



## Estimation of wettability using NMR data from core analysis and well logs in one of the reservoirs in south of Iran: A case study

Sajad Pourjahani<sup>1</sup>, Ahmad Vaezian<sup>\*2</sup>, Mansour Ziaee<sup>3</sup>, Yousef Shiri<sup>4</sup>

1, 2, 3, 4 Shahrood University of Technology, Faculty of Mining, Petroleum and Geophysics Engineering, Shahrood, Iran

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Corresponding author: [avaezian@yahoo.com](mailto:avaezian@yahoo.com)

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Conventional well log

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J-function

### Extended Abstract

#### Summary

The main objective of this research is to investigate wettability data obtained from integration of well logs and nuclear magnetic resonance (NMR) data from core analysis in the Shuaiba formation at the depths of 1708 to 1845 meters in one of the oil wells in the Persian Gulf. The data include well logging records and NMR data from 10 core samples, in which 5 samples having mercury injection capillary pressure (MICP) data and the other 5 samples have been used for validation by applying United States Bureau of Mines (USBM) data. This study employs a combined method based on MICP

laboratory data analysis, J-function, and NMR and well logging data to qualitatively predict reservoir wettability. Despite various studies in this field, this research aims to effectively utilize limited available data and predict wettability in surrounding wells using analytical and integrative methods to extract useful information on a larger scale. Data limitations include conventional well logging charts, MICP, USBM, and NMR data from only 5 points in the well. These data were used to generalize new methods presented in previous studies. Initially, relationships for capillary pressure using NMR and neutron and gamma porosity logs were derived from MICP laboratory results. USBM laboratory results were then used to validate these relationships. The qualitative wettability of the studied formation was found to be neutral, consistent with USBM test results. The findings indicate that the estimated wettability is reliable and can be used in the industry to determine wettability in conditions with limited laboratory data.

### Introduction

Considering increasing demand for accurate reservoir identification in oil and gas exploration and development, wettability plays a crucial role as it affects the distribution of oil and water. Wettability indicates the tendency of one fluid to spread or adhere to the rock surface in the presence of another fluid, which has a considerable effect on fluid distribution, capillary pressure, flooding, and residual saturation. Evaluating wettability in a reservoir is one of the challenges engineers face, as no method can directly measure it. The aim of this research is to investigate wettability using neutron and gamma porosity logs, MICP, USBM, and NMR laboratory data. For this purpose, the capillary pressure was first determined by comparing the NMR and MICP data. Then, the capillary pressure obtained from conventional logs was determined using gamma and neutron porosity logs and USBM data. Finally, by comparing the two obtained capillary pressure curves, the estimated wettability was evaluated.

### Methodology and Approaches

The well logging data used in this research includes gamma ray (GR) and neutron porosity (NPHIE) logs. The NMR laboratory data includes transverse relaxation time (T2) distribution and pore size distribution, available for 10 different core samples. These samples, labeled from A1 to A10, belong to the Shuaiba Formation within the depth range of 1708 to 1845 meters and are categorized into four different rock types. NMR laboratory data for these 10 oil-based core samples have been provided for this research. The MICP laboratory data in this research also include injection pressure and mercury saturation, available for the first 5 core samples. The USBM wettability index data are also available for the other 5 core samples and have been used for validation purposes.

## **Results and Conclusions**

In this study, the relationship between wettability derived from NMR data and conventional well logging data in one of oil fields located in the Persian Gulf was investigated. A summary of the results, obtained from this study, is as follows :

-Using NMR and MICP laboratory data, relationships for determining capillary pressure using T2 with correlation coefficients of 0.84, 0.79, 0.83, and 0.90 for 4 different rock sample types were obtained that led to acceptable values for capillary pressure .

- Using neutron porosity and gamma logs and MICP laboratory results, relationships for determining capillary pressure with a correlation coefficient above 0.81 were obtained, indicating a very good match of these relationships with the observed results. To evaluate the obtained capillary pressure relationships, capillary pressure curves for samples A6 to A10 were plotted using NMR and conventional well logging data, and their wettability qualitative amounts were found to be neutral, and completely consistent with the results obtained from the USBM test.

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