Unconventional Source Rock Heterogeneities; Effects Of Inorganic Geochemical Composition On Thermal Maturation

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Objectives/Scope: Unconventional hydrocarbon resources have received increasing attention from both industry and academia due to increased demand of energy. Despite this interest and the number of studies which have investigated methods to efficiently exploit these energy resources, the petroleum industry is still facing challenges in accurately identifying sweet spots, due to the presence of multiple hydrocarbons play fairway and differences in the predicted versus actual thermal maturity. These challenges in sweet spot identification may result from the inorganic geochemical properties of source rocks that can vary for a given time interval in a basin.

Methods, Procedures, Process: Our team analyzed Upper Cretaceous (Maastrichtian) Jordan source rock interval, using core samples from a 72 m long vertical well, drilled in the Al-Lajjun area of Western Jordan. The Jordan source rock is a carbonate-rich Type II S source rock interval, which is compositionally similar to major Arabian unconventional prospects (Tuwaïq Mtn, Hanifa and Shilaif Fms) and others around the globe as well. However, it is thermally immature and therefore can be considered as an immature analogue to the mature unconventional Type II S source rock prospects. Initial characterization of the source rock interval used Spectral Gamma-Ray and RockEval 7S. Detailed inorganic geochemical analysis and artificial maturation experiments were then performed to highlight the presence of inorganic geochemical compositional heterogeneity and its effects on source rock hydrocarbon generation potential and thermal maturity.

Results, Observations, Conclusions: The bulk geochemical analysis showed three dominant cycles of organic matter distribution. Each cycle peaks with a 18-20% TOC and 4-5% sulfur content. These cycles also display variations in elemental and mineralogical composition, with calcite and quartz the dominant minerals. Following artificial maturation, samples with different compositions exhibit variations in thermal maturity and expulsion trends. Samples with a higher Si-content show an early expulsion of HC. Results also illustrate decreased corresponding Tmax values for Si-rich samples, when compared to Ca-rich samples of similar maturity. The type of bitumen is also variable and changes with source rock composition and thermal maturity.

Novel/Additive Information: The results of this study highlight that significant inorganic compositional heterogeneities may exist in a source rock interval, which can impact both the source rock properties and hydrocarbon generation. The heterogeneities can also result in discrete maturation and may lead to multiple hydrocarbon play fairways within a source rock interval.