Source to Sink In Reservoir Prediction: Integrating Provenance Data and Machine Learning to Predict Reservoir Distribution

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Abstract

The Triassic of North Africa is characterised by the hydrocarbon rich TAG-I play, comprising fluvial-aeolian sandstones of variable reservoir quality. In this study we address a variety of factors that influence reservoir quality, from reservoir facies and architecture to sedimentary provenance, and develop a predictive model to aid exploration. Analysis of depositional facies encountered in wells drilled within the Tendrara - Missour Basin indicate sandstones locally sourced from a distributary fluvial system (DFS). Outcrop studies from the adjacent Kerrouchen and Oukaimdeden basins recognise two distinctive depositional facies: distributary fluvial systems (DFS) and an axial braided-meandering type fluvial system. Whilst both contain potential reservoir quality sandstones, the reservoir architecture of the axial systems exhibit higher gross reservoir thickness (i.e. higher N: G) and compositional data suggests better pore scale properties cannot be estimated from outcrop study alone.Our study undertakes a novel approach to this problem: we integrated a petrographic compositional and textural database of outcrop sections from across Morocco, with a similar database within the Tendrara - Missour Basin, to make predictions on reservoir quality, measured by porosity. To do this, we utilised an open-source neural network machine learning library and trained the model on the Tendrara subsurface dataset. This model predicts porosity variation for samples within the Tendrara-Missour basin, given a range of compositional and textural parameters. Model accuracy is to within ±1% porosity (MAE: 0.85) indicating that the model makes a reasonable prediction of reservoir porosity.The outcrop dataset was used to predict the expected porosity of a braided-meandering type fluvial system within the Tendrara-Missour Basin. The outcrop basins were used as analogues for the textural parameters of the fluvial system, with the composition varying between an Oukaïmeden composition, a Kerrouchen composition or a Tendrara composition. The model predicted that a braided-meandering type fluvial system would have ~10% higher porosity, alongside improved reservoir architecture, than the DFS type systems currently drilled within the region, providing a potential high quality unexplored play within deeper parts of the basin.