Field Analytical Techniques for Geochemical Surveys

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Introduction

Obtaining geochemical results in the field has been a persistent dream for exploration geologists in the last century, and a few practical geochemical? tests were developed, but shipping samples to faraway labs and waiting weeks for results was the rule. This remained a dream until around 1990, when technology developments of portable instruments allowed on-site measurement of the first key metals in solids. This development progressed rapidly and by 2010, most geochemists could have access to portable field analytical methods, if they decided so. These instruments were soon used for environmental investigations too. At the same time, field instruments for water analysis were developed, with applications in the environmental, ore processing and exploration domains.

Results

The present communication is based on our own work (Negrel et al. 2007; Liakopoulos et al. 2010; Lemiere et al. 2014), and, more importantly, on major contributions since 1995 by several field geochemists (Kalnicky & Singhvi 2001; CL:AIRE 2008; Hall et al. 2012). An important set of thematic papers on pXRF was also published in GEEA in 2014 (vol. 14) and a review paper on pXRF is currently in preparation, which will provide a comprehensive set of references.

Field analytical techniques cannot provide the level of optimisation laboratory analyses do. However, they are needed where there is no other option. They offer flexibility and/or reactivity in field operations.

Current validated applications for analysing solids (mostly by pXRF) comprise:

- mining rock face evaluation, ore processing monitoring, soil remediation and waste management (operations, etc.) requiring fast decision-making measurements and analyses,

- site evaluation grids (mainly on soils, both for environmental and mineral exploration surveys),

- fast drill-hole logging and drilling decisions,

- screening of samples to select which ones will be analysed in the lab, and

- identification of potential resources from waste.

Current validated applications for analysing water (mostly with voltammetry, polarography or ion selective electrodes), along with physicochemical sensors) comprise:

- wastewater treatment or discharge monitoring, including process monitoring and alarm networks requiring fast decision-making measurements and analyses,

- catchment mapping and reconnaissance (both for environmental and mineral exploration surveys),

- screening of samples to select which ones will be analysed in the lab, and

- catchment or pit lake reconnaissance and monitoring, groundwater logging and monitoring requiring improved measurements and analyses for site investigations.

Discussion

Impassioned debate followed development since 1995 about the quality of field analyses vs. laboratory analyses, with often non-neutral contributions from instrument suppliers and from the laboratory profession. Beyond instrument limitations, it appeared soon that sample preparation and sample representativeness were key issues to interpret field analytical results. This is still the case today, even if documented evidence of field-lab concordance is frequently published – by geochemists who pay attention to sample preparation and representativeness. The late apparition of relevant standards, to the notable exception of EPA 6200 (1998), did nothing for a smooth acceptance of field methods or their beneficial introduction in the analytical toolbox of applied geochemists.

Benefits of field analysis comprise in-situ analysis, without transport issues, implementation of dynamic and adaptive sampling plans along results collection (Robbat, 1997; Crumbling, 2001; US-DOE, 2001, Triad), increase of data density and quality (through larger data sets) and better representation of transient phenomena.

Possible pitfalls include improper interpretation of field data as a result of insufficient understanding of the sampling and measurement processes, use of heterogeneous data sets collected by different methods, and the lack of critical examination of data.

Current developments of new or adapted technologies cover mineralogy (portable XRD, micro Raman, IR spectroscopy), light inorganic elements (LIBS, pXRF), organic substances (IR spectroscopy, GC, GC/MS) and more focused applications.

Field techniques offer their best value when they cooperate with the laboratory throughout the investigations.

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