The Evaluation of Challenging Volcaniclastic Reservoir Through Geochemical Assessment

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ABSTRACT

Meruap KSO is a prolific oil block located in Jambi Sub-basin, South Sumatra Basin. Volcanic activity in the Miocene supplies the volcanic material from western part of Sumatra to Air Benakat Formation as the primary reservoir in this block. There are two types of lithology that strongly influenced by volcanic material, namely pyroclastic-fine tuff and volcaniclastic-conglomerate to volcaniclastic-sandstone.

A careful core observation of pyroclastic-fine tuff reservoir show light gray color, paralel lamination and aqueous flow structures, relatively good porosity ranging from 10-25% but with low permeability (less than 10 mD). In the other hand, volcaniclastic-conglomerate to volcaniclastic-sandstone reservoir show dark gray color with graded bedding structure, and vary porosity (5-30%) and permeability values (0.1 mD to 1000 mD). These reservoirs also demonstrate an anomalous conventional log reading such as high gamma ray and present the neutron-density crossover where density porosity is greater than neutron porosity. Most of them are consist of volcanic glass (rhyolite composition) with low grain density, high potassium content, zeolite, calcite, siderite as the product of altered volcanic glass that contribute to give lower grain density. These materials make an irregular wireline log reading that seems like a hydrocarbon zone, yet production result showed 100% water. Therefore, a new method is proposed to solve the complicated case of this challenging reservoir through geochemical analysis by using Geochemical Logging Tools (Elemental Capture Spectroscopy & Spectral Gamma Ray).

The first important step is core evaluation using thin section, X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF) data of several lithologies that classified as reservoir. Then, the chemical and physical parameters are determined from several minerals that configure the matrix in petrophysical model, categorized as QFM radioactive (QFM_Rad), QFM non-radioactive (QFM_NR), clay minerals (CLAY), and carbonate (CAR) based on spectrolith model from Herron (1988). RCAL and XRF result showing that all minerals in our own petrophysical model for rhyolitic-fine tuff has average grain density of 2.49 g/cc and comprises of several elements are Ca 0.24 %, Fe 1.65 %, K 3.38%, Na 3.90%, Si 34.21% and Ti 0.1%, classified as modified Rhyolithic rock fragment. Afterwards, percentage of dry weight minerals are obtained from Geochemical Logging tools logs using combination spectrolith model and Th-K-U ratio plot. These percentages used for predicting grain total density, porosity, bound water, cation exchange capacity (CEC), cementation factor (m), permeability lambda, and irreducible water saturation (Swirr).

Based on the result and interpretation, we interpret that Air Benakat Formation in Meruap KSO has at least five eruption series with enhancement of QFM radioactive which classified as pyroclastic (rhyolitic composition), volcanogenic (absence of QFM_RAD), and

volcanoclastic (non-rhyolitic composition) based on crossplot total silica content(SiO2) vs total Alkali (K2O+Na2O). It corresponds to 31 possible reservoir zones which can be correlated. Chemical Index of Alteration (CIA) and the distribution coefficient of zoning for weathered (coefficient K) analysis give a good explanation of the relationship between diagenetic process with reservoir quality. An increasing weathering in volcaniclastic reservoir resulting a relatively low quality reservoir (low porosity and permeability values) whereas the presence of low resistivity zone is affected by conductive mineral (pyrite).