Application of scanning probe spectroscopy in monitoring of oil pollution

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Traditional scanning of oil pollution in soils requires lengthy sample preparation and gives no information about how well the sample properties are represented by the measured values. The use of pattern recognition chemometric procedures with spectroscopy offers a simple and effective solution for the identification of sludge by hydrocarbons derived from oil.

A transition from traditional to hyperspectral measurements not only provides a completely new qualitative nature of the data, but also increases the quantity of the information. The challenge is to reduce the dimensionality of the data while retaining important spectral information with the power to classify areas of a sample effectively. Such complex signals require advanced chemometric procedures to extract the relevant information especially because the measurements are performed directly in the process.

Applying an imersion fiber probe from J&M Analytic AG, five types of sludge with different characteristics and of different origins were studied: treated contaminated soil, post-processed bottom barn sludge, barn flotsam, bottom barn sludge, and sewage treatment refinery sludge. Data collection was performed from the near infrared spectral range to UV-region.

Principal component analysis with autoscaling revealed that sample differentiation was possible using the wavelength range from 200 to 600 nm (UV-Vis). Different types of sludge are grouped in separate clusters. In this case there is a clear division into three highly contaminated sludges on one side, and two relatively clean sludges on the other side. That suggests the greatest effect on the position of the first principal component of oil products in sludge. The first principal component describes 98% of the variance of the samples in the multidimensional space. No relationship between the second and higher principal components and any of the measured properties of the samples was found.

The results obtained show clearly differentiated clusters for the different of types of sludge and correct predictions, thus allowing the differentiation contaminating soils in a reliable manner. Additionally, no prior treatment of the samples is required, thus minimizing the important errors associated with this step of the analytical process. As for the future development, the widespread use of hyperspectral surveys in the cosmic space, air and ground surveillance, expands the boundaries of the proposed methodology, and will make the monitoring of oil pollution in the soil even more effective and faster.