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Basalt identification by interpreting nuclear and electrical well logging measurements using fuzzy technique (case study from southern Syria)

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HIGHLIGHTS

- Apply fuzzy analysis technique on the nuclear and electrical well logging data of Kodana well in Southern Syria.
- Determine and differentiate between four kinds of basalt.
- Establish the lithological section of the studied well.

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ABSTRACT

Fuzzy analysis technique is proposed in this research for interpreting the combination of nuclear and electrical well logging data, which include natural gamma ray, density and neutron-porosity, while the electrical well logging include long and short normal. The main objective of this work is to describe, characterize and establish the lithology of the large extended basaltic areas in southern Syria. Kodana well logging measurements have been used and interpreted for testing and applying the proposed technique. The established lithological cross section shows the distribution and the identification of four kinds of basalt, which are hard massive basalt, hard basalt, pyroclastic basalt and the alteration basalt products, clay. The fuzzy analysis technique is successfully applied on the Kodana well logging data, and can be therefore utilized as a powerful tool for interpreting huge well logging data with higher number of variables required for lithological estimations.

1. Introduction

Well logging research has been developed and extended for petroleum purposes (Schlumberger, 1991; Chang et al., 1997; Rogers et al., 1992; Baldwin et al., 1990) by benefiting from the advanced technologies in computation. Those advanced technologies have been rapidly extended for mining and lithological descriptions, where they have proven to be very valuable. Different statistical techniques have been already developed for lithological determination from geophysical borehole logs, such as principal component, discrimination function and cluster analysis. These methods are incorporated in computer programs for data interpretation (Borsaru et al., 2006; Asfahani, 2011; Kassenaar, 1991; Fullagar et al., 2002). Neural network methods are also applied for determining the rock types from well logs, (Baldwin et al., 1990; Rogers et al., 1992; Wong et al.,1995; Pezeshk et al., 1996).

Asfahani (2011) has adapted the threshold concept with one variant, and proposed a statistical analysis approach to integrally interpret the nuclear and electrical well logging data. The proposed statistical approach showed the ranges of the variable logs, which have been successfully applied for characterizing the basalt section in southern Syria. Using these statistical ranges, a computer program has been prepared to interpret the borehole logging data, and to automatically establish the borehole cross section (Asfahani and Abdul Ghani, 2012). Based on this approach, four kinds of basalt have been identified in the studied region as follows: hard massive basalt, hard basalt, pyroclastic basalt, and alteration basalt products, clay.

Factor analysis technique is applied on the well logging data for estimating the shale volume in the Pannonian basin of Central Europe, Szabo (2011). Statistical factor analysis technique has been also recently proposed as a suitable tool for interpreting well logging parameters to characterize and identify the different kinds of basalt (Asfahani, 2014).

The present paper proposes the application of the fuzzy

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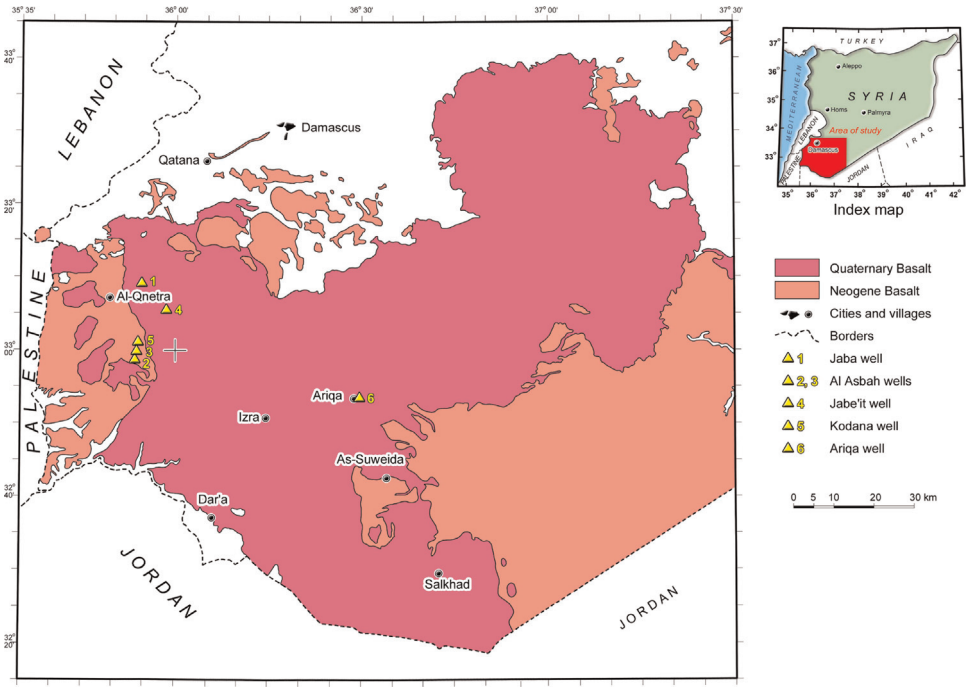

Fig. 1. Location of the studied well in Southern Syria.

technique for interpreting nuclear and electrical well logging parameters to identify the different kinds of basalt and establish the cross section of the studied well. Fuzzy logic analysis of well logs has been recently applied extensively in many reservoir characterization studies. Fung et al. (1997) have applied a self-generating fuzzy rule extraction and inference system for the prediction of petrophysical properties from well logging measurements. Huang et al. (1999) have applied a fuzzy interpolator for permeability prediction based on well logs from the North West Shelf in Australia. Cuddy (2000) has used the fuzzy logic to determine hydrocarbon formation lithofacies and permeability from well log data in the southern North Sea.

Several holes drilled in the volcanic study region in Southern Syria, to depths of more than 150 m, have been logged for identifying and characterizing basalts by means of nuclear and electrical well logging techniques, (Asfahani, 2011). The locations of these wells are shown in Fig. 1.

Five traditional well logging parameters have been taken into consideration when using the fuzzy proposed technique for basalt characterization in the drilled wells in southern Syria: Total count

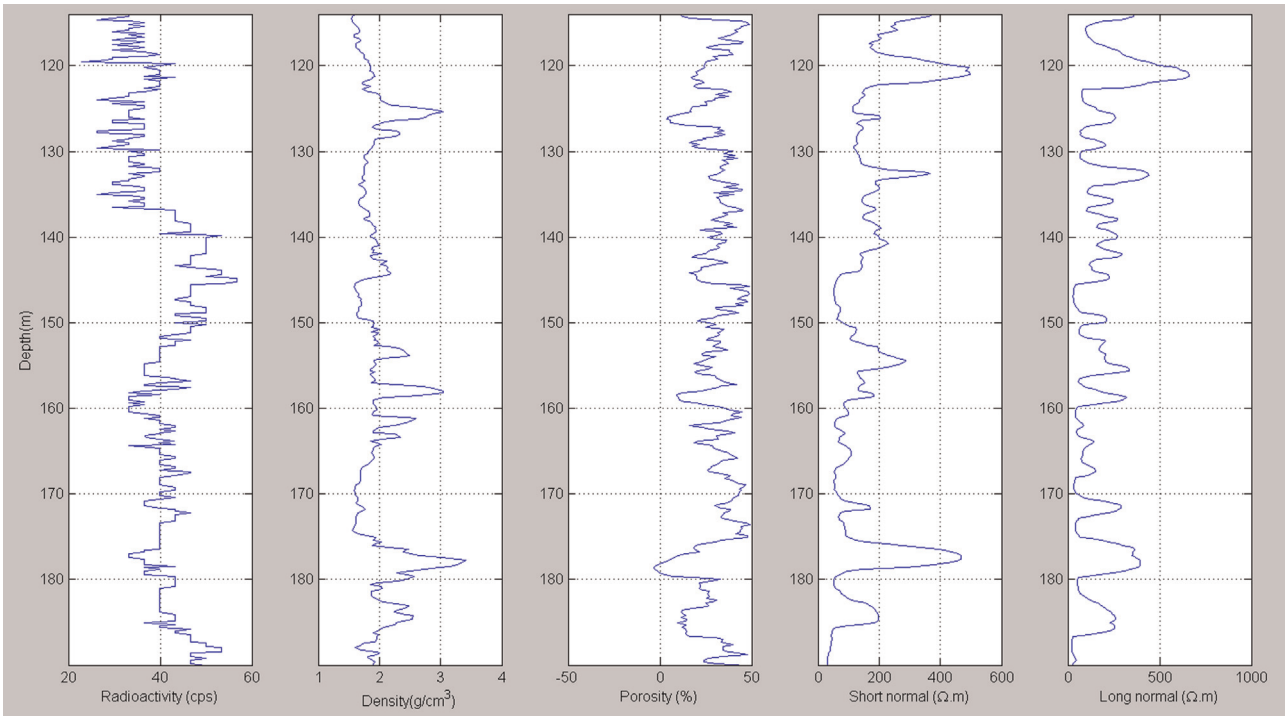

Fig. 2. Nuclear and electrical well logging measurements of the Kodanna well for fuzzy technique.