[EA]The Uncertainty in Assessing Fault Seal Analysis in Carbonate Reservoir*

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Search and Discovery Article #42525 (2020)**
Posted May 11, 2020

*Adapted from extended abstract based on oral presentation given at 2019 AAPG Asia Pacific Technical Symposium, The Art of Hydrocarbon Prediction: Managing Uncertainties, August 7-8, 2019, Bogor, (Greater Jakarta), Indonesia
 DOI:10.1306/42525Putra2020

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Abstract

One of the unsolved topics of carbonate reservoirs is the relation between faults and permeability. Generally, fault seal analysis (FSA) is applying a sandstone reservoir algorithm by using the Volume of shale (Vsh) value obtained from log calculations. However, the value may not reflect the exact conditions on carbonate reservoir analysis where in most cases the carbonate reservoir does not contain clay minerals. Research related to fault material of carbonate rock has not been giving a conclusive result. Therefore, the aim of this study is to discover the relation between limestone facies and clay mineral content and to determine the appropriate method in calculating Shale Gouge Ratio (SGR) using various Vclay calculation methods to conduct FSA in carbonate reservoirs. Generally, the data of this study is derived from subsurface data and the study object is focused on the Miocene limestone reservoir of Kais Formation in the Salawati Basin, Northwestern part of the Bird's Head, West Papua.

Based on structural framework analysis and subsurface maps, three main structural patterns can be identified within the study area: strike-slip fault system trending NE-SW, normal fault system trending NNE-SSW, and normal fault system trending N-S. The classification of Kais limestone facies consists of Mudstone, Mudstone-Wackestone, Wackestone-Packstone, Packstone-Grainstone, Floatstone-Rudstone, and Boundstone, while the classification of Miocene depositional environments are lagoonal patch reef or mounds and lagoonal pinnacle reef.

The methodology that is used in this FSA study consists of several phases: Phase I, build a juxtaposition diagram using an existing geological model and well data. The primary horizons, such as Klasafet, Kais, Kais Reef, Intra Kais, Base Kais, and Basement are projected to the fault plane, both on the foot wall side and the hanging wall side (Figure 1); Phase II, calculate a Vclay fraction in each horizon in each fault. Petrophysical analysis of well data are used to determine the clay fraction in each stratigraphic unit. Afterward, these data are compiled to estimate the possibility of Volume of clay (Vclay) between wells. The Vclay attribute of the wells are mapped at the footwall side and the hanging wall side by interpolating Vclay log from wells. The Vclay determination is using three types of methods: the deterministic method, the non-linear method proposed by Larionov (1969), and the Multimineral model method; Phase III, calculate the value of SGR in each fault plane using vertical movement (throw) and Vclay fraction using a formula proposed by Yielding et al. (1997) (Figure 2). SGR describes the

proportion of clay or shale that may be carried into the fault zone by various mechanisms. The more clay or shale content in the rocks, the greater proportion of clay or shale in the fault zone, therefore the capillary entry pressure will be larger; Phase IV, validating the SGR value with pressure data (DST/RFT) from the wells which are separated by a fault.

The different methods in determining Vclay produce the different values of SGR because they are strongly influenced by the percentage of shale or clay in the rock interval which is displaced by the fault. In this study, SGR calibration is carried out based on the pressure difference between K1 and K2 wells that are separated by a fault. The K1 well is located in the hanging wall while K2 is located in the foot wall. The calibration results show that the SGR cut off 7% using Vclay Multimin and 13% using Vclay Larionov method can be used to determine the fault seal capacity in the Kais Limestone reservoir. Drilling results show that the hydrocarbons only accumulate in the hanging wall and are not continuously accumulate up to the foot wall. This evidence is supported by the failure of the K2 well to find hydrocarbons in the foot wall area.

References Cited

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Yielding, G., B. Freeman, and D.T. Needham, 1997, Quantitative fault seal prediction: AAPG Bulletin, v. 81, p. 897-917.

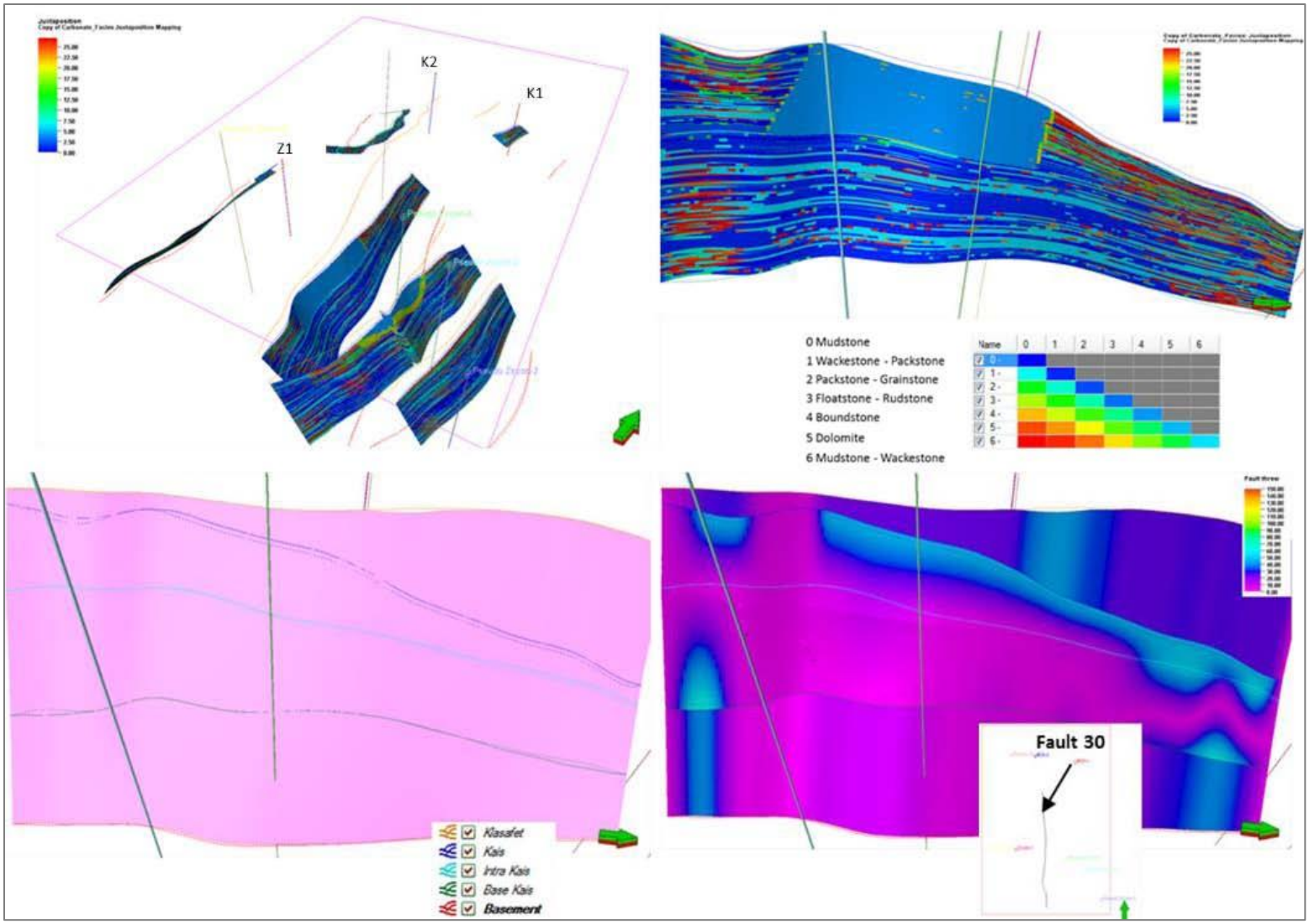

Figure 1. Example of Juxtaposition map or Allan map diagram in the study area.

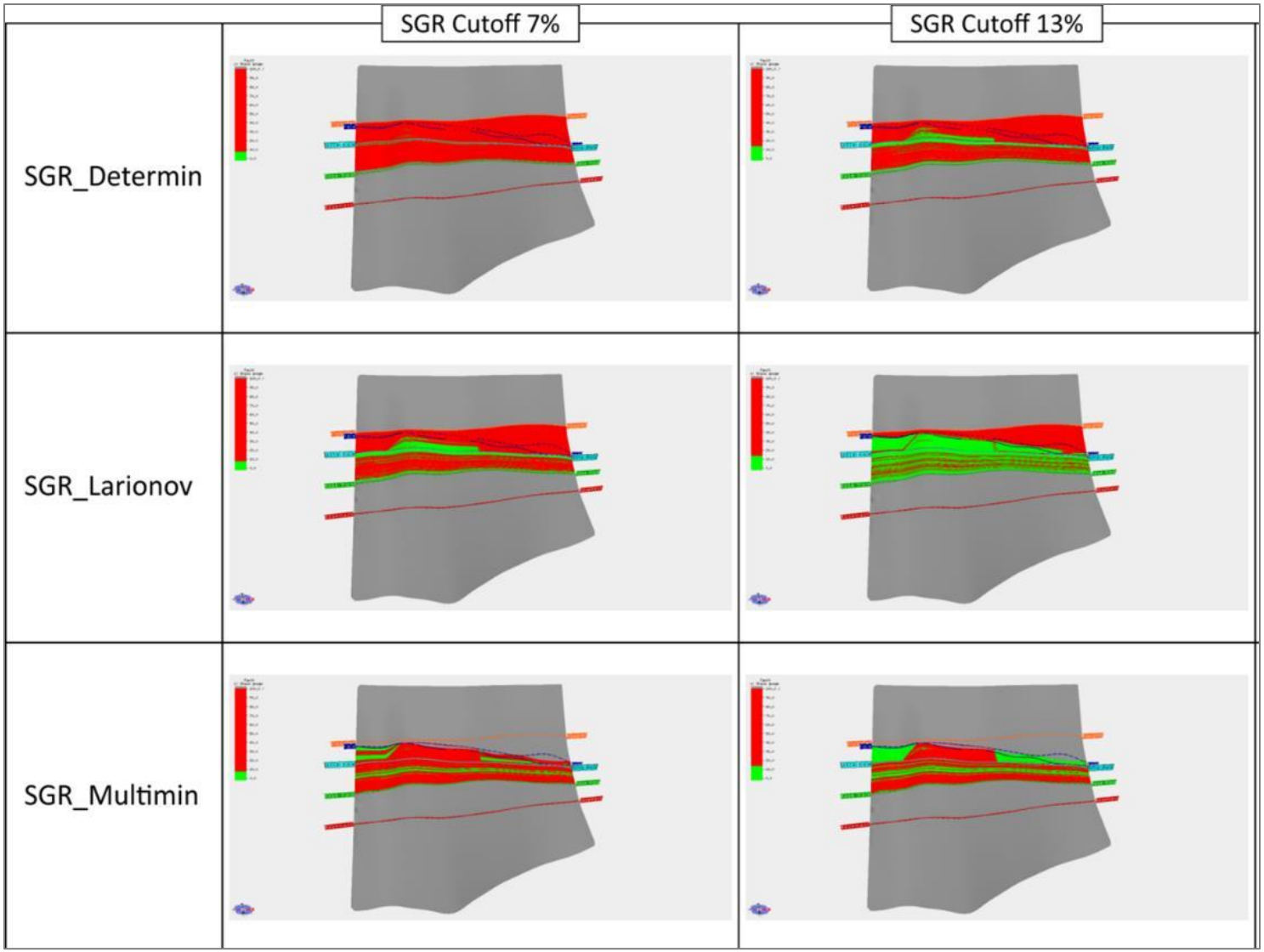

Figure 2. Example of SGR sensitivity comparison using Vcl Larionov and Multimin method in the study area.