Seismic Characterization of Complex Salt Dome Structures using Machine Learning

Osama Alsalmi, Saleh Dossary, Gino Ananos

Saudi Aramco

Abstract

Salt dome interpretation is an important step to unveil the hydrocarbon potential in seismic exploration. By virtue of low permeability and high ductility, salt is an efficient caprock with the potential to hold hydrocarbon underneath. Traditionally, salt is interpreted manually by an expert; however, with the growing size of seismic data this approach proves inefficient. Moreover, bias may be introduced by the interpreter making the interpretation less accurate. To overcome these limitations, we propose a new approach to characterize salt domes in seismic sections using machine learning. Convolutional Neural Networks (CNNs) gained popularity in image segmentation tasks. In this study, a machine learning model based on U-Net architecture is used to segment salt bodies from seismic data. This architecture is characterized by both contracting and expanding paths. In the contracting path, several image size reduction operations are performed to allow for feature extraction at multiple resolutions. Conversely, in the expanding path, the image is restored to its actual size regaining spatial information. To further enhance the robustness of the model, several augmentations (slight image alteration) were introduced including rotations, brightness change, and random resize. The model is tested on two datasets, SEG SEAM, and F3 North Sea. The SEAM dataset is simulated data using complex salt body geometries and sedimentary surfaces, while the F3 dataset is a 3D seismic dataset acquired in the North Sea for the purpose of exploration and can be accessed publicly. Results from our study show high fidelity (87% intersection over union on average) in salt characterization in these two different seismic datasets. Our approach is efficient, automatic, and bias free.