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Field portable X-ray Fluorescence (FPXRF) Analysis – Case Studies on Validation and Application in Geomorphology

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The determination of element concentrations in sediments and soils is a basic methodical approach in both geomorphology and soil science. The evolution of field portable X-ray fluorescence (FPXRF) analysers provides new possibilities in the detection and quantification of element distributions in soils and sediments. In principle, FPXRF analysers rapidly can determine element concentrations on sites of interests directly by *in situ* measurements without pre-treatment and sampling. So far, some studies were carried out using FPXRF spectrometry to analyse heavy metals on contaminated sites showing that it is a proper and easy to handle technique for a fast assessment of extent and spatial distribution of a metal contamination. However, investigations with FPXRF analysers are very less known in geomorphology and soil geography although these branches obviously have various applications for such a technique yielding instantly element concentrations of soils and sediments on a site scale, e.g. in a soil pit or on a catena.

In order to strengthen the analytical competence of geomorphologic research this paper aims (i) to describe the principles and technical characteristics, (ii) to validate the *ex situ* performances and (iii) to test the *in situ* applications of a FPXRF analyser. In detail, statistical parameters of *ex situ* repeat measurements are presented to characterise detection limits, precision and comparability of FPXRF analyses. Moreover,

selected results from a research project studying the heavy metal contamination of alluvial soils in a historic mining area exemplifies the applications *ex situ* element quantification and *in situ* detection of small-scale element distributions.

The results show that FPXRF instruments can properly analyse element concentrations in sediment and soil samples and offer a wide range of applications in soil science and geomorphology. Detection limits, precision and comparability of *ex situ* (intrusive) measurements with the evaluated NITON XL 722s FPXRF analyser are sufficient to quantify and differentiate element concentrations from about 10 mg/kg to several 1000 mg/kg. Because of the easy to use, the celerity and especially the missing of any pre-treatment of samples FPXRF analysis is appropriate for a fast element screening of sediments and soils. On this basis further analyses can be planned more accurately and specifically reducing time and money. Operating with long time *ex situ* measurements FPXRF can be applied to quantify metal contents comparably to total contents derived form aqua regia dissolutions. But, element dependence of the XRF analyses must be considered and evaluations specific to the aim and scope of the studies should be arranged prior to this. *In situ* measurements are able to characterise the small-scale distribution of element concentrations in soils and sediments. Of course, this approach easily can be modified for applications on smaller scales and greater areas. That means, FPXRF analysers can be used to map element concentrations on a site and landscape scale. Perhaps this is the most important finding concerning the study of soils within the scope of geography and especially geomorphology. However, the operator strongly influences the performance of the measurement and therefore he should have a basic knowledge of both the FPXRF instrument he uses and the soil or sediment he analyses.