Using Hyperspectral Imaging to Facilitate Upscaling of Petrophysical and Geological Data for Unconventional Reservoirs: Application and Results from the Third Bone Spring Shale and the Austin Chalk

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ABSTRACT

Hyperspectral core imaging (HCI) involves a method of non-destructive, infrared spectroscopy to capture mineralogical and textural information of the slabbed face of a core. Originally developed for the mining industry, imaging spectroscopy has been focused on the visible–near infrared (VNIR), and short-wave infrared (SWIR) segments of the electromagnetic spectrum. While of undoubted value in mining applications, these wavelength ranges cannot identify tectosilicates or sulfate phases common to oil and gas formations and the information generated can be hampered by the low reflectance of typically dark and fine-grained lithologies of 'unconventional' core.

We utilized a workstation that combines a long-wave infrared (LWIR) hyperspectral camera with a SWIR hyperspectral camera and a high resolution RGB line scan camera to scan cores from the Third Bone Spring Shale and the Austin Chalk. Until very recently, commercial imaging technology for the LWIR has not been available due to cost and technical challenges. The relatively new LWIR spectrometer, which contains a specialized lens to obtain data at a high resolution of 300–500 µm per pixel, measures fundamental absorption features related to a bonds between oxygen and a variety of cations, which allows for identification and mapping of tectosilicates, carbonates and some clays, as well as hydroxides, sulfates, and phosphates. The combination of LWIR and SWIR therefore provides a powerful tool for a wide range of minerals. In addition to mineral identification, the LWIR is sensitive to changes in the particle size of minerals, especially quartz and carbonate. We illustrate the processing routines we have developed to

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capture these variations and demonstrate how they provide important information as to the nature of minerals (i.e., sediment vs. cement), and how these data can be applied to sedimentary and sequence stratigraphic studies.