Deep Dissolution facies inference in borehole images carbonate reservoirs by Auto ML

Luciana O. Dias, Bernardo M. O. Fraga, Clecio R. Bom, Márcio A. Silveira, Ana Paula O.Muller, Candida M. de Jesus, Elisangela L. Faria, Marcelo P. Albuquerque, Márcio P. Albuquerque

Reservoir characterization is an important task combining information from a variety of sources to build a comprehensive geological and petrophysical model. After perforation, the first analysis uses information from the logging tools. Using an ensemble of different mathematical models it is possible to make a description of the physical properties and structures of each layer. This information can help understand how the reservoir was formed, and help engineers and geophysicists describe the fluid dynamics of the well. The most usual sources of information are acoustic and microresistivity images, velocity models from seismic data and magnetic decay. Analyzing this quantity of information is a long task, which may take years; however, it is an essential piece of information to assess the feasibility of exploration. The reservoir characterization is done by a team of highly experienced experts combining and analyzing data from several sources to reach a conclusion. In the Brazilian pre-salt region, especially, the heterogeneity of the carbonate reservoir presents an additional challenge, and there has been a continuous effort to overcome these difficulties regarding large-scale production. Interpreting the intensity of dissolution on a given depth interval is an important step in studying a reservoir, as it can indicate the occurrence of extra-matrix and karst porosity, which will influence the well's permeability model. The areas with strong dissolution are more likely to have severe fluid leakage, an important aspect to consider during the drilling process. Currently, facies identification is made by geologists using borehole acoustic data, performing preprocessing steps and visually assigning a dissolution value to a given range, a time-consuming process. Methods to automate this task would also cut the time needed to have a reliable reservoir characterization. In the current application, we explored the features of ultrasonic images. It presents the sound wave reflections by a transducer centralized inside the well, and high-resolution acoustic images can be used to characterize dissolution in reservoirs. Acoustic image analyses have been made using traditional image processing techniques, where they selected specific parameter values to segment the different pore structures in the image, in the end distinguishing between four levels of permeability. These parameters are chosen manually and, therefore, could change for different fields, even different wells on the same field. In this work, we propose a Deep Learning Classification pipeline that learns from acoustic data and classifies the facies in terms of their amount of dissolution. We used Auto Machine Learning to build a CNN model to classify dissolution facies based on acoustic images from different carbonate reservoirs in the Brazilian pre-salt region. We tested our model in a blind sample of seven different wells from the same location. The inference is made in minutes, an enormous gain compared to geologists taking almost a full workday to classify the facies with the same image.

Obs.: the results of this work were submitted to the Petroleum Science and Engineering