

Fast (>50 Hz) U-Pb LA-ICPMS spot dating of U-bearing minerals using an aerosol rapid introduction system

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Recent developments in laser ablation systems include ultrafast-response laser-ablation sample cells, developed primarily for making rapid 2D or 3D LA-ICPMS maps (“images”) of elemental or isotopic composition of millimeter-sized areas of sample. Here we investigate the potential of these ultrafast-washout sample cells for rapid U-Pb spot dating of U-bearing phases (zircon, rutile, titanite and apatite), using a Photon Machines Analyte Excite laser ablation system coupled via an aerosol rapid introduction system (ARIS) to an Agilent 7900 ICPMS.

The ARIS system enables combined wash-in and wash-out times of 20 ms - 30 ms to baseline (depending on tube diameter), and thus easily facilitates minimal washout (3 s) between each spot analysis. However as the ARIS resolves individual single pulses at fast sample rates, spot analyses require a high repetition rate (> 50 Hz) so the signal does not return to baseline, and duty cycles (> 80 ms) that span several laser pulses. All spot analyses employed 250 to 300 pulses, repetition rates of 53 to 65 Hz (total ablation times of 4.1 to 5.7s) and low fluence (1.75 – 2.5 J/cm²). Pit depths measured by white light interferometry were typically 12 µm.

The standards and spot sizes used in sessions were: zircon [18µm] 91500 (P), Penglai, WRS-1348, Plesovice, Temora2; apatite [36 or 47µm] Madagascar (P), Durango, McClure Mountain, Emerald Lake, , Kovdor, Slyudyanka; rutile [36µm] R10 (P), R19, PCA-S207, Sugluk-4; and titanite [36µm] MKED1 (P), OLT1, BLR-1, FCT and Khan, where (P) denotes the primary standard. U-Pb data were reduced in Iolite with the VizualAge[1] DRS, and a modified DRS for variable common Pb in the primary standard [2].

Secondary standard data typically reproduce with an accuracy and precision of < 1% for pre-Cenozoic reference materials and < 2% for younger standards, with a combined ablation and washout time of c. 8 s. Spot analyses of > 1000 grains can thus be conducted in less than 3 hours with a precision and accuracy comparable to conventional analytical protocols, facilitating the acquisition of huge detrital datasets. [1] Petrus and Kamber (2012) *G&GR* **36**, 247-270. [2] Chew *et al.* (2014) *Chemical Geology*, **363**, 185-199.