Workflow for Hydrocarbon Mass-Balance Calculation of Unconventional / Hybrid Systems: Southern Delaware Basin Example

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Abstract

Quantification of hydrocarbon masses from source to trap through basin evolution is fundamental in petroleum system analysis. In order to quantify the hydrocarbon masses throughout the whole petroleum system, it is essential to accurately estimate the generated-expelled-retained masses within the source rock. The quantified hydrocarbon masses from generation to production volume and residuals must be in balance following the fundamental laws of mass conservation. This is particularly important for unconventional/hybrid systems, where the reservoirs are self-sourced and juxtaposed-sourced, and the retained portion of the generated hydrocarbons determines the oil and gas in place. A generic example illustrates the methodology and workflow proposed, including the calculation and distribution of the original and present-day source rock properties (TOC, HI, and organic porosity), present-day residuals, and the amount of generated, expelled and retained hydrocarbons, as well as the migrated amounts to the producing zones. The workflow integrates source rock quality and quantity, Rock-Eval pyrolysis, petrophysical logs, and production data with the case study of Southern Delaware Basin. The heterogeneity of source rock properties in the basin and data uncertainty were also considered and accounted for. The preliminary results of this hydrocarbon mass-balance assessment reveals the source rock expulsion/retention efficiency, undiscovered resource potential (i.e., under-balanced) and hydrocarbon migration/mixing (i.e., over-balanced) in the studied unconventional/ hybrid system. The findings and outcomes of this workflow can serve as a reliable input and calibration for basin

model predictions in other similar settings of unconventional/hybrid systems.