Incorporation of detailed lithologic description in heterogenous fine-grained lithologies with DeltaLogR and improved calculations of carbon burial

Jason A. Flaum

USGS Central Energy Resources Science Center

Since the discovery of world-class hydrocarbon reservoirs within fine-grained rocks there has been a concerted effort to improve our understanding of the heterogeneity in composition, texture, and structure of these lithologies. Such improved characterization has led to several paradigm shifts in interpretations of the depositional processes and environments associated with the occurrence of carbon-rich rocks in the geologic past. These paradigm shifts have resulted in improved exploration and development of both continuous resources and conventional resources via application to the assessment of source rocks.

Prior to the recent paradigm shifts mentioned above organic-rich fine-grained rocks were interpreted to be homogenous and having been deposited in quiescent oxygen deficient environments. Such interpretations were the basis of many of the tools developed for the exploration of source rocks. One such tool is DeltaLogR, a petrophysics based method of calculating organic-richness of mudstones. Originally developed for assessment of organic-richness in homogenous, argillaceous lithologies, application of DeltaLogR to heterogenous calcareous lithologies that are typically associated with Mesozoic continuous resource plays has proven difficult. In particular, two primary limiting factors have been identified: 1. Establishing a proper baseline; and 2. False positives associated with resistivity increasing at a greater percentage than sonic in cemented limestones.

In this study we present detailed lithologic and geochemical descriptions of Cenomanian-Turonian aged calcareous mudstones from the Greenhorn Formation of the USGS #1 Portland Core. These descriptions are then utilized to establish proper recognition criteria for the identification of proper baseline units and false positive DeltaLogR values throughout the study interval. Utilization of proper baseline units and removal of false positive values in the Greenhorn Formation allowed for accurate determination of organic carbon concentrations throughout the unit when compared to measured values. The methodology presented in this study demonstrates that the DeltaLogR method can be an essential tool for evaluating organic carbon concentrations over a range of lithologies.

Bio:

Jason Flaum is a research sedimentologist at the USGS Central Energy Resources Science Center in Lakewood Colorado. Following completion of his PhD at Northwestern University he spent 11 years in industry at ExxonMobil and TOTAL evaluating continuous resource plays and source rock evaluations around the world. He has now been at the USGS since September, 2020 where he is part of an integrated research team utilizing inorganic and organic geochemistry, sedimentology, petrography, and petrophysics to evaluate the depositional processes and environments associated with the accumulation of organic and inorganic carbon-rich strata during extreme climate events throughout the Phanerozoic.