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High-resolution (<5 micron/pixel) 2D geochemical imaging of biogenic carbonates using a Nu Vitesse TOF-ICPMS

GAVIN L FOSTER[1], J ANDY MILTON[1], CHRISTOPHER D STANDISH[1], PHIL SHAW[2], LUKAS SCHLATT[2] AND BENCE PAUL[3]

[1]University of Southampton
[2]Nu Instruments
[3]Elemental Scientific Lasers

Presenting Author: g.l.foster@soton.ac.uk

Many applications at the forefront of the Environmental and Earth Sciences require in-situ micro-scale geochemical imaging of composite materials. Such analyses are however challenging, requiring analytical techniques that are either expensive with limited accessibility (e.g. synchrotron and nanoSIMS) or time-consuming and able to only analyse a limited range of elements (e.g. electron probe). Laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) as a tool for generating 2D images has grown in popularity, however many analytical issues remain when generating high-spatial resolution geochemical images using this approach. Here a fast wash-out laser ablation system coupled to the near-full mass spectra capabilities of the Nu Instruments Vitesse time of flight (TOF)-ICPMS is used to rapidly generate 2D geochemical images at <5 micron/pixel resolution. Image processing and quantification is achieved with iolite 4, ensuring these images are free from the artifacts that typically plague LA-ICPMS. The rate of image acquisition is limited by the wash-out rate of the laser ablation cell, implying that very rapid wash-out cell designs and fast repetition rate lasers would further reduce the time required to generate the images and dramatically increase throughput. By applying our quantitative LA-TOF-ICPMS method to a range of biogenic carbonates (coral skeletons and foraminifera) we provide valuable insights into biomineralization mechanisms and vital effects that enable more robust reconstructions of past environments.