Usage of deep learning techniques to recognize and map shallow faults at Albacora Leste Field.

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Abstract

The Albacora Leste field is a mature Deepwater Oil and Gas field in Brazil, located at a geologically active environment, the Campos basin continental margin, and constantly being re-developed with sub-sea installations in place. The field was discovered in 1986 and started operations in 2006 in water depths between 1,000 and 2,150 meters. It is the site of intense re-development by PRIO, producing approximately 30,000 barrels/day of heavy Oil. Albacora Leste is geographically located in a present-day geologically active environment at the slope of the Campos basin continental margin. Fault systems extending to or near the seafloor are dangerous to sub-sea equipment and drilling operations. The goal of this study is to evaluate if a deep learning methodology can aid in detecting the shallow faults, and to assist mapping faults with the accuracy needed for secure sub-sea operations.

Mapping all faults in detail in the needed timeframe is humanly impossible. Until recently, the only viable option has been using seismic attributes to identify the faults. This methodology has proven effective, but it has the limitation of not generating interpretation objects that can be added to earth models. By choosing a supervised deep learning approach to have the maximum possible control on the results and created our convolutional neural networks (CNNs) developed specifically for the Albacora Leste field. After extensive trial and error, it was discovered that the results of the CNNs could be improved by limiting the work area to the Neogene and Quaternary sequences only, creating a stratigraphic mask, and geographically dividing the Albacora Leste field into three areas with vertical masks to constrain the CNNs to areas of interest AOIs.

We created three modified ENETs, one for each area of interest (AOI). AOI-1 0.09% of the seismic lines were labeled, a network trained for 25 epochs, and 277 faults were mapped. AOI-2 0.06% of the seismic lines were labeled, a network trained for 16 epochs, and 855 faults mapped. AOI-3 0.12% of the seismic lines were labeled, a network trained for 30 epochs, and 1506 faults mapped. The geometries of the recent faults have enough variability in Albacora Leste that limiting each of the 3 CNNs to specific stratigraphic sequences in our study Neogene plus Quaternary and limiting geographically to specific structural styles has led to the best results when compared to the seismic.

The methodology has proven effective in mapping the faults, revealing several other structural fault behaviors at some parts of the shallow area of the field that are different from the preferential NE-SW Campos basin fault trend. However, not only do earth models today still struggle to work with thousands of faults, but another challenge is related to quality control and validation by the interpreter of all the amount of data generated through the CNNs prior to their usage in further steps of G&G evaluation and quantifying their geological impacts.