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# Definition of Analogous Wells Using Pre-trained Transformers Networks: An Application in the Pre-salt of the Santos Basin

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## Abstract Summary

In geology the use of analogous is common to understand characteristics that cannot be observed in the subsurface. The objective of this work is to find analogous reservoirs based on features observed in 2D seismic sections using a pre-trained Artificial Intelligence model. The data used was a spreadsheet with information from wells, public seismic data and phyton libraries to generate cropped 2D seismic sections for each well. The architecture aimed to build latent representations and rankings of analogous wells were obtained using similarity metrics. For reservoirs with positive features, the results were coherent, indicating mostly wells with architectural elements of mounds and buildups. For reservoirs with parallel to subparallel reflectors, reservoirs with the same predominant configurations were indicated. The results were satisfactory and can help to obtain analogous wells in the seismic scale.

## Introduction

The use of analogous wells is common especially in the exploration of new frontiers. In the development and production stage, properties of analogous wells feed 3D geological models. Moreover, identifying wells that have already drilled similar situations can be an important step in reducing project risk.

Currently, the selection of reservoir analog wells in the Pre-salt relies on the experience and memory of the geoscientist and auxiliary tools. The overall objective of this work is to find analogous reservoirs based on geometry, depositional architecture and seismic patterns observed in 2D seismic sections using a pre-trained Artificial Intelligence model.

In the Pre-salt of the Santos Basin, the main reservoirs are the carbonates of the Barra Velha Formation, followed by the coquinas deposits of the Itapema Formation. The former commonly exhibit seismic facies with parallel to sub-parallel reflectors along the inner shelf (Moreira et al., 2007). Locally mounds and buildups develop with chaotic or non-reflective internal seismic facies (Carlotto et al., 2017, Rostirolla et al., 2021, Araújo et al., 2022). The coquinas of the Itapema Formation are important reservoirs in the Búzios and Mero fields. These may present seismic facies configurations with well-defined progradations, sometimes with a chaotic pattern (Carlotto et al., 2017, Araújo et al., 2022) or even parallel to sub-parallel reflections (Moreira et al., 2007, Araújo et al., 2022).

## Method

The data used was a spreadsheet with coordinates and depth of the base of the salt marker from the wells and eleven public seismic data covering the main fields of Santos Basin (Figure 1). The segyio and pandas libraries were used for indexing the seismic data, and the library seismictoolkit was employed to generate four cropped 2D seismic sections for each well within the pre-salt reservoir interval. The dimensions of the mounds and buildups (Petrobras 2020) assisted in defining a fixed window of interest around the wells. The misties at the base of the salt were disregarded in this work, as well as any limitations regarding the quality of the seismic data, such as event focusing and seismic illumination issues. The method treated the wells as vertical.

The weights that were used came from Petrobras's foundational seismic model using DinoV2 Transformers network. Self-attention matrix could be visualized for each seismic image. The architecture aimed to build latent representations of the seismic images to assemble a collection

of these representations. Finally, a comparison is made using similarity metrics and rankings of analogous wells were obtained.

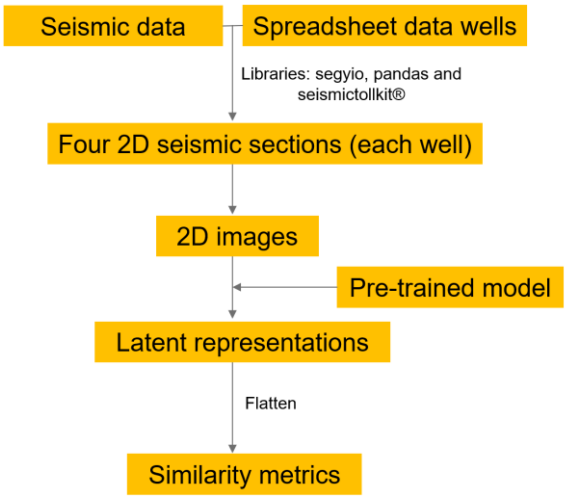


**Figure 1:** Methodology flowchart with the main steps of this work. Cosine similarity was the metric used to get the ranking of analogous wells.

## Results

Ranking of analogous for two wells with different external geometries and seismic patterns, consequently, reservoir characteristics are presented in Figure 2.

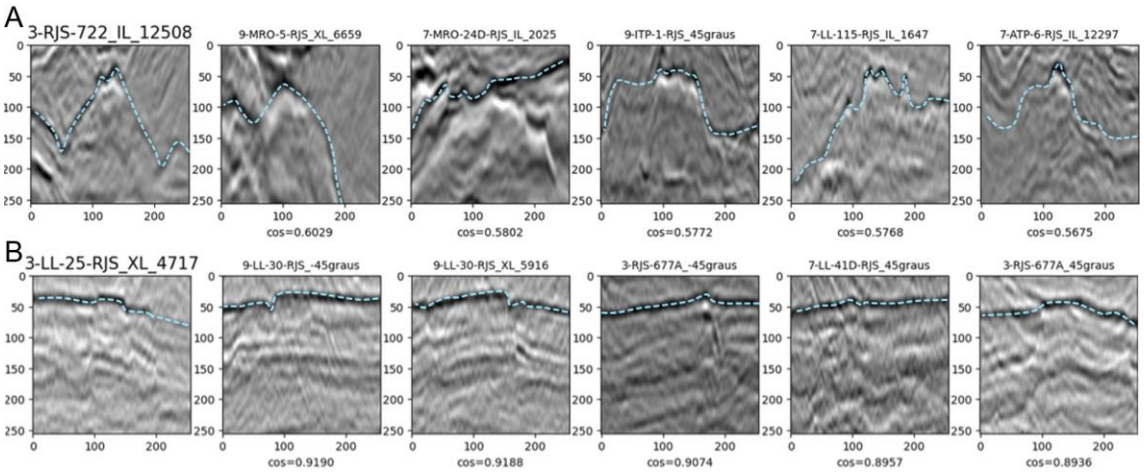


**Figure 2:** Ranking with five analogous wells. A) Buildup 3-RJS-722 (Atapu field). The wells pointed out as analogous 9-MRO-5-RJS, 9-ITP-1-RJS and 7-ATP-6-RJS have mounds or buildups architecture (Petrobras 2020). B) 3-LL-25-RJS, Tupi field, parallel and subparallel reflections patterns.

## Conclusions

For reservoirs with positive features the results were coherent, indicating mostly analogous wells with architectural elements of mounds and buildups. For reservoirs with parallel to subparallel reflectors, reservoirs with the same predominant configurations were indicated. The results were satisfactory in recognizing the internal configurations and the external shape of the pre-salt

reservoirs and the networks can assist in the selection of analogous wells. Complementary studies comparing facies associations, depositional domains or reservoir properties may reinforce this statement.

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