Spatial resolution and the analysis of complex geometries in LA-MC-ICPMS

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In typical LA-MC-ICPMS applications the requirement for large signals (ideally many volts, measured on Faraday cups), necessitates ablation using relatively large spot sizes, and comparatively rapid drill rates. Unfortunately, however, the size and/or geometry of many analytical materials precludes the use of such conditions. In such circumstances a number of alternative analytical approaches can be contemplated using a combination of appropriate ablation systems and time-resolved analysis (TRA) software.

Since ablation pits are generally many tens of microns in diameter and yet individual pulses may ablate only a few tenths of microns at a time, theoretically, depth profiling is capable of providing the best resolution and appears to be a viable technique as long as pit aspect ratios do not greatly exceed 2:1 (depth:width).

In many circumstances, however, (e.g. relatively large yet thin samples) depth profiling is not feasible and, in these cases line scans must be considered as an alternative analytical strategy. In this case excimer lasers offer the potential for ablation of a 'slit' rather than a simple spot, thus maintaining high resolution while still allowing ablation of sufficient material for analysis.

Finally, for samples with complex zonation, one further solution is to lower the spot size, increase the repetition rate, and ablate along a pre-digitised path using an appropriate translation speed to achieve optimum signal intensity.

In all these cases, adequate TRA software is essential to the task and yet, unfortunately, remains an area where individual users are often required to implement their own solutions.

Examples will be shown of all these approaches in the analysis of a range of common geological and zoological materials.

In-situ single spot analysis of B isotope ratios by laser ablation multiple ion counting ICPMS

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We have developed a method for the in-situ single spot B isotopic analysis of geological materials using laser ablation multicollector ICPMS. A New Wave UP213 laser was coupled to a Finnigan Neptune equipped with both Faraday and ion counting detectors. Samples with different B contents and isotopic compositions have been analysed, including B4 tourmaline and three MPI-DING glasses (StHs6/80-G, GOR132-G and GOR128-G).

Before firing the laser, the mass spectrometer was tuned and the ion counters were cross-calibrated by a peak jumping routine, using a very diluted B solution. Spot sizes varied between 60 and 80 μm and the laser energy ranged between 5 to 20 J/cm^2. The analysis run consisted of 30-40 cycles (each 1 s). The B signals were corrected for the B background (typically ~900 cps ^{11}B), measured before the start of laser firing. To correct for fractionation effects the standard-sample bracketing approach was applied using NIST SRM 610 as external standard. The corrected ^{11}B/^{10}B is finally referenced to NIST SRM 951) in order to obtain the delta notation.

The B4 tourmaline, containing up to 31400 ppm B, was measured using Faraday detectors, with internal precisions (on single spot analyses) better than 0.1‰ (1σ). The weighted average δ^{11}B is -8.3±0.15‰ (1σ). The MPI-DING glasses, with B contents between 11 and 23 ppm, were measured on multiple ion counters. They have δ^{11}B values of -4.3±2.4‰ (StHs6/80-G), +6.8±3.0‰ (GOR132-G) and +13.5±1.6‰ (GOR128-G). Within-run precisions are between 1.6 and 3.2‰, which are very close to the theoretically expected uncertainties based on counting statistics (~2‰).