U-Th-Pb chronology in Pleistocene carbonates using MC-ICP-MS

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Both marine and terrestrial carbonates can incorporate appreciable concentrations of U. For carbonates less than a few million years old the amount of radiogenic Pb is very small due to the long half-lives of U. U-Pb thermal ionization techniques have, nonetheless, been successfully applied to Pleistocene carbonates, resulting in precise ages. (Richards et al., 1998; Getty et al., 2001). New advances in the use of MC-ICP-MS enable Pb isotope analysis at $\pm$100 ppm, about 10 times more precise than standard thermal ionization techniques (Belshaw et al., 1998). Such precision allows measurement of U/Pb in a wider variety of young carbonates and at greater precision. We investigate the use of MC-ICP-MS for U-Th-Pb chronology in marine and terrestrial Pleistocene carbonates.

Samples from two locations have been analyzed. Marine carbonates from the Great Bahamas Bank were chosen from marine isotope stage 11 (~400 kyr), as identified by $\delta^{18}O$ stratigraphy. Aragonite and calcite fractions were separated from the >30µm fraction using sodium polytungstate, and grain size cuts from bulk sediment. Lacustrine carbonates from the McMurdo Dry Valleys, Antarctica (provided by B. Hall) of unknown ages were also selected. These were crushed to sand size and carbonate was separated by hand picking. The aliquots were processed using standard HBr-HNO_3-HCl chemistry for their U-Th-Pb concentrations and isotopic compositions.

We present U-Th-Pb measurements on these various subsamples utilizing the precision afforded by MC-ICP-MS. Mineral separates from marine carbonates yield disappointingly low µ ($^{238}U/^{204}Pb$) values, on the order of 200. Lacustrine carbonates from the Dry Valleys display U concentrations up to 41 ppm and low Pb concentrations (<1ppm), leading to µ values as high as 4500. These µ values provide significant radiogenic Pb even from carbonates from within the U/Th window. This allows testing of the consistency of U/Th and U/Pb ages. It also allows chronology for Dry Valleys climate change to be corrected for the pre U/Th period (Hall and Henderson, 2001).

References

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Ru and Mo isotopic constraints on the scale of isotopic homogeneity in meteorites and their parent bodies

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Recent Mo isotopic studies have indicated apparent non-mass dependent deviations in the composition of stable Mo isotopes in a variety of different primitive and evolved meteorites, relative to terrestrial Mo. Yin et al. (2002) reported Mo isotopic data for carbonaceous chondrites obtained by N-TIMS that either may reflect deficits in the s-process component, or enhancements of p-process components (^{92}Mo, ^{94}Mo) and r-process components (most notably ^{100}Mo). Using a different analytical technique (MC-ICPMS), similar patterns were found by Dauphas et al. (2002a, b), not only for Allende (CV3) and Orgueil (CI), but also for various groups of iron meteorites (e. g., groups IIAB, IIIAB, IIICD), mesosiderites and pallasites. These results are surprising in so far as high-precision Ru isotopic data on IIAB and IIIA iron meteorites obtained by N-TIMS overlap with terrestrial Ru at the 0.3 to 1.0 ε level (Becker and Walker 2002a,b). The Ru data show no resolvable and systematic enhancement in the p-, mixed s-,r- and pure r-process isotopes, relative to pure s-process ^{100}Ru. The Mo isotopic composition of some of the iron meteorites analyzed for Ru was measured by N-TIMS on the UMD Sector 54. Mass discrimination was corrected internally using $^{92}Mo/^{98}Mo$ and the exponential law for optimal precision and accuracy across the large mass range of Mo isotopes. Interference corrections were very small (Ru) or negligible (Zr). Our most precise data so far, multiple runs (n=4) for Negrillos (IIA), yielded $\varepsilon^{94}Mo=0.77\pm0.94$, $\varepsilon^{95}Mo=0.30\pm0.23$, $\varepsilon^{96}Mo=-0.14\pm0.18$, $\varepsilon^{97}Mo=0.57\pm0.46$, $\varepsilon^{100}Mo=0.95\pm0.99$. This, and data on ^{94}Mo, ^{95}Mo and ^{97}Mo in IIAB iron meteorites reported by Yin et al. (2002), indicate that Negrillos, and other IIAB iron meteorites, are indistinguishable from terrestrial Mo at the ±0.5 to 1.5 ε level. The Ru isotopic composition of the ordinary chondrite Allegan (H5) and Mo isotopic data for metal from Dalgety Downs (L4, Yin et al. 2002) are also normal at the 0.3 to 1 ε level. Ru isotopic data for Allende overlap with terrestrial Ru at the 0.5 to 1 ε level, however, a slight depletion of s-process isotopes would also be consistent with the data. We conclude that the parent bodies of IIAB and IIIAB iron meteorites and the ordinary chondrites are characterized by the same mix of Ru and Mo isotopes as the Earth.

References

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