Advances in High-Performance LA-ICP-TOFMS Imaging

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Elemental imaging with laser ablation (LA) ICP-MS has progressed from slow acquisition and cumbersome assembly of images in post-processing towards a near-real-time 2D imaging methodology. The main limiting factors that define the forefront of current innovation are the wash-out time of the LA cell, the measurement time on the mass spectrometer, and speed of data (post)processing.

Sequential mass spectrometers, such as quadrupoles, do not allow measurements of more than a few isotopes within the 2-4 ms response of a single laser ablation pulse, thereby limiting typical imaging data sets to a small number of analytes.

This acquisition speed bottleneck is overcome by utilizing time-of-flight mass spectrometers, acquiring a complete mass spectrum containing all elements at a rate of several tens of kHz, and thus enabling full elemental information from every laser shot. Therefore, one laser pulse per pixel is sufficient, drastically shortening the acquisition time for a given image. In our workflow, full coordination information is saved with every measurement, which allows for a real-time preview and straight-forward image creation in post-processing.

We present examples of LA-ICP-TOF-MS imaging of garnet samples from the South Carpathians, exhibiting the growth history in multi-element maps and profiles. Such information if widely used to reconstruct details of the regional geological makeup as well as for detailed studies on diffusion behaviour of elements in minerals, yet we demonstrate the advantages of rapid-aquisition, high-resolution, multi-element maps for these purposes. We also present performance metrics of the utilised instrumentation and advanced data interrogation techniques.