

Field based soil analysis

Portable FTIR and XRF



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Introduction

The amounts and quality of soil organic- and mineral- matter affects the quality of crops.

- Soil organic matter and clay minerals strongly influences the water holding capacity, pH and the supply of nutrients.
- The amounts of micronutrients in the soil affect plant growth and the nutritive value to consumers.

Cost effective methods for the direct analysis of soil in the field for mineral and organic components are in their infancy.

- Portable Fourier Transform Infrared (FTIR) spectroscopy has the potential to provide information about the amounts and quality of soil organic matter, clays and other soil minerals.
- Portable X-Ray Fluorescence (PXRF) spectroscopy has the potential to provide information about the amounts of individual elements in soil that are essential for the crops (e.g. copper) and those that may be undesirable (e.g. lead).

Therefore, we are developing methodologies for analysis of soils in the field using FTIR and PXRF. Such methods will allow detailed analysis and mapping of soils across individual fields.



Acknowledgement

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FTIR

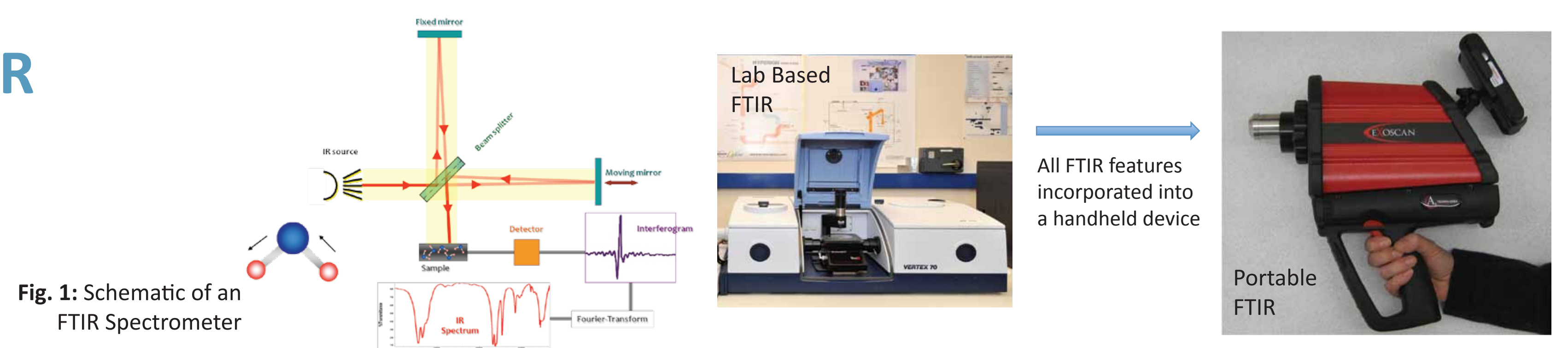


Fig. 1: Schematic of an FTIR Spectrometer

- In FTIR analysis, samples are irradiated with infrared radiation and a detector records which frequencies have been absorbed and then these are displayed in a “trace” or IR spectrum, see Fig. 1. This spectrum gives a chemical profile of the sample including both organic and inorganic components, see Fig 2.

- From the IR spectrum of a soil sample the nature and proportions of the soil organic matter and the minerals present can be determined. It can also be used to predict properties of the soil such as %C, %N and pH.

- The handheld FTIR allows rapid *in situ* characterisation of samples (see Fig. 3) with no sample preparation required, and is non destructive. However, work is still required to overcome problems created by soil moisture and particle size issues.

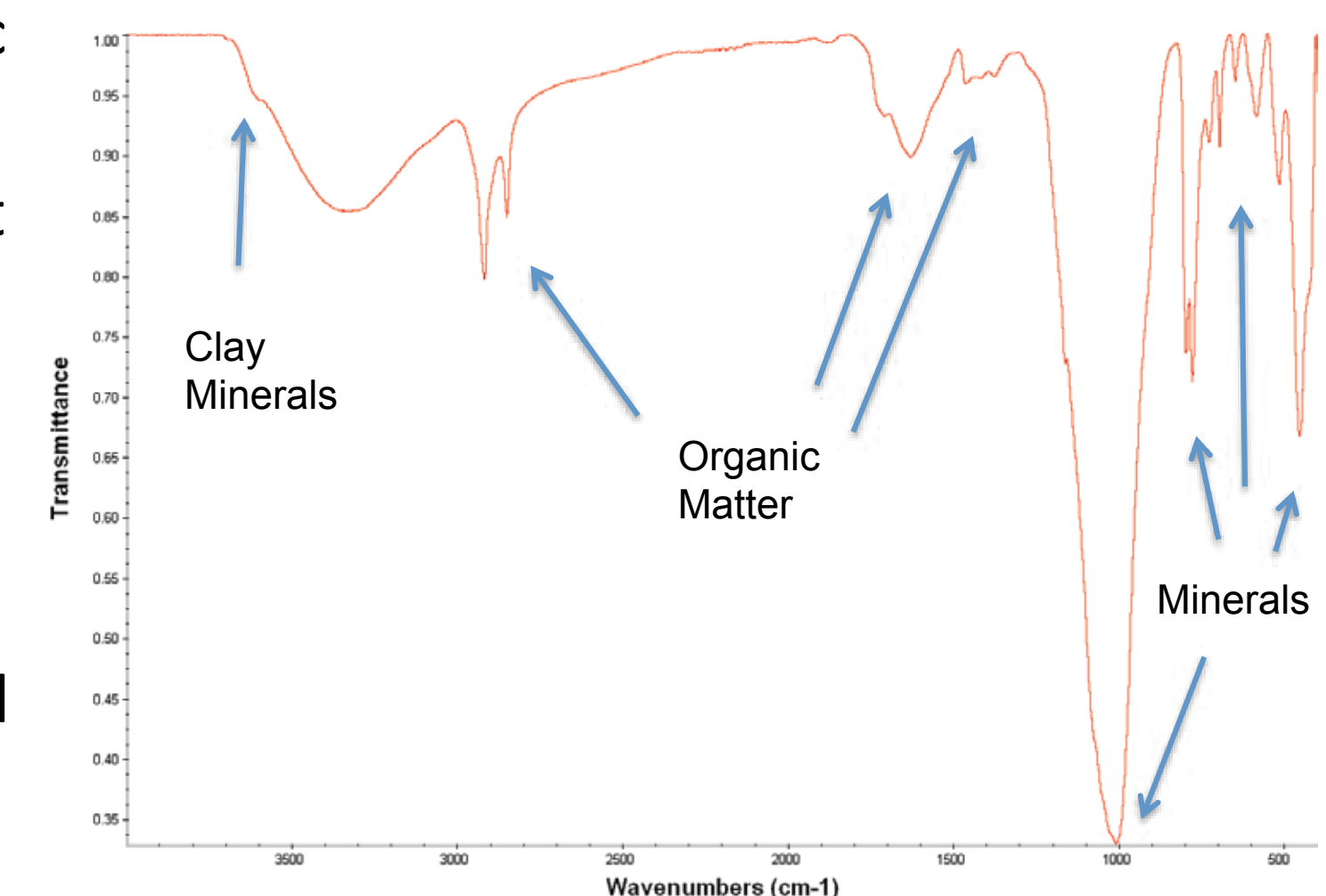


Fig. 2: IR Spectrum of a Soil Sample

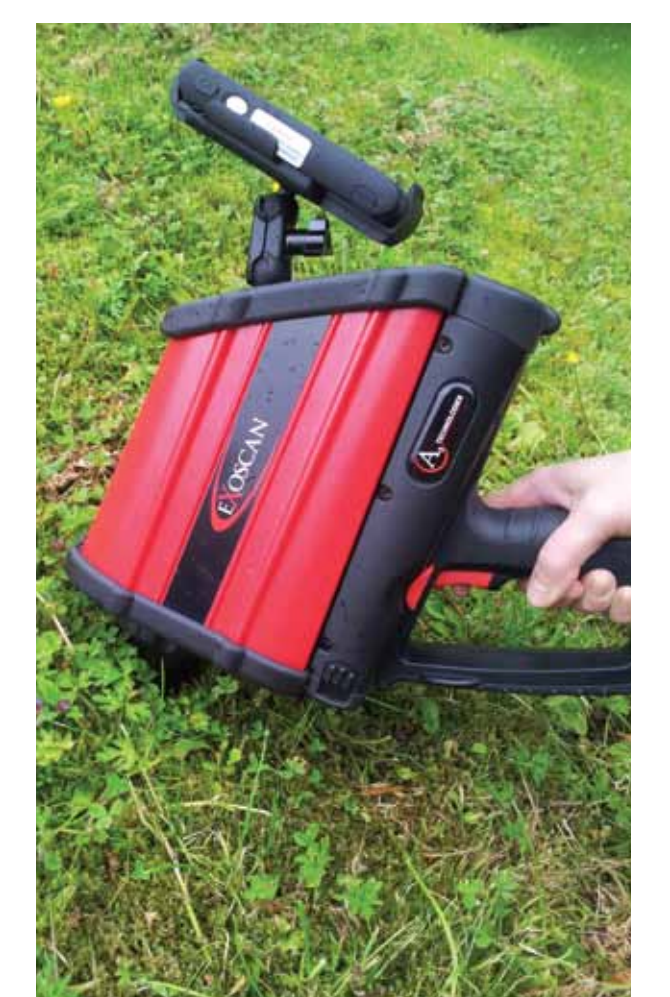


Fig. 3: Field analysis using portable FTIR

PXRF

- The principle of PXRF is depicted in Fig. 4. The device contains an X-ray tube which irradiates the sample. The incident rays eject electrons from the atoms of the elements in the sample, resulting in the emission of x-rays with energies that are characteristic of the elements present. The emitted rays are analysed using a silicon drift detector. The results are immediately displayed and stored.

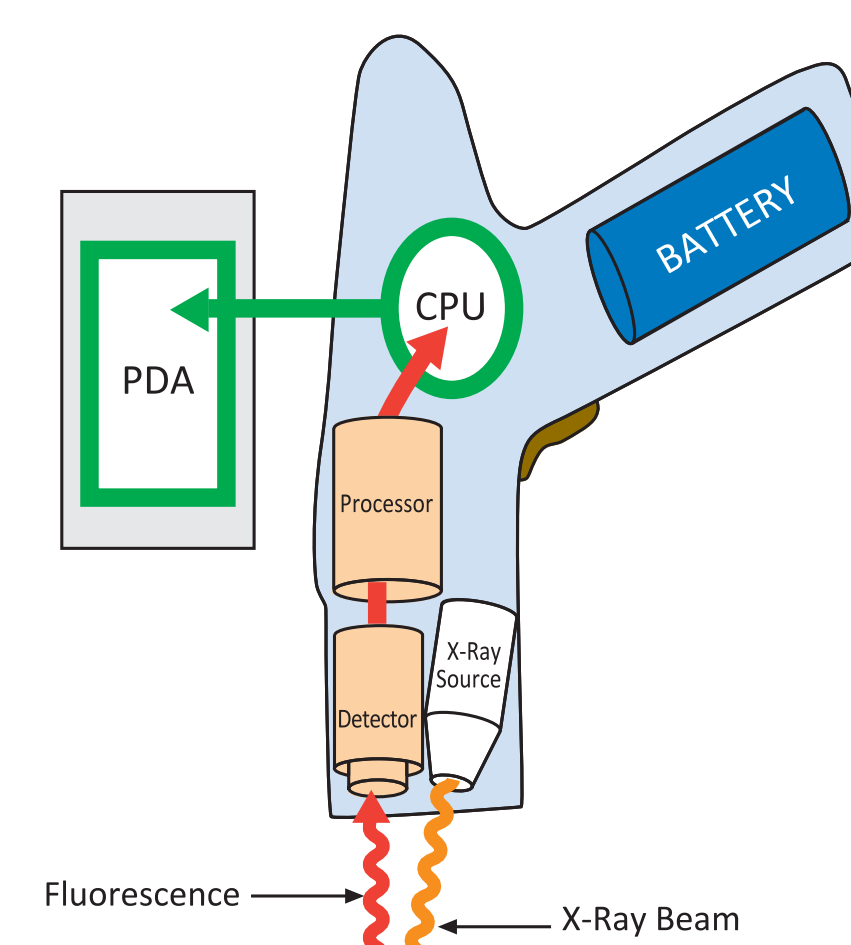


Fig.4: Schematic of a PXRF analyser.

- Analysis is rapid, 1-2 minutes per sample. Limits of detection are ~cadmium 25, lead 10, selenium 10, arsenic 15, copper 35, nickel 50, chromium 150 mg kg⁻¹ but depend on the x-ray source and sample matrix. It is not possible with our equipment to measure “light” element such as N and C. However, N and C can be assessed by FTIR.

- The use of the hand held device in the field and data for the analysis of a contaminated soil is depicted in Fig. 5.

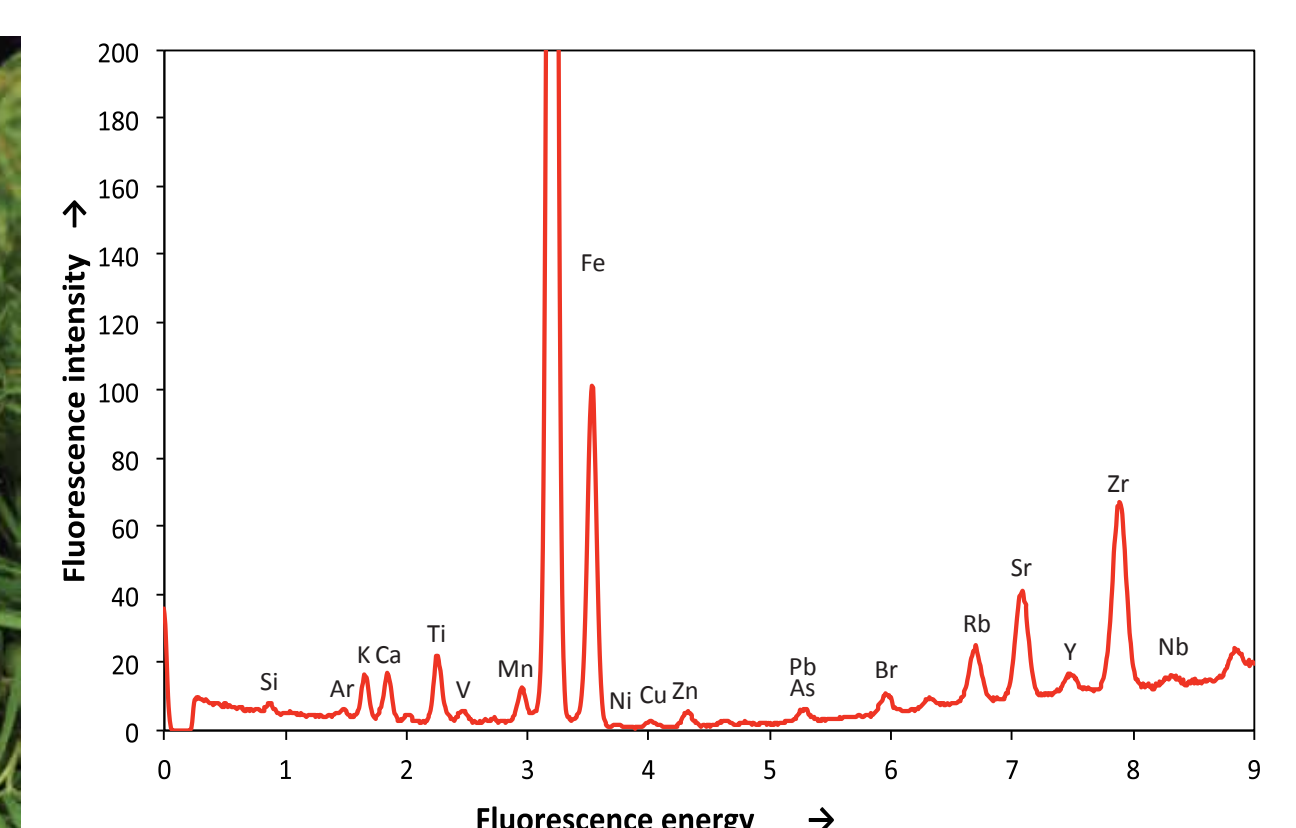


Fig.5: PXRF analysis in the field and an example spectrum of a reference soil.

Conclusions

Preliminary results for soil analysis using the new field based technology have been very promising:

- In the laboratory the portable FTIR has been shown, with dry soils in their natural state, to be capable of predicting several agronomically important parameters including N, C and pH with an accuracy approaching that of wet chemistry methods.
- In the field PXRF has been shown to be capable of detecting increased concentrations of essential elements (e.g. copper) and undesirable elements (e.g. lead) in soil treated with organic amendments.