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A FORWARD LOOK IN APPLICATIONS OF HIGH-SPATIAL RESOLUTION LA-ICP-MS U-Th-Pb GEOCHRONOLOGY

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ABSTRACT

It is now easier than ever to begin dating materials using U-Th-Pb geochronology. A basic quadrupole ICP-MS and laser ablation system is all that are needed and with recent improvements in efficiency of both instruments and analytical set-up, our ability to target lower U materials has increased significantly. As a result, younger zircons and lower U minerals such as apatite, rutile and carbonates are now possible to date with the U-Pb system. Sub-million year ages can now be determined and laser ablation ICPMS sensitivities even enable determination of U-series ages. This gives the potential to date materials in the 100 - 500 ka range by both U-Pb and U-series using LA-ICP-MS, allowing cross-calibration of these different dating methods applied to more recent volcanic activity.

Improvements in transmission efficiency of the laser ablated material from the sample cell to the mass spectrometer have had significant impact on the speed and throughput of data acquisition, allowing high speed elemental and isotopic mapping of materials to be a practical proposition. The insights these maps bring provide context to the interpretation of conventional static spot analyses, hugely increasing the strength of interpretation. This efficiency can be turned to the vertical dimension, increasing spatial resolution to the 10 - 100 nm scale whilst depth profiling mineral grains. Analysis of petrographic thin sections, again providing important context for interpretation, is therefore easier with this increased control on depth resolution which also lends itself to diffusion studies and within-grain U-Pb Discordia interpretation. This petrochronology, interpreting the elemental, isotopic and age information with petrographic context, usually using a 'split-stream' two mass spectrometer arrangement, represents a significant growth area for the geochronology community. This approach and ideology is then applied to a range of non-zircon minerals such as monazite, titanite, apatite, xenotime and rutile, to enhance understanding of thermal histories (magmatism, metamorphism and cooling) related to tectonics and the understanding of uplift and erosion rates.

The diversity of applications for laser ablation geochronology is increasing rapidly. The flexibility of this analytical tool and improvements in data quality are encouraging targeting of more varied mineral types and greater numbers of samples. Volumes of data generated are vast and tools for handling and visualising the data appropriately are required to ensure that data are validated and that appropriate interpretations are made. This brings together geoscientists with data scientists and mathematicians, broadening the skill base in U-Th-Pb geochronology and the required understanding and skills of the user. The future for LA-ICP-MS U-Th-Pb geochronology is therefore, bright, growing rapidly, with seemingly endless possibilities for application. Some of these future possibilities will be highlighted here along with the current applications that are pushing the boundaries of the methodology and enabling new scientific directions.