Imaging spectroscopy of intact soil samples - combining soil organic matter data with structural properties in intact soil samples

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Visible-near infrared (vis-NIR) spectroscopy is an acknowledged technique to observe simultaneously several soil parameters, such as soil organic matter and nutrient content, moisture, texture and mineralogy. Imaging spectroscopy provides a possibility to collect spectral information from intact soil samples with a high spatial resolution of 50×50 μm^2/pixel. In our study we identified physico-chemical soil properties using a hyperspectral vis-NIR camera (spectral resolution 196 bands between 400-1000 nm and spatial resolution of 50×50 μm^2/pixel) and combined them with information on intact soil structure obtained using X-ray CT (spatial resolution of $19 \times 19 \times 19$ μm^3/voxel). We used undisturbed soil cylinders (diameter and height 3 cm) from agriculturally reclaimed soils in the open-cast mining area of Garzweiler near Cologne, Germany. Soil samples were scanned with an X-ray CT, subsequently slices from the cylinder were embedded in resin (polyester) and scanned with the hyperspectral camera. For the first time image registration of 2D vis-NIR and 3D X-ray CT images were performed in elastix. This allowed us to correlate organic and mineral soil materials with structural data classified by image processing. We identified reclamation management and plant root influence on soil organic matter accumulation and soil structural development.