Analytical cosmochemistry: 1965-2010

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Cosmochemistry is predominantly observational and analytical. Many extraterrestrial materials are complex mixtures. Very small grains within these may carry unique signatures of early solar system conditions, events, and processes. The isolation and analyses of presolar materials are the best examples of this. Evolving from the days of mass spectra on strip charts analyzed with a magnifying glass, a 9H pencil and a Marchant calculator, the development of the first mass spectrometers with computerized data acquisiton by Wasserburg and Papanastassiou was driven by the recognition that potentially unfavorable parent/daughter ratios in meteoritic and lunar materials required another decimal point in the precision of isotopic ratios for geochronological purposes. The obvious importance of trace element and isotopic analysis in small areas of relatively rare, but not always perfectly preserved, meteoritical materials such as Ca-Al-rich inclusions spurred the development of ion probes.

In recent years NASA has supported laboratory instrumentation, recognizing that sample return missions are important, and these could be done on smaller budgets than Apollo. Stardust and Genesis were carried out within the Discovery Program low cost format. For Stardust, the experience with ion probe and transmisson electron microscope analysis gained from meteorite, and especially interplanetary dust, analyses provided the basis for quick return of important science results. Stardust has also injected a wide variety of synchrotron-radiation-based elemental and mineralogical techniques into the wider geo-and cosmochemical community. Meeting the scientific objectives of a solar wind sample return was not possible without the development of advanced high sensitivity, low background analytical facilities with the direct use of Genesis mission funds. The crash of the Sample Return Capsule has seriously complicated meeting Genesis science requirements, but, although much work remains, it can be fairly concluded that we have successfully met our highest priority science objectives. I can demonstrate that the investment made in advanced analytical facilities was a good one.

OKUM and MUH-1: Two new IAG-certified ultramafic rock reference materials

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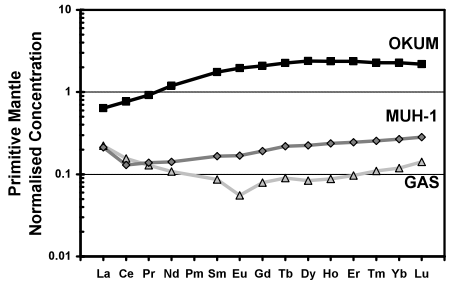
Owing to their low trace element concentrations, most currently available ultramafic reference materials are poorly characterised for many of the trace elements commonly used in lithogeochemical studies. Most certificates and available compilations (e.g. GeoReM) either omit many of the trace and ultra-trace elements or report values with large or poorly defined uncertainties. In order to fulfil the need for better characterised ultramafic rock reference materials, the International Association of Geoanalysts (IAG) undertook the comprehensive characterisation of a komatiite (OKUM) and harzburgite (MUH-1) using the protocol laid out by Kane *et al*. (2003) [1] and in compliance with the International Organisation for Standardisation (ISO) Guide 35 (1989 and 2006). By pre-qualifying laboratories through their prior performance in Geo*PT*™ proficiency tests using matrix-matched test materials, the data rejection rate was minimised (<8% for most REE), enabling robust and precise reference values to be obtained (see figure).

Initial results of statistical processing indicate that the expanded measurement uncertainties (U) for all of the REE in OKUM (as well as many of the HFSE and LILE) and most of the REE in MUH-1 are at least three times less than those for expected for routine laboratory measurements, as estimated from the Horwitz factor [2], and so match or exceed those required for certification. These reference materials therefore have the potential to be the best characterised of their kind currently available.



[1] Kane *et al*. (2003) *Geost. Newsletter* **27**, 227–244.
[2] Horwitz & Albert (1995) *Fres. J. Anal. Chem*. **351**, 507–511.