

ABSTRAK

Lapangan migas tua dan besar di Cekungan Sumatera Tengah salah satunya merupakan lapangan 'X' telah melewati puncak produksi dan mengalami penurunan laju produksi, sehingga diperlukan evaluasi ulang kualitas reservoir untuk mendukung pengembangan lapangan tahap lanjut. Reservoir utama pada lapangan ini berada pada batupasir Formasi Bekasap yang memiliki heterogenitas tinggi dan berkembang pada sistem estuarin yang didominasi oleh pasang surut, sehingga memerlukan pendekatan analisis yang terintegrasi dan detail, khususnya pada sumur-sumur tanpa data batu inti. Penelitian ini dilakukan menggunakan 6 sumur produksi dengan mengintegrasikan data batu inti, log sumur, serta metode *machine learning* untuk menentukan *Reservoir Rock Type* (RRT) dan kualitas reservoir. Analisis litofasies dan lingkungan pengendapan menunjukkan bahwa Formasi Bekasap tersusun oleh delapan litofasies yang dikelompokkan ke dalam lima asosiasi fasies utama, yaitu *tidal channel*, *tidal sand bar*, *transgressive upper shoreface*, *tidal mixed flat*, dan *tidal mud flat*. Analisis petrofisika meliputi perhitungan kandungan serpih, porositas efektif, saturasi air, dan permeabilitas yang menghasilkan 3 hingga 6 zona reservoir Bekasap. Berdasarkan pendekatan *Hydraulic Flow Unit* (HFU) yang didukung oleh metode *Flow Zone Indicator* (FZI), Winland R35, *Global Hydraulic Element* (GHE), dan *Modified Lorenz Plot* (MLP), reservoir batupasir Formasi Bekasap diklasifikasikan ke dalam empat *rock type* (RT-1 hingga RT-4), dengan RT-1 sebagai *rock type* berkualitas reservoir sangat baik dan RT-4 sebagai *rock type* berkualitas buruk. Prediksi *rock type* dan permeabilitas pada interval dan sumur tanpa data batu inti dilakukan menggunakan metode *Artificial Neural Network* (ANN) dan *Fuzzy Logic*. Hasil evaluasi menunjukkan bahwa ANN memiliki kinerja yang lebih baik dalam prediksi numerik FZI dan permeabilitas. Distribusi *rock type* hasil propagasi menunjukkan bahwa interval berkualitas tinggi umumnya berasosiasi dengan fasies berenergi tinggi seperti *transgressive upper shoreface* dan *tidal sand bar*, sedangkan interval berkualitas rendah berkembang pada fasies *mixed flat* dan *mud flat*. Penelitian ini menunjukkan bahwa integrasi *rock typing* berbasis HFU dengan metode *machine learning* memberikan kerangka yang andal untuk evaluasi kualitas reservoir dan dapat digunakan sebagai dasar dalam perencanaan pengembangan lapangan dan optimasi strategi perolehan hidrokarbon pada Lapangan 'X'.

Kata Kunci: *Reservoir Rock Type, Hydraulic Flow Unit, Machine Learning, Artificial Neural Network, Fuzzy Logic, Formasi Bekasap, Kualitas Reservoir, Cekungan Sumatera Tengah*

ABSTRACT

One of the large, mature oil and gas fields in the Central Sumatra Basin, known as Field X, has passed its peak production and is experiencing a decline in production rates. This necessitates a re-evaluation of reservoir quality to support further field development. The main reservoir in this field is located in the Bekasap Formation sandstone, which has high heterogeneity and developed in an estuarine system dominated by tides, requiring an integrated and detailed analytical approach, especially for wells without core data. This study was conducted using six production wells by integrating core data, well logs, and machine learning methods to determine the Reservoir Rock Type (RRT) and reservoir quality. Lithofacies and depositional environment analysis showed that the Bekasap Formation consists of eight lithofacies grouped into five main facies associations, namely tidal channel, tidal sand bar, transgressive upper shoreface, tidal mixed flat, and tidal mud flat. Petrophysical analysis includes calculations of shale content, effective porosity, water saturation, and permeability, which resulted in 3 to 6 Bekasap reservoir zones. Based on the Hydraulic Flow Unit (HFU) approach supported by the Flow Zone Indicator (FZI), Winland R35, Global Hydraulic Element (GHE), and Modified Lorenz Plot (MLP) methods, the Bekasap Formation sandstone reservoir is classified into four rock types (RT-1 to RT-4), with RT-1 being a rock type with excellent reservoir quality and RT-4 being a rock type with poor quality. Rock type and permeability predictions at intervals and wells without core data were performed using the Artificial Neural Network (ANN) and Fuzzy Logic methods. The evaluation results show that ANN has better performance in predicting FZI and permeability. The distribution of rock types resulting from propagation shows that high-quality intervals are generally associated with high-energy facies such as transgressive upper shoreface and tidal sand bars, while low-quality intervals develop in mixed flat and mud flat facies. This study demonstrates that the integration of HFU-based rock typing with machine learning methods provides a reliable framework for reservoir quality evaluation and can be used as a basis for field development planning and optimisation of hydrocarbon recovery strategies at Field "X".

Keywords: Reservoir Rock Type, Hydraulic Flow Unit, Machine Learning, Artificial Neural Network, Fuzzy Logic, Bekasap Formation, Reservoir Quality, Central Sumatra Basin