

Understanding Mass Transport Processes during Geochemical Characterization of Unconventional Plays

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Abstract

Geochemical characterizations of source rocks and their contained fluids are essential to the appraisal and development of unconventional resources. Many geochemical and characterization methods, such as pyrolysis, gas desorption, and isotopic measurements on rock or fluid samples, may involve one or more mass transport processes during sample preservation, pretreatment and analyses, including but not limited to Darcy flow, bulk and surface diffusion, and adsorption/desorption. These processes can change oil and gas geochemical fingerprints (ratios between compounds or isotopologues) in the field as well as in the lab. Whether the original hydrocarbon in-place and the geochemical fingerprints of reservoir fluids can be reliably reconstructed through lab measurements requires a quantitative assessment on the impacts from these processes. This work investigates the sensitivities of various geochemical parameters to different mass transport processes and some geochemical reactions. The following parameters are evaluated: 1) generation and expulsion rates of typical compounds (hydrocarbons, H₂S and heterocyclic aromatics) in geological bodies; 2) hydrocarbon generation and expulsion rates during lab pyrolysis on samples with different sizes; 3) gas isotopic fractionation during the flow in geological bodies and in lab samples; 4) oil compositional fractionation in geological bodies and in lab samples; 5) hydrocarbon loss during coring time and during lab treatments; and 6) collectable hydrocarbon during lab desorption and Rock-Eval pyrolysis. The results show that the dominating processes controlling geochemical parameters are often different under lab and under geological conditions.

These differences make it challenging to restore reservoir fluid properties through lab derived data. The dominating process should be distinguished during geochemical characterization. Correlations between the key parameters of different processes are often vague and not necessarily universal. These uncertainties should be considered when interpreting geochemical data to evaluate the quantity and properties of reservoir hydrocarbons, along with their migration and production from geological bodies.