Refining the complete uncertainty budget of quantified results measured by LA-ICP-MS

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The LA-ICP-MS analyst can improve the interpretation of quantified values if presented with a comprehensive uncertainty budget. As well as enabling judicious application of the results, an uncertainty budget rapidly guides the analyst in method optimisation and appraisal of analytical limitations and constraints.

The first attempt at estimating the total uncertainty budget for the quantification of trace elements by LA-ICP-MS was published by Luo et al. [1] with their calculation based on the EURACHEM/CITAC-Guide [2]. We have implemented that approach in a new software package LADR (pronounced “ladder’) that can load data files from most commercially available ICP-MS instruments.

The uncertainty calculation we are using has been refined and revalidated using both synthetic and representative real sample data sets. Assessment of the reported uncertainties has been derived from community guidelines [3] and complementary studies [4].

A significant benefit of determining and quantifying all of the factors contributing to the complete uncertainty is the ability to purposefully resolve separate components of the budget relating to precision and accuracy. Despite this, in practice it is typically not feasible to report many separate uncertainty terms along with analytical results. To facilitate the interpretation of measurement uncertainty, we introduce here the concept of *levels* of uncertainty as a useful practical tool to assist the analyst. The levels we define are called, in order: “Signal Precision”, “Quantification Precision”, “Within-Run Analytical Precision”, “Full Within-Lab Analytical Precision”, and “Full Analytical Uncertainty”. The software allows the analyst to report uncertainty values appropriate to a specific requirement, whether that be an intra-run, intra-laboratory, or inter-laboratory comparison.

The software package “LADR” is available for download from the authors’ website [5].

[1] Luo et al. (2007) JAAS **22.2**, 122-130. [2] Ellison & Williams (2012) Eurachem/CITAC guide, ISBN 978-0-948926-30-3. [3] Horstwood et al. (2016) *Geostand. Geoanalytical Res.* **40.3**, 311-332. [4] Gilbert et al. (2013) *Geostand. Geoanalytical Res.* **37.1**, 51-64. [5] http://norsci.com/ladr/ “LADR” (Mar 2019).