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Pushing the limits for in-situ U-series (U-Th) geochronology in carbonates

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U-series (U-Th) geochronology is a crucial tool in palaeoceanography, palaeoclimatology and archaeology for quantifying the ages of geologic materials and rates of geologic processes in the Pleistocene and Holocene. Laser Ablation (LA-) Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is routinely used for in-situ measurement of isotope systems, allowing for rapid, high spatial resolution analyses. Previous studies have shown the viability of LA-U-Th age 'screening' of carbonates (shallow and deep water corals, veins, and speleothems) allowing for 30+ dates per analytical session. However, this tool remains under utilised often due to concerns regarding limited precision and external reproducibility.

In this study we present results from multiple years of LA-U-Th analyses and continued improvements in methodology. These results highlight that with careful selection of primary reference materials together with optimal instrumental tuning and high sensitivity, U-Th age uncertainties of 2-5% (2σ; U ~0.5 to 5ppm) are routinely achievable. With multiple repeats, age precision of <2% are possible. The reference materials used in this study are cross calibrated between U-series labs, providing excellent agreement in accuracy.

Detection limits are ultimately limited by the counting statistics of ^{230}Th, and we show that accurate ages can be determined when approaching instrumental background (3σ ~0.4 cps). The corresponding age detection limit is primarily controlled by U concentration and can provide a maximum age constraint. Depending upon U concentration, this is ~5 ka in shelly material (calcite; U<1ppm), ~0.85 ka in deep water corals (aragonite; U~3-4ppm), and 0.5 ka in higher U vein material (aragonite; U~5ppm).