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Accelerating Sub-Bottom Profiler Interpretation using Machine Learning Techniques – In Deep Water Campos Basin

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Abstract

This study investigates the application of machine learning to 2D Sub-Bottom Profiling (SBP) data for geohazard assessment in the Campos Basin. A total of 226 SBP lines were converted into a Volume Data Storage (VDS) format and labeled into three stratigraphic classes: water column, mud layer, and mass transport deposits. A convolutional neural network (ENET) was trained to propagate these interpretations across the dataset. Results showed effective stratigraphic classification, reliable facies detection, and a significant reduction in interpretation time - from months to days. The approach demonstrates promising potential for improving efficiency and accuracy in offshore subsurface mapping using SBP data.

Introduction

Sub-Bottom Profiler (SBP) data is commonly used in oil and gas industry to support geohazard assessment and offshore studies like detail subsea engineering installation facilities to develop oil fields. These projects regularly have several lines and present specific parameterization to highlight shallow features, which makes the interpretation process both time-consuming and challenging.

Machine learning (ML) in seismic analysis can reveal intricate patterns and features, identifying anomalies that might be overlooked in traditional interpretations or speed up the interpretation process. The algorithms of machine learning are predominantly applied to 3D data rather than 2D due to the required preprocessing, that becomes more complex.

The use of VDS (Volume Data Storage) enabling optimization of large datasets retrieval and preprocessing. By providing a structured framework using brick format, fast slices, and random access, VDS allows the use of 2D data, enhancing the ability of machine learning algorithms to access and analyze seismic information quickly and effectively.

The aim of this work is to use 2D Sub-Bottom Profiler data to analyze the ability to use machine learning techniques on this type of data, helping the interpretation and improving the time it takes to interpret this data.

Method

Two hundred twenty-six *Chirp* (2-16kHz) SBP lines were acquired from AUV-Autonomous Underwater Vehicle in Campos basin deep waters and converted into a single VDS. This VDS was fed into supervised deep learning software using interpreter's labels as input and running a convolutional neural network created for the data needs, allowing maximum control of the results. ENET networks were created and 8% of the seismic was labeled to separate three classes: water column, mud layer and mass transport deposit. This network was trained for 9 epochs, resulting in a VDS probability cube for the three classes and horizons of each of them, covering all the SBP lines. The probability cube can be converted back to SEGY, and with the horizons, it can be used in other applications for further analyses.

Results

The mapping carried out followed a user-friendly approach, where a conceptual geological labeling model was previously established by the human interpreter, separating the different acoustic ecofacies indirectly associated with classes of layers or acoustic deep-water stratigraphic classes, which were identified and delineated using colors and painted on about five SBP lines (Figure 1).

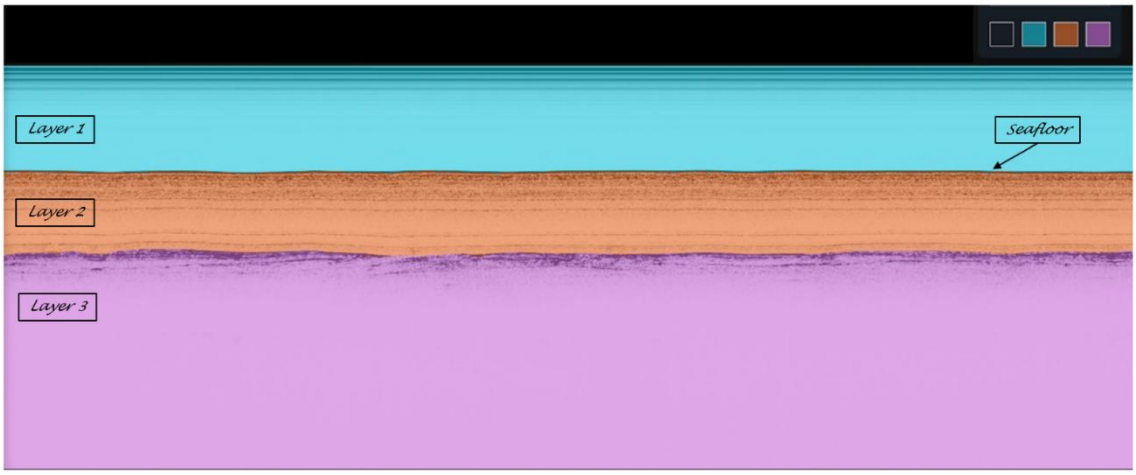

Figure 1: SBP section with layer labeling in deep-water field in the Campos Basin.

Based on the conceptual geological model established by the interpreter, the inferences were formulated and propagated to the other lines of SBP data (Figure 2). It is worth noting that some adjustments were necessary for the redefinition of the layers, through the re-editing of the annotations in the SBP sections, especially in cases where similar aspects were present in the mapped ecofacies, which in practice led to the generation of 'gaps' associated with errors in the inferences over small stretches, easily visible but causing disparity in the interpretation of the ecofacies.

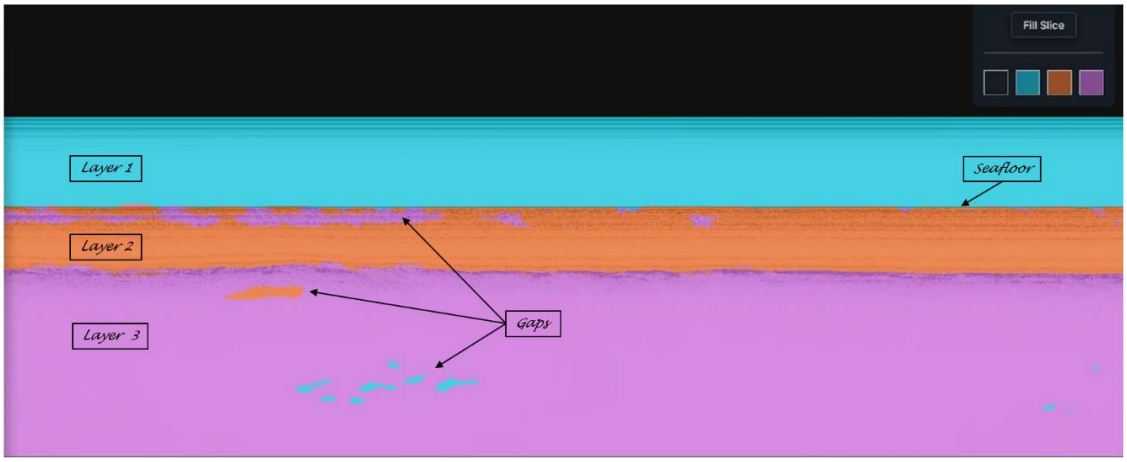

Figure 2 – SBP section with inferences and layer tracking with some “Gaps” in the Campos Basin.

Conclusions

The main results presented were the agility in scanning and propagating the inferences; good detection and effective separation of stratigraphic classes; and a drastic reduction in human interpretation time when compared to the method applied, decreasing from 1 to 2 months to just a few days. Overall, the employed tool yielded very satisfactory results, and the preliminary approach for mapping the layers for geohazard assessment proved promising in the detection and traceability of the ecofacies in the investigated SBP sections.

Acknowledgments

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