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Digital Petrography: Mineralogy and porosity identification using machine learning models

Microscopic petrographic analysis allows evaluating depositional environments and diagenetic processes from sedimentary basins. The results of these analyses, therefore, contribute to an enhanced reservoir characterization and guide the oil and gas exploration.

Images acquired from thin sections in the visible spectrum are used as input to create three sorts of machine learning models: 1. Image segmentation models with representative classes of the rock mineralogy and porosity; 2. Object detection models to automatically identify features of interest, such as phosphatic fragments; and 3. Classification models for labeling images with different porosity types. Systematical application of these models in new images standardizes descriptions and reduces subjectivity and human errors during thin section analysis. Convolutional filters were applied in all the models, followed by machine learning classification algorithms, such as artificial neural networks and random forest. Datasets used for training are from thin sections of carbonate rocks, which are prepared from sidewall core samples of oil wells, specifically from the pre-salt reservoirs of Santos Basin, on the southeast coast of Brazil. Evaluation of the models' abilities to generalize is done through the use of 10-fold cross-validation tests and by correlation with other sources of data, such as chemical microanalysis. Results show high percentages of correctly classified instances during cross-validation. Correlations indicate low root mean square errors and elevated coefficients of determination.

Speaker Biography

Rafael Andrello Rubo is a geologist working at Petrobras, a Brazilian multinational energy corporation, where he conducts stratigraphic studies applying data science. He was graduated from Universidade Estadual de Campinas and participated in an exchange program at University of Missouri. He is pursuing a master's degree in Petroleum Engineering at Universidade de São Paulo. He has also taken an MBA course at Fundação Getúlio Vargas in Finances and Investment Management, and he is also post-graduated in Mineral Metallurgical Systems at Universidade Federal de Ouro Preto.

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