Introducing a comprehensive data reduction algorithm for high-precision U-Th geochronology with isotope dilution MC-ICP-MS

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Multi collector inductively coupled plasma mass spectrometry (MC-ICP-MS) is being increasingly utilized for U-Th geochronology of carbonate deposits with comparable precision to thermal ionization mass spectrometry (TIMS) [1, 2]. While attention has been paid to propagation of uncertainties for U-Th-Pb analysis by TIMS and the isochron technique [3,4], a comprehensive data processing scheme is lacking for MC-ICP-MS. To address this need, we have developed an algorithm in Mathematica application to allow for step-by-step monitoring of the data reduction process. The program is flexible and affords the user easy control over input variables. Adjustments for background and spike isotope contributions, abundance sensitivity and instrumental mass bias are implemented through the code, followed by age calculation and propagation of uncertainties with Monte Carlo simulation. A rigorous standard bracketing procedure was adopted using Uranium (CRM-112A) and Th (IRMM-035) standard solutions, doped with IRMM-3636a $^{233}U/^{236}U$ "double-spike", to account for deviations of isotope ratios from certificate values and improve accuracy. Following a single U/TEVA extraction chromatography step to separate U from Th, ten replicate ages from a speleothem in Cathedral Cave (CC), Utah showed excellent agreement (R^2 = 0.999) with results previously measured at the University of Minnesota by single collection ICP-MS [5]. The external reproducibility of our analytical technique was evaluated by analyzing six aliquots of an in-house standard, prepared by homogenizing a piece of the CC speleothem, which returned a mean age of 21468±120 y (2SD). A limited amount of the standard powder is available upon request for interlaboratory calibration. We have successfully dated 36 samples from caves in the Bahamas, the Dominican Republic and Iran.

[1] Fietzke *et al* (2005) *J Aanal Atom Spectrom* **20**, 395-401.[2] Hoffmann *et al* (2007) *Int J Mass Spectrom*, **264**, 97-109. [3] Ludwig & Titterington (1994) *GCA* **58,** 5031-5042 [4] McLean *et al* (2011) *G3*, **12**. [5] McGee *et al* (2012) *EPSL* **351–352**, 182-194.

Carbon mineralization in artificial wetlands

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Carbon mineralization is a promising strategy for mitigating global climate change. We have extensively studied the microbiology, geochemistry, and mineralogy of alkaline wetlands found in hydromagnesite [$Mg_5(CO_3)_4(OH)_2{\cdot}4H_2O$] playas as a biogeochemical analogue for carbon mineralization [1]. These wetlands are fed by Mg-HCO_3 groundwaters and are unique habitats for carbonate precipitating microbes, including cyanobacteria and algae. Growth of these phototrophs within pond systems has also been proposed for producing biofuel [2]. Carbonate precipitation and biomass production could be facilitated using specially designed artificial wetlands that receive waters rich in dissolved cations (e.g., Mg^{2+} and Ca^{2+}). This offers a low energy strategy for sequestering carbon dioxide (CO_2) within carbonate minerals and biomass. Utilization of phototrophs is advantageous in that many species are halophilic and can be grown on non-arable land such as mine sites [3]. As a potential application, we consider mine tailings facilities that produce Mg-rich leachate waters. In microcosm experiments, a phototrophic consortium was able to induce carbonate precipitation from leachate waters, yet precipitation was limited by the availability of CO_2. A larger-scale (10 m long) flow-through wetland fed by Mg-HCO_3 waters demonstrated that a carbon sequestration rate of 120 t CO_2/ha per year could be achieved. Geochemical modeling using mine site water budgets also indicates that up to 17% of a mine's annual greenhouse gas emissions could be sequestered [4]. Coupling of carbonate precipitation and biomass production in artificial wetlands may represent an economically efficient alternative to other technologies currently under development for CO_2 sequestration.

[1] Power *et al* (2009) *Chem. Geol.* **260**, 286-300 [2] Mata *et al* (2010) *Renewable Sustainable Energy Rev.* **14**, 217-232 [3] Jansson & Northen (2010) *Curr. Opin. Biotechnol.* **21**, 365-371. [4] Power *et al* (2011) *Env. Sci. Technol.* **45**, 9061-9068.

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