Nanoscale trace element analysis of zircon via high spatial resolution SIMS in a FIB-SEM

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Focused Ion Beam Scanning Electron Microscopes (FIB-SEMs) can routinely achieve ion beam spot sizes < 25 nm using a gallium liquid metal ion source (LMIS). The primary use of such instruments is for sputtering material away for site-specific sample preparation or for 3D ‘slice and view’. Recently, FIB-SEMs have been fitted with a Time of Flight Secondary Ion Mass Spectrometer (ToF-SIMS), which enables the instrument to be used for mass spectrometry in addition to other functions.

ToF-SIMS with a LMIS has a number of advantages for analysis of zircon and other accessory phases. Spatial resolution of <50 nm can be achieved for elemental maps and the detection limits for alkalis and REEs are much lower than for energy dispersive x-ray spectroscopy (EDS) [1]. Other advantages include light element analysis, isotopic analysis, and sub-µm depth profiling. When low beam currents are used (e.g., 200 pA), only a few tens of nanometers of material are removed from the sample surface, allowing the analysed region to be prepared for subsequent site-specific sample preparation such as Transmitted Electron Microscopy (TEM) or Atom probe Microscopy (APM).

Here we present results from a number of studies of zircon. ToF-SIMS was used to reveal that a dark CL region at a zircon core-rim boundary was associated with an increased concentration of the trace element Y. Analysis of shocked zircons revealed trace elements such as Y, Ca, Al and Fe concentrated at features such as twins and reidite lamellae, giving insights into trace element migration due to shock metamorphism.

[1] D Alberts et al (2014), *Instrumentation Science & Technology* 42, p. 432-445.