Geophysical Research Abstracts
Vol. 16, EGU2014-201-3, 2014
EGU General Assembly 2014


# Novel Estimation of the Humification Degree of Soil Organic Matter by Laser-Induced Breakdown Spectroscopy (LIBS) Compared to Laser-Induced Fluorescence Spectroscopy (LIFS)

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Soil organic matter (SOM) constitutes an important reservoir of terrestrial carbon and can be considered an alternative for atmospheric carbon storage, contributing to global warming mitigation. Soil management can favor atmospheric carbon incorporation into SOM or its release from SOM to atmosphere. Thus, the evaluation of the humification degree (HD), which is an indication of the recalcitrance of SOM, can provide an estimation of the capacity of carbon sequestration in soils under various managements. The HD of SOM can be estimated by using various analytical techniques including fluorescence spectroscopy. In the present work, the potential of Laser-Induced Breakdown Spectroscopy (LIBS) to estimate the HD of SOM was evaluated for the first time. In a LIBS experiment a high-energy laser pulse irradiates the sample and the energy absorbed by the sample causes a local heating of the material that results in its evaporation or sublimation. The high temperature of the ablated material generates a small plasma plume and, as a result of the plasma temperature, the ablated material breaks down into excited atomic and ionic species. During the plasma cooling, the excited species return to their lower energy state emitting electromagnetic radiation at characteristic wavelengths. In a LIBS spectrum the measurement of the characteristic emission wavelengths provides qualitative information about the elemental composition of the sample, whereas the intensities of the signals can be used for quantitative determinations. The LIBS potential for the analysis of organic compounds has been explored recently by using the emission lines of elements that are commonly present in organic compounds, such as the predominant C, H, P, O and N. LIBS elemental emissions were correlated to fluorescence emissions determined by Laser-Induced Fluorescence Spectroscopy (LIFS), which was considered as the reference technique. The HD of SOM determined by LIBS showed a strong correlation to that determined by LIFS, suggesting a great potential of LIBS for this novel application.