Changes in Organic Carbon and Redox Conditions During Deposition of the Hue Shale-Gamma Ray Zone on the North Slope, Alaska

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Abstract

The Cretaceous Hue Shale and the underlying Gamma Ray Zone (GRZ) is a condensed mudstone section of the Brookian sequence with type II and type III kerogen, and it is one of the major source rocks that fill the world-class conventional oil fields on the North Slope, Alaska. Although, the research on the Hue Shale as an unconventional shale reservoir is still at an early stage, where exploration activities are very limited. The Hue Shale thickens to the east in general. However, regional variations of thickness and more importantly total organic carbon (TOC) have been reported. In this research, a suite of twelve core samples of the Hue Shale and GRZ are selected. These cores are collected from six wells covering a wide spectrum of thermal maturity with four wells in the National Petroleum Reserve Alaska and two wells in the state land. A combined geochemical and petrographic methodology is utilized to address the regional redox conditions and the preservation of organic carbon. TOC, T_{max}, hydrogen index, and production index are acquired through pyrolysis to characterize the abundance, thermal maturity, the origin, and the evolution of organic matter. Scanning electron microscope (SEM) coupled with energy dispersive X-ray spectroscopy (EDS) and cathodoluminescence (CL) is used to investigate the mineralogy and diagenesis of the Hue Shale and GRZ. Pyrite fraction, crystal forms, and pyrite framboid size distributions are used as an indicator of the redox conditions during deposition. The results show substantial variance in oxygen levels in the water column. High abundance and small sizes of pyrite framboids, which indicates a

depleted oxygen environment, show better preservation potential of TOC.