geoconvention
Calgary • Canada • June 17-19 2024

Analysis of rock type and flow units in clastic reservoirs using core samples from the Bredasdorp Basin (Field F-A) in South Africa

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Summary

The current study is focused on rock type and flow unit classification for reservoir characterization in clastic reservoirs. The new finds in the Outeniqua Basin have brought Offshore South Africa back into industry prominence. The F-A gas and oil play in Southern Africa was chosen for its unique prospect to study the factors influencing fluid storage and flow in a reservoir.

The F-A gas field is situated 120 km offshore the southern coast of South Africa on the north side of the Bredasdorp Basin, which is a sub-basin of the Outeniqua Basin. The focus of this study is on a shallow-marine sandstone reservoir located inside a combination of structural and stratigraphic closures in the boreholes. The secondary objectives consist of shelf sandstones and fluvial sandstones.

Cores from five wells FA2, FA4, FA10, FA12, and FA13 were obtained and utilized for both standard and specialized core analysis using data provided by Petro South Africa (PetroSA) Company. By combining routine and special core analysis with a detailed core description, it becomes possible to quantify and identify the rock types and flow units in the reservoir.

The Bredasdorp Reservoir was categorized into four flow units and rock types based on lithofacies Identification, rock type, capacity to transmit fluids, space between rock particles for fluid storage, Windland R35, modified Lorenz plot, and statistical grouping technique.

Four rock types and groups have been identified: the first group represents poor reservoir quality (PRT4, Nano-port type) consisting of shale, lithic, siltstone, and very fine sandstone; the second and third groups reflect intermediate reservoir quality (PRT3 & PRT2, Micro to Meso port type) composed of siltstone and very fine to fine sandstones; the fourth group represents good reservoir quality (PRT1, Meso port type) made up of fine to medium sandstones.

Theory / Method / Workflow

Five well cores in the research area of the Bredasdorp basin, off-shore South Africa were examined. Cores provide the direct examination of reservoir parameters and function as a benchmark for the calibration of additional assessment instruments, such as well logs. The primary objective of coring and subsequent core analysis is to mitigate uncertainties in reservoir evaluation by acquiring data that accurately reflects the characteristics of the reservoir in its original state.

The advancements in core analysis techniques, including regular and special core analysis, have enabled the simultaneous assessment of crucial petrophysical parameters together with other metrics that rely on the reservoir rock's properties.

Statistics are used to quantify the variability of natural attributes within the porous medium, such as the relationship between porosity, pore throat, rock types and permeability. To gain insight into the quality of the reservoir and establish correlations among the wells, unconventional approaches were employed.

Results, Observations, Conclusions

The reservoirs exhibit a non-uniform spatial distribution of reservoir parameters. The comprehensive characterization of the core description plays a crucial role in the identification and analysis of variations in texture, grain size, and lithology. Furthermore, there exist variations in the petrophysical (porosity and permeability) features of these entities.

The spatial distribution of shale inside the reservoir can have an impact on fluid flow dynamics. The efficacy of routine core analysis in describing a reservoir with significant heterogeneity and subtle variations at a small scale is limited.

Special core analysis and statistical efforts have been undertaken to address several challenges of the estimation of reservoir attributes. The incorporation of porosity, permeability, unit characteristics, hydraulic rock types, flow units, and the geologic framework represents a superior approach compared to the conventional method.

Novel/Additive Information

An endeavor was undertaken to integrate and examine the existing static and dynamic characteristics of cores on the reservoir under investigation. The present study outlines the methodologies and strategies employed to assess the porosity-permeability of shale, siltstones, and fine to medium-grained sandstones within the study reservoir.

Despite variations in measurements obtained through core analysis, this study successfully generated a quantitative estimation of the reservoir and established appropriate reservoir boundaries.

Acknowledgments

The authors would like to thank Petro-South Africa for supporting us. Also, Prof. Mominitu Opuwari is a lecturer in the Earth Sciences department for the deep discussion about geological and petrophysical concepts.

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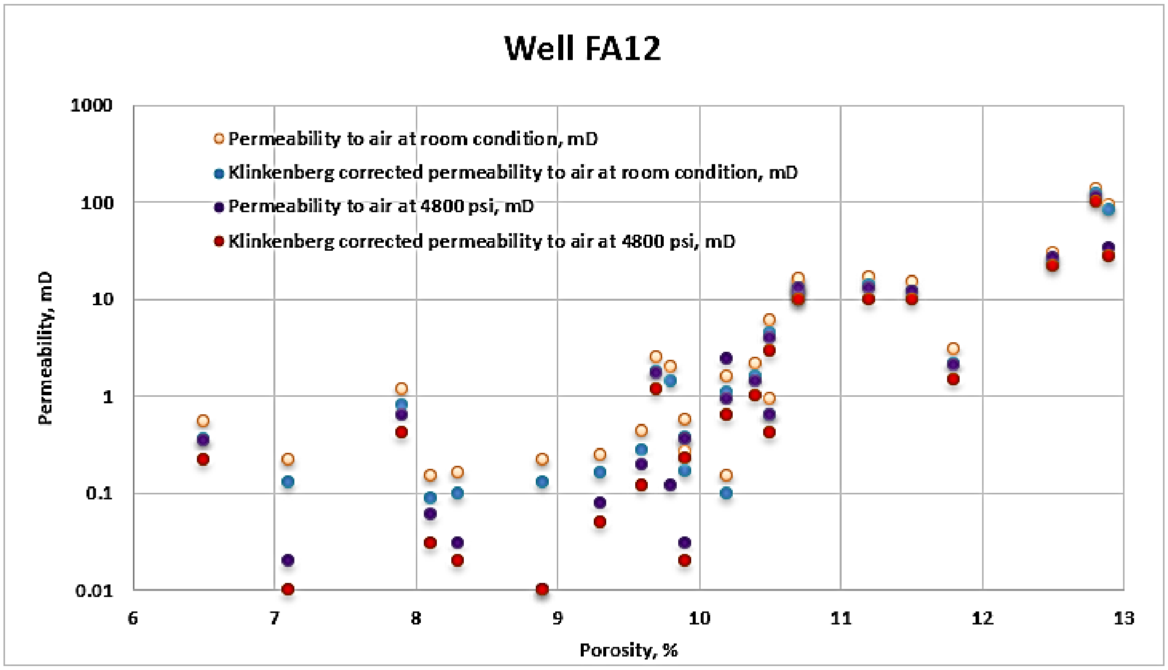

Figure 1: A graphical representation of the porosity and permeability values obtained from a set of twenty-five core plug samples under room temperature conditions and confining (overburden) pressure

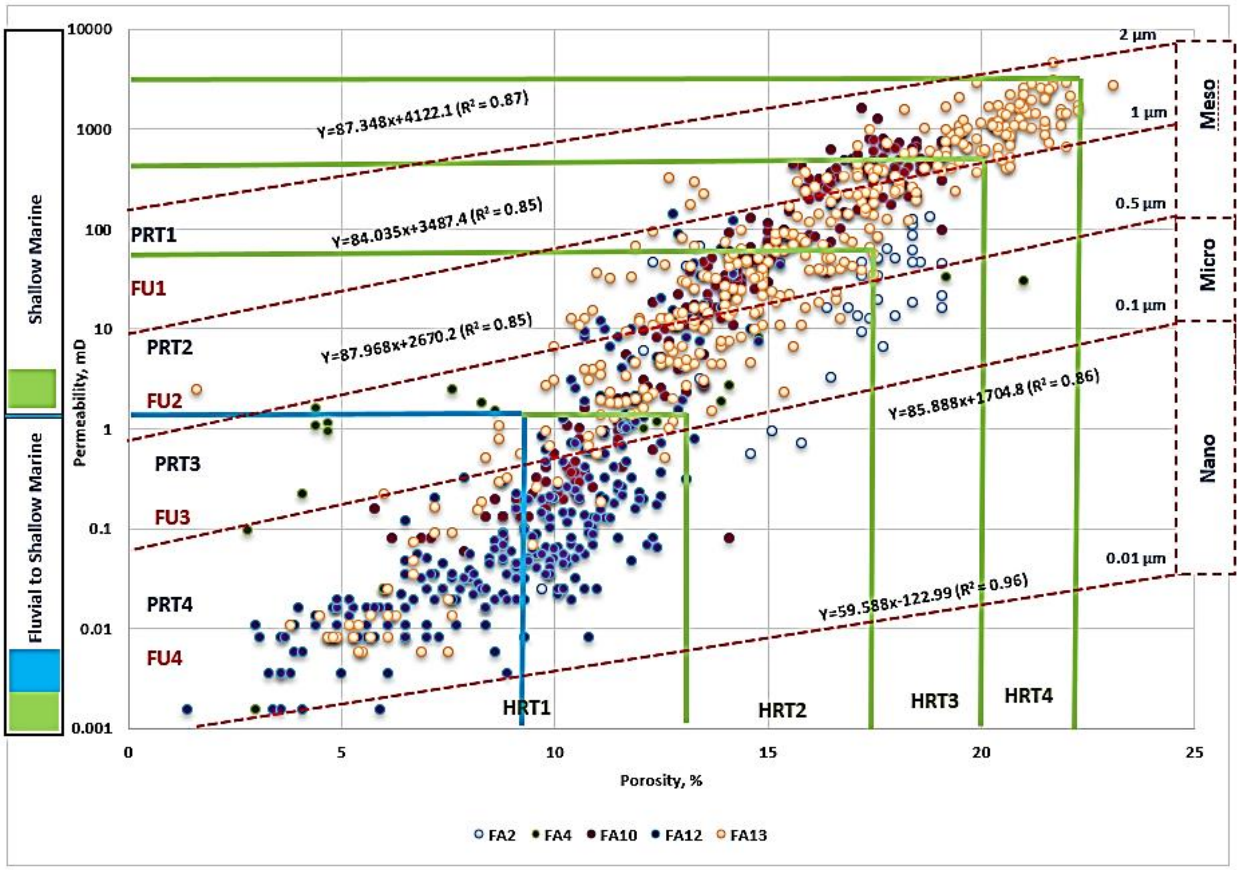

Figure 2: Winland plot illustrates the relationship between hydraulic rock types and key parameters such as porosity, permeability, and the dominating pore throat size. The porosity and permeability values exhibit significant variation. A total of four distinct hydraulic rock types were identified, all of which fall within the range of pore throat sizes spanning from 0.01 to 2 microns across the full core intervals

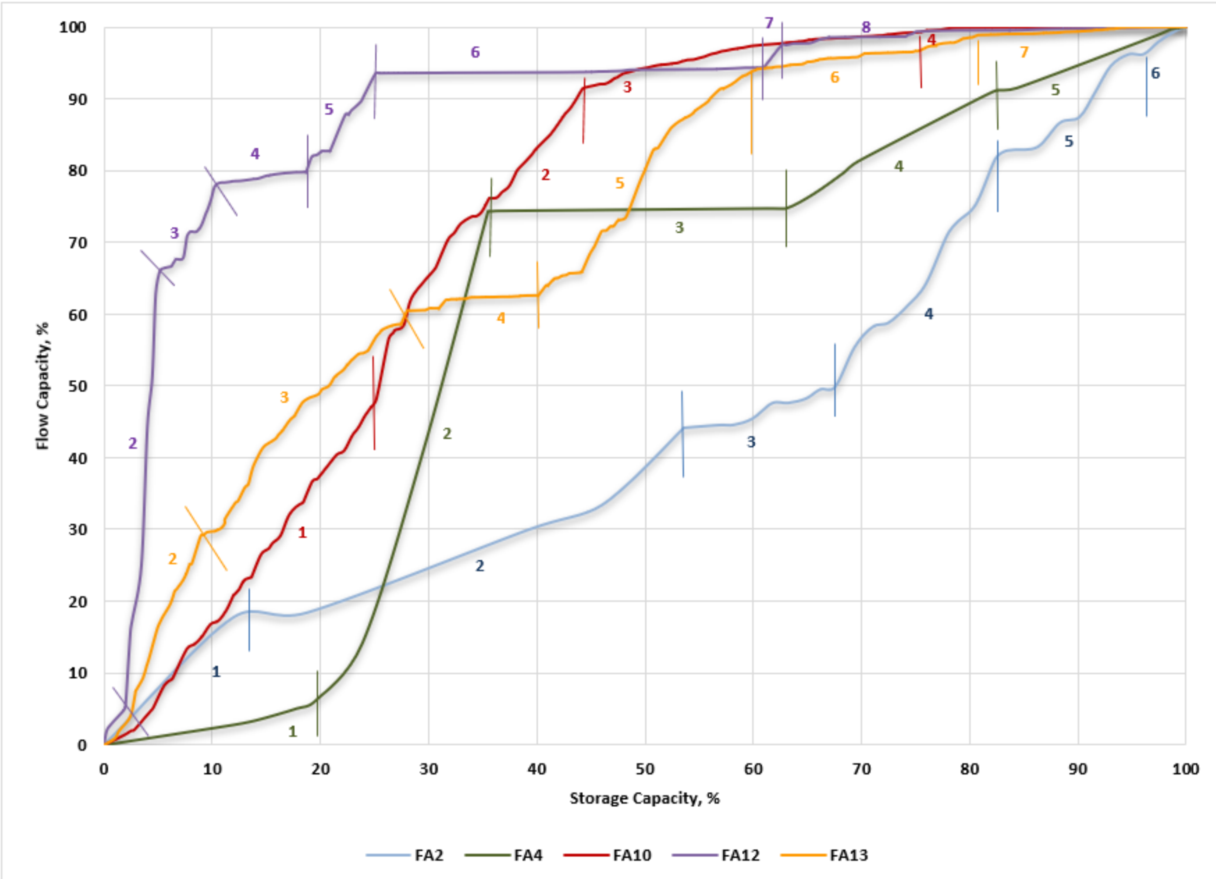

Figure 3: The MLP illustrates the flow units based on the relationship between cumulative storage capacity and cumulative flow capacity, derived from the porosity and permeability of the cores examined