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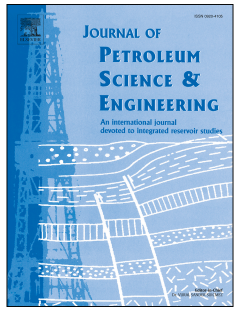

Identification of flow units using the joint of WT and LSSVM based on FZI in a heterogeneous carbonate reservoir

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Identification of Flow Units Using the Joint of WT and LSSVM based on FZI in a Heterogeneous Carbonate Reservoir

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Abstract

The objective of this study was to develop an accurate method for predicting hydraulic unit types in a heterogeneous carbonate reservoir. There is a significant practical potential in the use of the flow unit characterization. Identification of flow units in inhomogeneous carbonate reservoir presents a great challenge to geologists and engineers. A new method for dividing the flow units was proposed in this study based on the joint of wavelet transform (WT) and least squares support vector machine (LSSVM) within the most productive carbonate reservoir of the Minghuazhen Formation in Region A, Block X in the Petrochina Dagang oilfield. Petrophysical properties derived from core data and logging from 21 representative wells were analyzed. The flow units were classified as five types based on the flow zone index (FZI) approach. The WT and LSSVM were jointly used for learning and training each unit. The well logs were broken down into high and low frequency data using WT. Sensitivity analysis of parameters of training samples to select the largest impact was performed with C5.0 decision tree to obtain a WT-trained set. A predictive model was then established by training LSSVM model. The final trained model with the identification rule and criterion for the classification of flow units was used for identifying flow units in the cored and non-cored intervals of reservoir. The result from this study is consistent with core data and is more accurate than that from the previous investigations. It is concluded that using the combination of the WT and LSSVM improved the accuracy of classification of flow units in the Minghuazhen Formation.

Keywords: flow unit, well logs, wavelet transform, least squares support vector machine, heterogeneous reservoir.

1. Introduction

Flow units are defined as sections of the whole reservoir that are laterally and vertically continuous with homogeneous geological and petrophysical features that are different from that in other sections (Hearn et al., 1984; Abbaszadeh et al., 1996; Aguilera, 2014; Lopez and Aguilera, 2016; Enayati-Bidgoli and Rahimpour-Bonab, 2016). Each flow unit expresses rock facies with similar characteristics (Liu et al., 2016; Abdallah, 2016) and represents a specific sedimentary environment that controls fluid flow behavior (Ghadami et al., 2015; Aliyev et al., 2016). Flow units can be utilized to segment a reservoir into different zones that are appropriate for simulation of fluid flow (Bhattacharya et al., 2008) and production behavior (Enayati-Bidgoli et al., 2014). Flow unit modeling is commonly used in field exploration and development planning, dynamic simulation of hydrocarbon production and water flooding schemes (Borgomano et al., 2008). It is also utilized in ultimate oil recovery prediction, optimization of well location placement, pressure and fluid contact evaluation, and reservoir performance forecast (Enayati-Bidgoli et al., 2014). Different methods have been used in identification of