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Seeing through the oil: Hyperspectral imaging for the enhanced visibility of sedimentary and biogenic features in Athabasca oil sands core

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Summary

One of the primary goals of oil sands core logging is to identify sedimentary and biogenic features that are indicative of the depositional environment. This is important for facies classification and further geological interpretation, however, these features are typically difficult to observe in bitumen-saturated strata. Methods that are currently used in the industry to aid the examination of oil sands core include x-ray radiography, CT scanning, resistivity-based borehole imaging and high resolution digital photography. In this study, we investigate the application of hyperspectral imaging for the same purpose. Hyperspectral imaging is a remote sensing technique that combines reflectance spectroscopy with high resolution digital imaging. In addition to producing a high resolution digital image of the target, a reflectance measurement for a specified wavelength interval is collected for each pixel of the digital image. The reflectance response of a target material varies as a function of wavelength because the absorption of light is controlled by chemical composition. Knowing the spectral properties of oil sands constituents (quartz, clays, water and bitumen), different components of the image can be emphasized or suppressed by investigating and manipulating different wavelengths in the data cube.

Shortwave infrared (1.0-2.5 µm) spectral imagery was obtained for a suite of drill core at high and low resolution (0.2 and 1.0 mm/pixel, respectively). The core is from the Kearl Lake area in the Athabasca deposit (13-17-95-8W4M) and runs from Devonian carbonates at the base to the upper McMurray Fm. at the top. Preliminary results show that both large-scale (> 5 cm) and small-scale (< 5 cm) sedimentary features are enhanced in the spectral imagery relative to unaided viewing of the core and/or digital photographs of the samples (Figure 1). Biogenic sedimentary structures (i.e. trace fossils) are also greatly enhanced in the spectral imagery, particularly at high resolution. Features that are otherwise invisible, including delicate lamination, cryptic bedding contacts and trace fossils, such as the example shown in Figure 1 (inset), are readily visualized. Provided that sedimentary and biogenic features are present in the surfaces exposed in a core sample, hyperspectral imaging has the potential to provide a simple, efficient and cost-effective alternative to current methods used to aid the examination of oil sands drill core.

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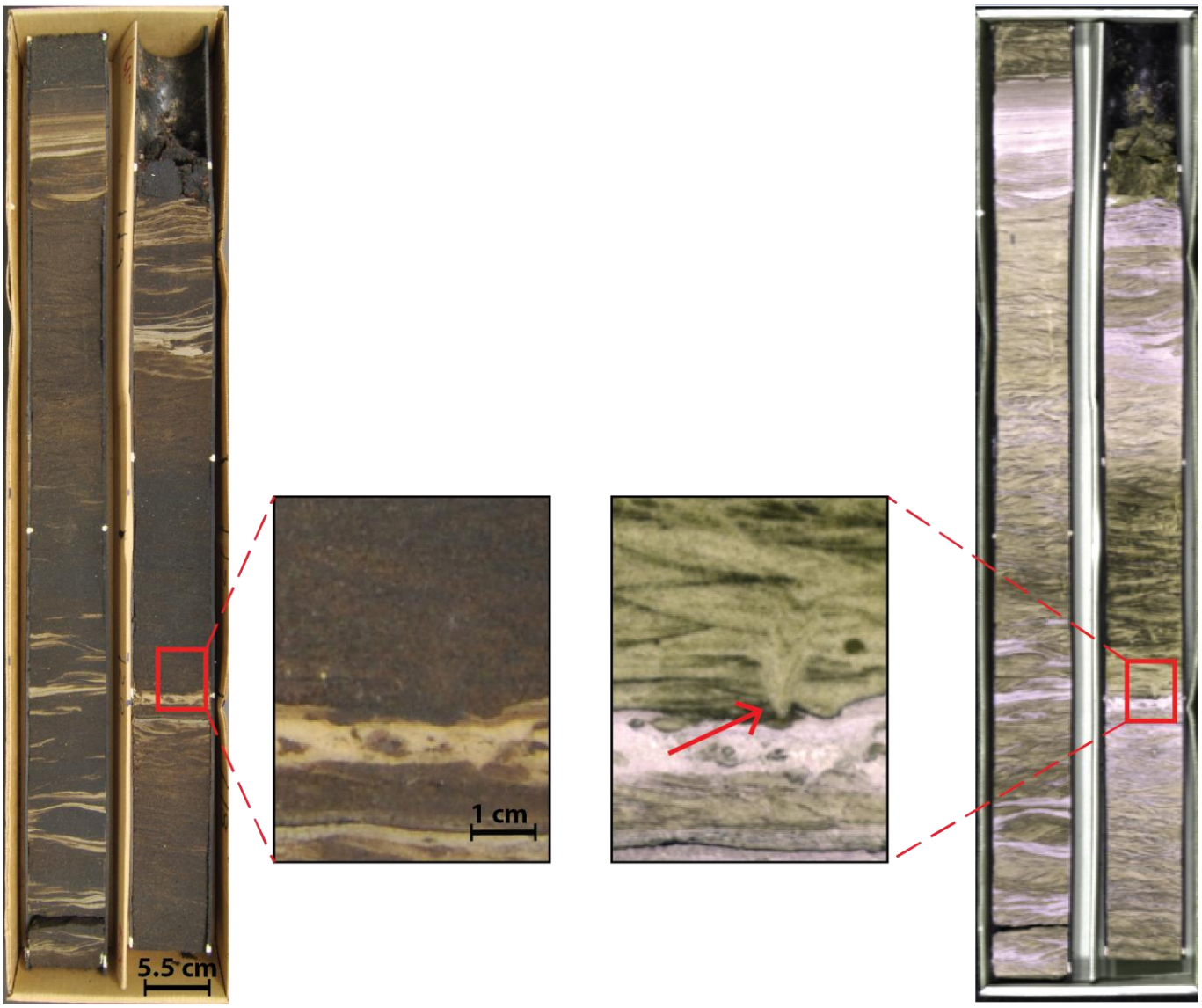

Figure 1: A photo of a box of oil sands core (left), and a shortwave infrared spectral image of the same (right). Scale is the same for both images. Current ripple cross-bedding is greatly enhanced in the spectral imagery relative to the photo. Insets: Features that are completely invisible in the photo, such as this example of *Siphonichnus* (indicated by arrow), are clearly visible in the high resolution (0.2 mm/pixel) spectral image.