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Applications of hyperspectral sensing in oil sands mining operations

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This study provides an overview of applications of hyperspectral sensing that have been researched for use in oil sands mining operations. Included are spectral models or tools developed to estimate several characteristics of oil sands, including mineralogy, sedimentological fabrics, bitumen content [1][2], particle size, and qualities that relate to the separability of bitumen from oil sand during the flotation process. A number of characteristics of tailings residues that pertain to their management and monitoring of their settling performance can also be sensed including moisture content and the cation exchange capacity of solids surfaces. Examples will first be provided for the preliminary up-stream operations, that is, sensing of drill core, mine wall, and crushed ore, contrasting this technology with other well-log methods. Upstream investigations potentially offer the means to characterize the ore prior to its arrival at the separation cell for flotation of the oil, and thus may enable feed-forward control of the flotation process. Spectral imagery of oil froth during bitumen recovery performance tests, conducted using a small water flotation cell, reveals spectral features associated with bitumen, quartz, and clay in the froth; and this imagery can be used to classify froth types and relate them to the processability of ore of varying characteristics. Finally, the role of spectral imaging to address information needs in the downstream operations, namely tailings residues, is discussed. In particular, the ability of clays to expand or swell in the presence of water is of importance in establishing the post-depositional strength and geotechnical stability of a tailings deposit for reclamation purposes. The surface activity of oil sands tailings solids is typically determined using the methylene blue index (MBI). Several spectral features in reflectance spectra have been characterized, in particular those attributed to the presence of quartz and clays. These features were employed to develop a predictive model of MBI.

References:

[1] Rivard B. et al. (2010) Can J Chem Engineering 88(5): 830-838
[2] Speta M et al. (2015) AAPG Bulletin 99(7): 1245-1259