

## Fractals for Geoengineering

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The effectiveness of fractal toolbox to capture the scaling or fractal probability distribution, and simply fractal statistics of main hydrocarbon reservoir attributes, was highlighted by Mandelbrot (1995) and confirmed by several researchers (Zhao et al., 2015). Notwithstanding, after more than twenty years, it's still common the opinion that fractals are not useful for the petroleum engineers and especially for Geoengineering (Corbett, 2012). In spite of this negative background, we have successfully applied the fractal and multifractal techniques to our project entitled "Petroleum Reservoir as a Fractal Reactor" (2013 up to now). The distinguishable feature of Fractal Reservoir is the irregular shapes and rough pore/solid distributions (Siler, 2007), observed across a broad range of scales (from SEM to seismic). At the beginning, we have accomplished the detailed analysis of Nelson and Kibler (2003) Catalog of Porosity and Permeability, created for the core plugs of siliciclastic rocks (around ten thousand data were compared). We enriched this Catalog by more than two thousand data extracted from the last ten years publications on PoroPerm (Corbett, 2012) in carbonates deposits, as well as by our own data from one of the PEMEX, Mexico, oil fields. The strong power law scaling behavior was documented for the major part of these data from the geological deposits of contrasting genesis. Based on these results and taking into account the basic principles and models of the Physics of Fractals, introduced by Per Bak and Kan Chen (1989), we have developed new software (Muuk'il Kaab), useful to process the multiscale geological and geophysical information and to integrate the static geological and petrophysical reservoir' models to dynamic ones. The new type of fractal numerical model with dynamical power law relations among the shapes and sizes of mesh' cells was designed and calibrated in the studied area. The statistically sound power law relations were established for the reservoir' hydraulic units distribution in space and time, as well as for the corresponding well testing data.

### References:

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