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Application of Neutron-Gamma Technologies for Soil Elemental Content Determination and Mapping

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Abstract : In-situ soil carbon determination over large soil surface areas (several hectares) is required in regard to carbon sequestration and carbon credit issues. This capability is important for optimizing modern agricultural practices and enhancing soil science knowledge. Collecting and processing representative field soil cores for traditional laboratory chemical analysis is labor-intensive and time-consuming. The neutron-stimulated gamma analysis method can be used for in-situ measurements of primary elements in agricultural soils (e.g., Si, Al, O, C, Fe, and H). This non-destructive method can assess several elements in large soil volumes with no need for sample preparation. Neutron-gamma soil elemental analysis utilizes gamma rays issued from different neutron-nuclei interactions. This process has become possible due to the availability of commercial portable pulse neutron generators, high-efficiency gamma detectors, reliable electronics, and measurement/data processing software complimented by advances in state-of-the-art nuclear physics methods. In Pulsed Fast Thermal Neutron Analysis (PFTNA), soil irradiation is accomplished using a pulsed neutron flux, and gamma spectra acquisition occurs both during and between pulses. This method allows the inelastic neutron scattering (INS) gamma spectrum to be separated from the thermal neutron capture (TNC) spectrum. Based on PFTNA, a mobile system for field-scale soil elemental determinations (primarily carbon) was developed and constructed. Our scanning methodology acquires data that can be directly used for creating soil elemental distribution maps (based on ArcGIS software) in a reasonable timeframe (~20-30 hectares per working day). Created maps are suitable for both agricultural purposes and carbon sequestration estimates. The measurement system design, spectra acquisition process, strategy for acquiring field-scale carbon content data, and mapping of agricultural fields will be discussed.

Keywords : neutron gamma analysis, soil elemental content, carbon sequestration, carbon credit, soil gamma spectroscopy, portable neutron generators, ArcMap mapping
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