USING WELL LOG INTERPRETATION METHODOLOGY FOR DETERMINING THE FRACTURE SYSTEM PROPERTIES FOR CARBONATE FORMATION

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Introduction

The proposed article shows the methodical aspects of defining the parameters of fractures systems, as generally understood qualities of the rock formation. Knowing the deep angle and direction of the fractures, their aperture and frequency of their occurrence and, in consequence the fracture related permeability and porosity of the rock formation is crucial for describing the layers with double porosity systems, generally encountered while studying the carbonate formations. Depending on available well logging measurements fractures can be analyzed using: qualitive methods, eg. CFA (complex fracture analysis) or quantitative methods, based on well scanners (CAST, FMI, XRMI) imaging, estimating the FPI (Fractures Porosity Index), which can be compared to laboratory measurements and macroscopic description of well cores.

Laboratory data

For the analysis we used the set of laboratory data obtained from the Palaeozoic carbonate formation located under the Carpathian orogen by the Oil and Gas Institute National - Research Institute during the last three decades (Leśniak and Darłak, 1995). The set contained 90 samples of permeability and porosity, taken from polished sections and thin sections using random travers methodology (Paduszyński, 1965).

CFA (Complex Fracture Analysis)

Qualitative methodology of defining the fractures of the rock formation (Sowiżdżał and Stadtműller, 2010) based on the analysis of geophysical anomalies found in profiles, which are understood as determinants of the presence of fissures, allows us to detect intervals of intense fracturing. In the method the entirety of geological information is used which enables the parametrization of the studied profile in three categories, as intensely fractured, slightly fractured or unfractured.

FPI (Fracture Porosity Index)

If the electric well scanner measurements are available, it is possible to conduct a quantitative analysis of the fracture system and estimate the FPI parameter (fracture porosity index). The procedure has two stages (Stadtműller and Kowalik, 2012) - the first is the filtration of imaging in order to distinguish single fissures, the second focuses on calculating the aperture (Luthi and Souhaite, 1990) and surface of the distinguished fissures, which, by comparing it to the total surface, can be used to determine the FPI index in the form of dimensionless value from the [0,1] range.

Results

On the graphic (Fig.1) the example of quantitative fracture analysis can be seen. The FPI estimation and elements of CFA analysis employing CALI, GR, RHOB and DT logs were used to analyze a marly limestone formation. The anomalies on the curves corresponding with the presence of fissures were marked with colours. Clear correlation between the occurring anomalies and the fractured intervals can be seen. The exception is the top part of the analysed profile, which can be related to the presence of vertical fissures that do not register on the acoustic anomaly. The next graphic (Fig.2) contains the histograms corresponding to: a) the distribution of apertures in described fissures X-axis 0.01 – 0.13, avg. 0,056mm; b) the distribution of FPI parameter X-axis 0-1, avg. 0,17; c) the distribution of laboratory measured fissure porosity X-axis 0 - 100%, avg. – 4%.

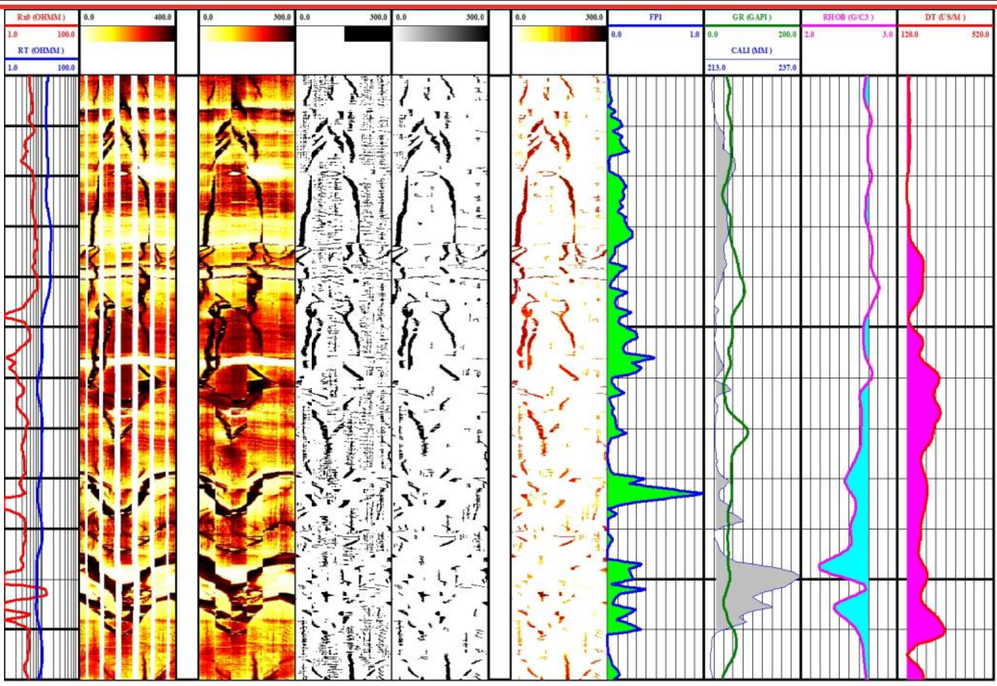

Figure 1. *The example of results of FPI analysis with CFA elements.*

Figure 2. *Histograms of: a) fracture aperture; b) FPI values; c) laboratory data*.

Conclusions

The obtained results prove the effectiveness of the interpretative procedures for estimating the fracture systems, especially regarding the quantitative analysis. However, as in every study of this kind, it is crucial to underline the issues of scale. The laboratory data cannot be used to calibrate the data obtained from wells directly, as it is the description of only a part of physical reality. Both types of available data, e.g. laboratory and field obtained, should be in consequence understood as complimentary.

References

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