Soil Contaminant Detection Utilizing Field Portable UV-VIS-NIR Spectrometer

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Abstract

Remediation of contaminated soil sites is important to our environment and the growing population that interacts with these resources. Contamination of soil due to leaks, spills and seepage is a worldwide problem usually diagnosed by costly and time-consuming methods primarily using wet chemistry. Problems in remediation efforts involve finding technologies that are less time-consuming and more cost effective over time. Field portable spectrometers that cover key spectral ranges in the ultraviolet, visible and near infrared regions provide a solution for fast and easy identification of contaminants in soil. Using a field portable spectrometer to measure Petroleum Hydrocarbons (TPH) in soil is a fast and nondestructive method of analysis. Applying UV-VIS-NIR technology to these samples hydrocarbon spectra can potentially be characterized by four main absorption features at 1180nm, 1380, 1730nm, and 2310nm. This presentation aims to highlight the utility of field portable NIR technology for researchers in addressing potentially contaminated environments.

UV-VIS-NIR PORTABLE SPECTROMETERS TO IDENTIFY CONTAMINANTS IN SOIL

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AGU FALL MEETING

BACKGROUND

Contamination of soil due to leaks, spills and seepage are a worldwide problem that is typically diagnosed by costly and time consuming methods like wet chemistry.

Hydrocarbons have very specific absorption features in the infrared. These features can be detected with UV-VIS-NIR spectrometers. Recent technological advances have allowed the development of high resolution/accuracy portable field spectrometers that can take measurements *in situ* without the need for sample preparation.

OBJECTIVE

The objective of this study is to:
Demonstrate that UV-VIS-NIR spectrometers can be used to quickly and non-destructively detect and identify contaminants in soil.

METHODS & MATERIALS

- 54 **uncontaminated** soil samples were collected from three locations
  1. 18 ML samples from the McLennan Reserve, Tyringham, MA
     - classified as a **clay loam** with the dominant mineral being **montmorillonite**.
  2. 18 BR samples from the Black Rock Consortium, Cornwall, NY
     - classified as **sandy loam** with the dominant mineral being **illite**
  3. 18 PF samples from the Pittsfield State Forest, Pittsfield, MA
     - classified as **silty clay loam** with the dominant mineral being **illite**

- 5.8 grams of wet soil from each location was dried
- 3.3 grams of dry soil from each location were placed in a sample tray and contaminated with diesel, gasoline, and oil as follows:
  - 9 samples with 0.012oz per contaminant
  - 9 samples with 0.032 oz per contaminant
  - 9 samples with .0.052 oz per contaminant
- The contaminated soil was compacted using a Spectral Evolution Benchtop Probe with Compactor
- A Spectral Evolution oreXpert high resolution spectrometer was used to acquire the sample spectra

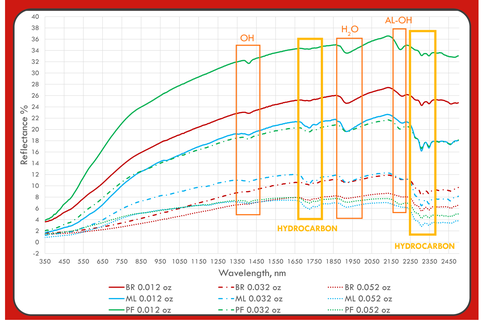
The analysis of the spectral data focused on the following two regions of hydrocarbon absorption:

- Triplet at 1700-1770nm
  - Aromatic Carbon stretch/Carbonyl-Carboxyl C-O stretch
  - Heavy Hydrocarbons
- Triplet at 2290-2360nm
  - Overlapping C-H from 1700-1770nm region
  - Heavy Hydrocarbons

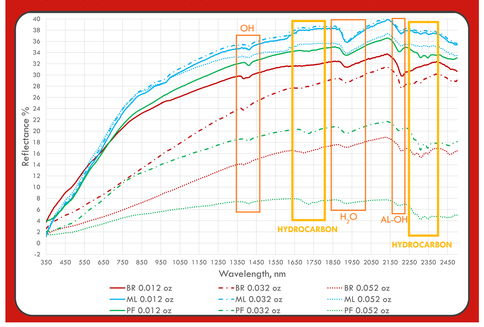
RESULTS

- Hydrocarbon features from the **diesel** in the soil samples are visible in the triplets present at 1700-1770nm and 2290-2360nm.
- The samples contaminated with **gasoline** show a shape and broadness of the hydrocarbon features – the distinction here will make it easier to identify a gasoline contaminant vs diesel in soil.
- The hydrocarbon feature here looks similar to that of the diesel. Notice the spectral shift to the right for the **engine oil** hydrocarbon – so one could also distinguish hydrocarbons based spectral shift.

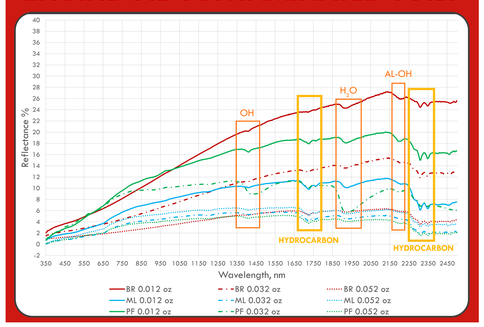
DIESEL CONTAMINATED SOILS



GASOLINE CONTAMINATED SOILS



ENGINE OIL CONTAMINATED SOILS

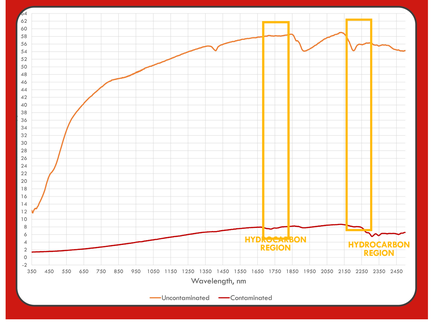


CONCLUSIONS

Focusing on the 1700-1770nm and 2290-2360nm spectral regions using a high-resolution spectrometer allows the instant identification of hydrocarbons in contaminated soils.

UV-VIS-NIR field spectrometers provide a simple and accurate way of identifying contaminants without sample preparation or destruction.

UNCONTAMINATED VS CONTAMINATED SOILS



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