3D Reconstruction of Micro-CT Images of Carbonate Porous Media for Simulating Fluids and Predicting Wormhole Formation along Preferential Pathways during Acidization

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SBGf Conference
18-20 NOV | Rio'25

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Introduction

The formation of wormhole-like channels during acidizing in carbonate rocks is a complex process driven by the interaction between the heterogeneity of the porous structure, the chemical reactivity between the acid and the rock, and the dynamic flow conditions. These factors control the development of preferential flow paths and dissolution fronts. Traditional methods, such as Computational Fluid Dynamics (CFD) and pore network models, provide insights but face limitations due to simplifying assumptions and high computational demands.

This study seeks various ways to improve segmentation and binarization within the image domain using computational techniques that differentiate between the Matrix and the Pores. These techniques are integrated with computational methods for 3D reconstruction from multiple 2D slices obtained via MicroCT. The computational reconstruction contains essential structural information, enabling the identification of preferential pathways and highly porous zones that guide acid flow. This enhances the understanding of the rock's internal geometry and the mechanisms governing dissolution during acid treatment.

Method and Theory

The study is based on an integrated framework of image processing, neural networks, artificial intelligence applied in petrophysics and fluid simulation, in which the preprocessing stage uses algorithms based on adaptive thresholding for binarization, segmentation, and noise correction. From this, 3D reconstruction of the rock is performed using computational techniques to visualize connectivity, characterize zones of high porosity and surface roughness, and identify the preferential flow paths of the acid within the rock.

Results and Conclusions

This work is currently in progress, with fluid simulation tests underway. By the end of the study, the objective is to extract relevant information about the behavior and formation of wormholes in carbonate rocks through a combined approach of image processing and fluid simulations. This integration aims to identify possible new pathways created by the acid and determine their origins. The analysis of the geometric parameters of the porous structure is expected to enable more accurate predictions of preferential flow paths and provide a deeper understanding of the physical mechanisms behind dissolution.