

# SPECTRAL EVOLUTION

## Soil Science—Application Note #2

Reflectance spectroscopy in the VIS/NIR range has been used for years as a nondestructive tool for evaluating soil properties. The measurement of water, carbon, nitrogen, and organic matter using a UV/VIS/NIR field spectrometer or spectroradiometer can provide critical information on soil health.

Traditional soil sampling processes are slow and expensive: gathering soil samples, preparing them for analysis, sending them to the lab, and waiting for the return of the analysis. As a result, very few locations in the United States, let alone the rest of the world, have accurate soil maps. As concerns grow about more efficient agricultural practices, the effects of climate change, over-fertilization with chemicals, erosion, and pollution, the availability of field spectrometry for soil science becomes increasingly popular. In addition, a field spectrometer or spectroradiometer offers the possibility of accurately categorizing soil/land changes over a large area.

NIR reflectance spectroscopy performed in the field offers a relatively simple, non-destructive, reliable, inexpensive, fast, and accurate method for characterizing soil. Sample preparation involves only air drying and crushing/grinding, analysis doesn't change or affect the sample in any way, no chemicals or hazardous materials are used, measurements are very fast, and several different soil characteristics can be gleaned from a single scan. Testing can be performed in a lab, or more effectively, *in situ*.

Spectral signatures of materials are defined by reflectance or absorption as a function of wavelength. NIR spectroscopy measures the reflectance of infrared light wavelengths for samples and the shapes of the soil spectra correspond to mineral composition, organic matter, clay content, water, iron form and amount, salinity, and particle size distribution. Depending on what's in the soil, individual molecular bonds vibrate and absorb light with a specific energy quantum related to the difference between two energy levels. The energy quantum is directly related to frequency and inversely related to wavelength. The resulting absorption spectrum produces a characteristic shape that can be used for analysis. The data collected can provide a picture of soil health and fertility for food source management and security, as well as natural resource management and land conservation/development.

Spectral libraries continue to be built to allow calibrations to be based on a small number of samples and then applied in the rapid analysis of large numbers. For example, in one field application, 800 spectra were collected in samples from the Railroad Valley Playa in Nevada in one day, using a SPECTRAL EVOLUTION PSR-3500 field spectroradiometer with a standard four degree field of view lens from a distance of one meter. Solar radiance of the reflected light was also captured in the same measurement.

The spectra collected can be analyzed using a range of third party analysis and chemometric packages, including GRAMS, The Spectral Geologist (TSG), and others. These software products are used for geochemical analysis and interpretation of basic soil composition, especially organic matter, texture, clay mineralogy, nutrient availability, fertility, structure, and even microbial activity.



*Soil analysis using NIR spectroscopy can measure water, carbon, nitrogen, clay, pH, and organic matter.*



*SPECTRAL EVOLUTION field spectroradiometers and spectrometers are easy to use, non-destructive, reliable, fast, and accurate*

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# SPECTRAL EVOLUTION

## Typical Soil Applications:

- ◆ Topsoil fertility
- ◆ Erosion risk
- ◆ Hydraulic properties
- ◆ Soil degradation
- ◆ Soil mapping and monitoring
- ◆ Crop monitoring during growth cycle



*The PSR-3500 spectroradiometer is ideal for soil analysis in the field or in the lab.*

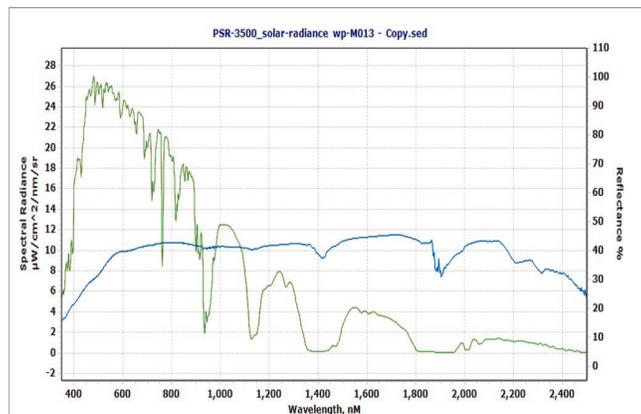
*Soil reflectance scan of the Railroad Valley Playa in Nevada taken using the PSR-3500 showing the soil reflectance (blue trace) and the solar radiance of the reflected light (green trace).*

A field spectroradiometer, such as the PSR-3500 or PSM-3500 spectrometer, allows a researcher to apply hyperspectral and multi-spectral data from satellite and airborne flyovers with field measurements. The PSR-3500 and PSM-3500 are ideal for soil analysis and mapping applications because they deliver:

- ◆ Fast, full spectrum UV/VIS/NIR measurements with a spectral range from 350-2500nm with just one scan
- ◆ Ultra-fast operation with autosshutter, autoexposure and auto-dark correction before each new scan – no optimization step
- ◆ Small and lightweight with rechargeable Li-ion batteries for field operation
- ◆ Superior signal to noise ratio with faster scan times and better reflectance measurement
- ◆ Reliable field performance with an all photodiode array platform and no moving gratings
- ◆ Detachable, field replaceable fiber optic and field swappable optics for varying target sizes and different measurement modes
- ◆ Single user operation with optional rugged PDA that provides a sunlight readable screen plus the ability to tag spectra with GPS, digital camera images, and audio notes
- ◆ Standalone operation with 1,000 scan storage

The PSR-3500 and PSM-3500 come equipped with DARWin Data Acquisition software that collects data and saves it to a compatible ASCII format for use with 3<sup>rd</sup> party chemometric analysis software without requiring post-collection processing.

In addition to the PSR-3500 and PSM-3500 SPECTRAL EVOLUTION also offers a full range of other portable spectroradiometers, spectrometers, lab spectrometers, and spectrophotometers. For more information, visit: [www.spectralevolution.com](http://www.spectralevolution.com).



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