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Rapid and Accurate U-Th Dating of Ancient Carbonates using Inductively Coupled Plasma-Quadrupole Mass Spectrometry

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Here, the potential for rapid and accurate U-Th dating technique of marine aragonite skeletons (deep-sea corals, Lophelia pertusa) and secondary calcite deposits (speleothems and stalagmites) has been explored using inductively-coupled plasma-quadrupole mass spectrometry (ICP-QMS). The analytical procedure includes a largely simplified chemical separation technique for uranium (U) and thorium (Th) using UTEVA resin. The developed technique permits simultaneous quantification of uranium [238U] and thorium [232Th] concentrations and their respective isotopic composition, required for U-series disequilibrium dating. Up to 50 U-Th dates per day can be achieved through ICP-QMS with 234U and 230Th reproducibility (2sigma) of 3-4 permil and 1 percent, respectively. The high sensitivity (> 300 000 cps/ppb) together with low background (<0.5 cps) on each mass between 228-236 amu allowed U-Th dating of ancient deep water corals (15-260 kyrs) and stalagmites (30-85 kyrs) at precision levels of less than 2%. Consequently, the combination of simplified chemistry using UTEVA with state-of-the-art ICP-QMS isotopic measurements that do not require a U-Th separation step now provides an extremely rapid and low-cost U-series dating technology. The level of precision is most convenient for numerous geochronological applications, such as the determination of climatic influences on ecosystem development and carbonate precipitation. As a first-example application we present ICP-QMS U-Th dates of North Atlantic deep-water coral fragments retrieved in the southeastern Porcupine Seabight (MD01-2463G, Mound Thérèse), indicating a purely interglacial growth of deep-water corals on so-called carbonate mounds over several climate cycles.