GFREE[i] Approach to Geologic Characterization of "Tight Gas" Reservoirs

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[i]GFREE: Acronym for "Geology and Geophysics, Formation Evaluation, Reservoir Engineering, Economics, and Externalities", a research team at the University of Calgary focused on the multidisciplinary characterization of tight gas reservoirs.

Abstract

Increasing demand for natural hydrocarbon gas, coupled with a steady reduction of conventional reserves in North America, has led to greater interest in what were formerly considered to be marginal gas reservoirs. Petroleum industry operators are becoming more interested in unconventional energy resources, out of which gas from tight reservoirs is one of the most important. Technical understanding and development of this type of reservoir is at a more mature stage in the US than in Canada. However, significant efforts are being conducted in Canada to quantify and develop the "tight gas" reserve potential which is suspected to be large. In this context, the GFREE team at the University of Calgary is working in concert with NSERC, AERI and Conoco Phillips to develop an interpretative workflow to characterize these reservoir rocks. The key input data for this analysis workflow are well cores, well logs, drill cuttings, outcrop studies and subsurface analog models based on present-day analogous environments. For this presentation we outline the geologic workflow followed by the GFREE team, which includes a detailed stratigraphic correlation, the definition of sedimentary facies and the petrographic characterization of the reservoir rocks. Porosity and permeability measurements are used to quantify the storage capacity and deliverability of each individual sedimentary body. Production data is included as a final constraint, in order to define the most favourable reservoir architecture combination among the previous analyzed geologic features.

The GFREE workflow is currently being applied to the upper part of the Monteith Formation, the lowermost stratigraphic interval of the Late Jurassic – Early Cretaceous Nikanassin Group in the Deep Basin of Alberta (Stot, 1988; Miles et al, 2009). The study area corresponds to the south-east part of the Wapiti Field, approximately 400 Km NW of Edmonton. In this area and for this particular stratigraphic interval, the pore geometries and the distribution of sedimentary facies seem to be among the most important factors to define the quality of the reservoir intervals. The rock properties are affected by different diagenetic processes, and the later seem to be constrained by the boundaries of the sedimentary bodies, the sediment composition, and the tectonic history of the area.

The depositional environment is interpreted to have been shallow marine, but reworked by tides. The reservoir rocks comprise very fine to fine grained, moderately to very well sorted sub-litharenites and litharenites, with quartz, shale, chert, and feldspar fragments as the major detrital components. The primary intergranular porosity has been almost completely destroyed by pervasive quartz overgrowth and variable amounts of carbonate cement precipitation, as well as, mechanical and chemical compaction. In contrast, secondary porosity is common and is represented mostly by alteration and microporous dissolution of feldspar and chert fragments, channel-like enhancement along stylolitic seams, small discontinuous fractures, larger fractures bounded by stylolitic seams, and microporosity from kaolinite booklet growth. Areas of pervasive quartz overgrowth are interconnected by tabular or slot pores formed between quartz overgrowth surfaces that developed around individual quartz fragments. These slot pores are often plugged with authigenic clays, thus a reduction on its effective permeability should be expected.

Available routine core analysis data is being used to evaluate the storage capacity and deliverability of the reservoir rock in the cored intervals. Further porosity and permeability measurements are being performed on drill cuttings to account for the same properties on the intervals where cores are not available.

In general the GFREE workflow suggests that higher reservoir quality should be expected for the upper half of the coarsening-upward sequence representing the upper Monteith Member interval within the study area.

References

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