



RECENT ADVANCES IN GEOANALYSIS AND THEIR IMPLICATIONS

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ABSTRACT

The nineties are certainly the decade of ICP mass spectrometry (ICP-MS) in geoanalysis. It has been somewhat of a delayed acceptance, in view of the fact that it was the geo-sector of analysts who quickly appreciated the power of this ultra-sensitive technique when it was launched commercially (in Canada) in 1983 (Hall, 1992). However, the ruggedness and user-friendly design of the second generation of instruments have now established ICP-MS amongst the core group of tools employed by the commercial laboratory which provides analyses for the exploration community. Not to be left behind, research into new detectors for analysis by ICP emission spectrometry (ICP-RS) has culminated in another generation of this instrumentation, boasting improvement in its detection limits by an order of magnitude coupled with full automation and excellent productivity. Whereas we recently thought of solution detection limits by ICP-MS and ICP-ES being in the ppt and ppb regions, respectively, we now must lower those images, to the ppq and ppt ranges for many elements. Such detection capability has opened the doors to accurate and precise determination of trace and ultra-trace elements in selective leaches and in waters.

At the Geological Survey of Canada (GSC), we have examined in detail three leaches designed to specifically extract elements bound in soils and sediments in the following phases; humic and fulvic organic complexes; Mn oxides; and amorphous Fe oxyhydroxides (Hall et al., 1996a,b). This paper discusses the strengths and weaknesses of these leaches, focussing on elements such as Pb, Cd, Hg, Sb, Bi, As, Au and I. The complete sequential extraction scheme used by the GSC (based on overviews in the literature; Chao, 1984; Kersten and Forstner, 1989) is also described, together with examples of its usefulness in discriminating and apportioning element sources (e.g., clastic dispersion vs hydromorphic transport vs diagenesis). The "Enzyme" leach, designed to specifically dissolve elements bound to amorphous Mn oxides, has been widely employed by the exploration industry. Several case histories comparing signatures derived from its application with those using the GSC protocols will be discussed.

The sensitivity of ICP-MS and ruggedness of ICP-ES now provide the analytical capabilities to support hydrogeochemical exploration. Surveys carried out by the GSC in the Maritime provinces demonstrate the power of this technique, wherein 50–60 elements are determined in samples of reasonable size (e.g., 50 ml). Modification to the front-end of an ICP mass spectrometer, such as a hydride generation unit on flow injection, provides the added sensitivity required to measure elements such as Se, Te and Bi down to their background levels. Examples of successes in pinpointing mineralisation will be given. Further progress in lowering detection limits for the PGEs, including Au, is required so that relatively small sample volumes may be used. Areas for continued research in geoanalysis are outlined.

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