Synthetic Well Logs from Virtual Outcrops: a Database-Driven Approach

G. Bello[1], J. Howell[1], A. Hartley[1], N. Naumann[1], J. H. Pugsley[1], and K. Aliyuda[1]

Search and Discovery Article #42597 (2025)**
Posted November 4, 2025

*Adapted from extended abstract based on oral presentation given at AAPG International Conference and Exhibition (ICE) Rio de Janeiro, 30 September - 3 October, 2025.
 DOI:10.1306/42597Bello2025

[1]Department of Geosciences, University of Aberdeen, Scotland, United Kingdom

Abstract

Depositional facies are the fundamental control on petrophysical properties within subsurface reservoirs, aquifers and repositories. Outcrop analogues provide dimensional information on architectural elements and their constituent facies and are routinely used to predict the distribution of those properties in subsurface systems. Outcrop observations are typically different to those made in subsurface datasets, especially in well logs. Selecting appropriate analogues and matching them to subsurface reservoirs remains a challenge. Behind outcrop boreholes are one way to bridge the gap between the outcrop and the subsurface but these are typically expensive and rarely collected. Creating synthetic well logs from the outcrop is a lower cost solution which can potentially generate large volumes of data.

This study uses a novel empirical approach to generating synthetic well logs from outcrop data. The challenge is addressed by building a relational database of petrophysical responses for key architectural elements in a series of cored wells. Using publicly available data from the UK and Norwegian sectors of the North Sea, the database is populated with gamma ray, deep resistivity, sonic and density-neutron measurements. It provides a comprehensive record of petrophysical log responses corresponding to the architectural element's classification defined within the SAFARI data standards. This dataset allows the development of an innovative semi-automated methodology that integrates machine learning, geodata-science and geostatistics to generates synthetic well logs from architectural-interpretations of virtual outcrops. The resulting synthetic well logs have been validated through direct comparison with drilled wells located behind outcrops. These comparisons demonstrate a high degree of similarity, confirming the feasibility of performing realistic petrophysical scenarios by populating interpreted virtual outcrop cross-section with multiple synthetic well logs. This approach further strengthens the connection between subsurface reservoirs and their analogue outcrops.