, so that below it the data are zeroed.

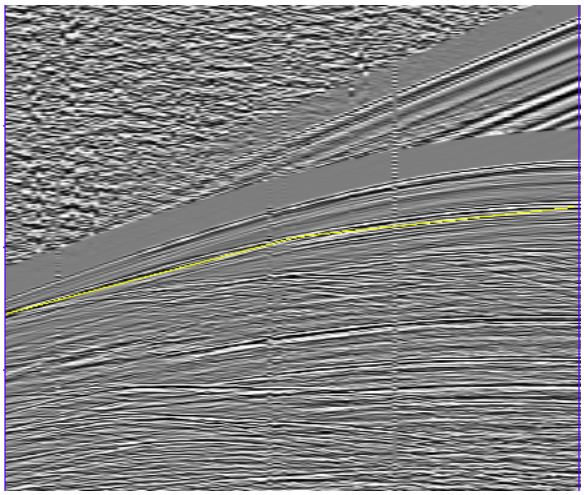


Figure 3: Muting applied bellow the oceanfloor

The first stage in which the first problems occurred was in the application of a gain which was effective for resolution of the reflections in the water column. The automatic gain or gaussianico with mobile window was not efficient, because it is observed that there is a loss of the resolution of the data in the proximity of the oceanic floor (figure 5) compared of the figure 4, even using small movable windows which could also cause an increase in the noise of the data and the exponential gain did not was effective to improve the water reflection.

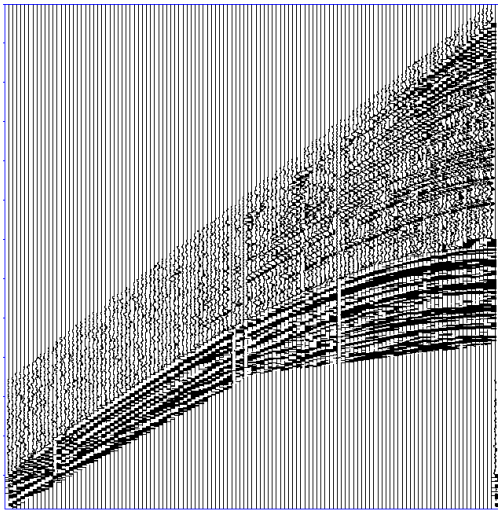


Figure 4: Shot gather record 1500 Line 0214-0266 with mute bellow the ocean floor

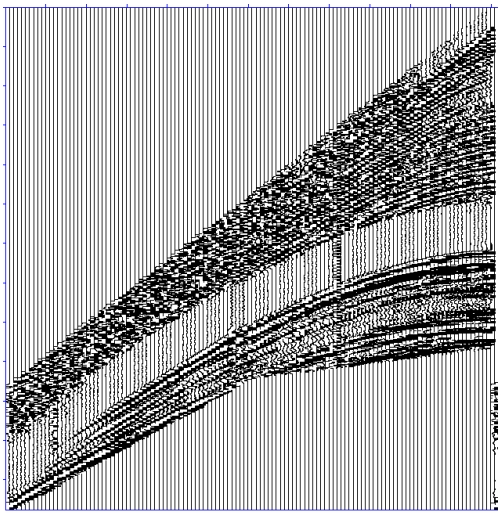
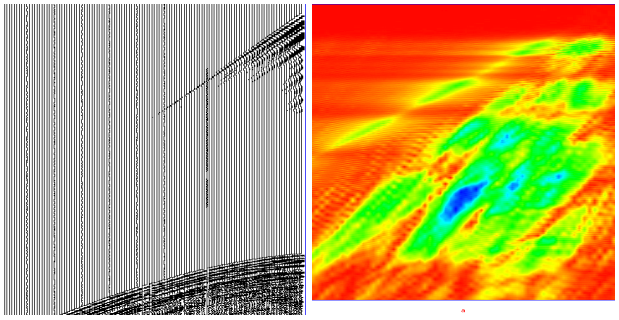


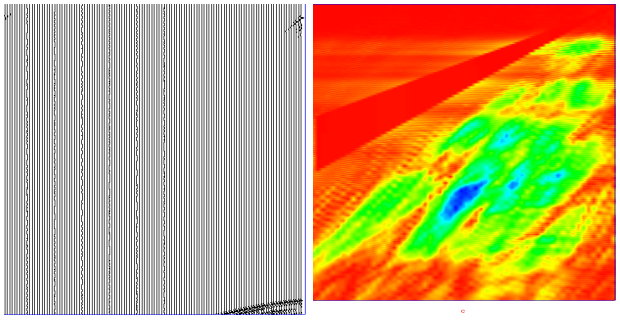
Figure 5: Shot gather 1500 Line 0214-0266 muted with a AGC

To remove the direct wave, for all depth water column the SVD was very effective to removing almost all direct wave and even other linear events such as reverberation of the water surface (Figure 7) compared with de original data(Figure 6).Just in the closed offsets the removing was not good at the begin of data. The FK filter did not was good to remove direct wave because also remove the ocean reflection data (Figure 8).



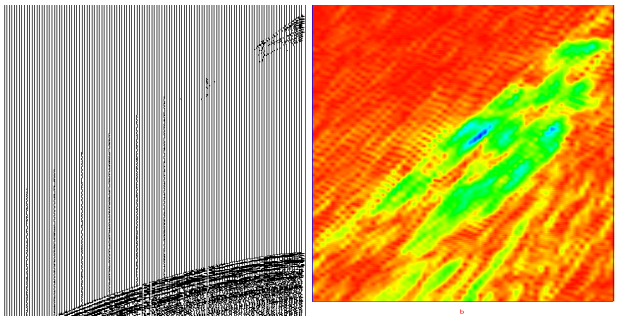
(a) (b)

Figure 6: (a) Shot gather 1500 Line 0214-0266 (b) fk spectrum of shot gather 1500 Line 0214-0266.



(a) (b)

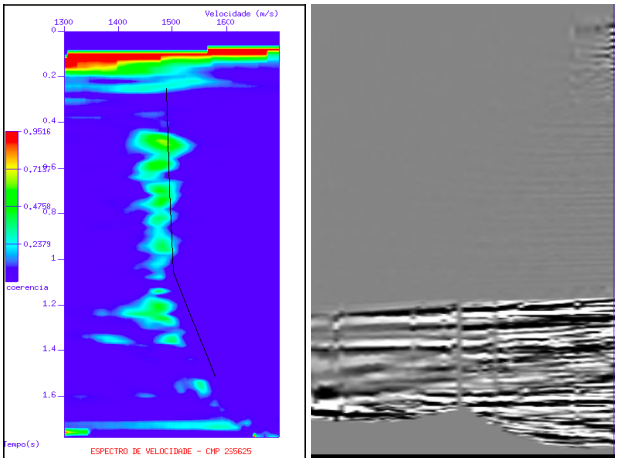
Figure 7: (a) Shot gather 1500 Line 0214-0266 after fk filter (b) fk spectrum of Shot gather 1500 Line 0214-0266 after fk filter.



(a) (b)

Figure 8: (a) Shot 1500 Line 0214-0266 after svd filter (b) fk spectrum of Shot gather 1500 Line 0214-0266 after SVD filter.

For the velocity analysis, it was necessary to choose a velocity spectrum between 1300 and 1700 m/s, so that the velocities of the thermohaline structures were close. So when this determined that the speed range of analysis was not difficult but exist a velocity inversion zone at the data what we can not put because a limitation of the software that don't work with velocity inversion zones(Figure 9a), facilitating both the NMO correction for which the automatic seismic of the Seismic Unix Package was not used and a manual dumb was done so that we could better observe the situation of the reflectors.



(a) (b)

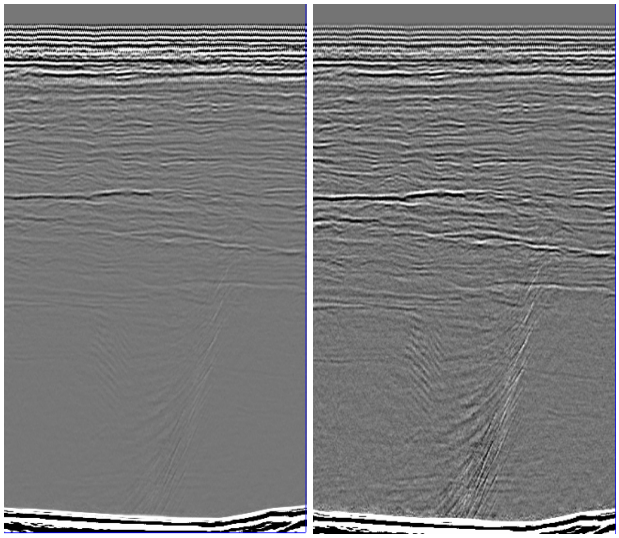
Figure 9: (a) Semblance Velocity Spectrum of a Shot gather record 1500 Line 0214-0266, inversion zone at 1,2s (b) NMO correction of a Shot gather 1500 Line 0214-0266

For improve the resolution of water reflections was used the spherical divergence correction that use the velocity field to calculate the distance with the journey time,velocity and offsets and apply a better corrections, and it was the better way to improve the reflectors.

Conclusions

It was possible to observe that the methodology works for the identification of the thermohaline structures and that it is still necessary an improvement in some steps like a gain, what is a crucial step for during processing, to use before the velocity analysis for a better visualization of the reflector and take a better velocity camp, however, with this processing it's possible to see a Oceanographic phenomenon called by Internal Waves (figure 10, see (Oliveira, 2019) for an overview) and it will be confirm with a processing of another Seismic Sections.

It is also necessary to improve the NMO correction to support the zones of inversion of velocity that are corresponding the zones of oceanic mixture, thus obtaining better reflectors it is possible to know better these zones and in the future to generate better inversions. The other steps of the processing were made easy without major problems so we can observe the great importance of the previous steps for the best extraction of the thermohaline structures.



(a) (b)

Figure 10: Comparation of (a) Stacked Section of Line 0214-0266 (b) Stacked Section of Line 0214-0266 after spherical divergence correction. This image showed few oceanographics structures like as superficial mixed zone (on top), thermocline (medium) and internal waves on the bottom.

Acknowledgements

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