



High-precision measurements of uranium and thorium isotopic ratios by multi-collector inductively coupled plasma mass spectrometry (MC-ICPMS)

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Isotopic compositions of U-Th and ^{230}Th dating have been widely used in earth sciences, such as chronology, geochemistry, oceanography and hydrology. In this study, five ages of different carbonate samples were measured using ^{230}Th dating technique with U-Th high-precision isotopic measurements by multi-collector inductively coupled plasma mass spectrometry, in Uranium-series Chronology Laboratory, Institute of Geology and Geophysics, Chinese Academy of Sciences. In this study, the precision and accuracy of uranium isotopic composition were estimated by measuring the uranium ratios of NBS-CRM 112A, NBS-CRM U500 and HU-1. The mean measured ratios, $^{234}\text{U}/^{238}\text{U} = 52.86 (\pm 0.04) \times 10^{-6}$ and $\delta^{234}\text{U} = -38.36 (\pm 0.77) \times 10^{-3}$ for NBS-CRM 112A, $^{234}\text{U}/^{238}\text{U} = 10.4184 (\pm 0.0001) \times 10^{-3}$, $^{236}\text{U}/^{238}\text{U} = 15.43 (\pm 0.01) \times 10^{-4}$ and $^{238}\text{U}/^{235}\text{U} = 1.00021 (\pm 0.00002)$ for NBS-CRM U500, $^{234}\text{U}/^{238}\text{U} = 54.911 (\pm 0.007)$ and $\delta^{234}\text{U} = -1.04 (\pm 0.13) \times 10^{-3}$ for HU-1 (95% confidence levels). The U isotope data for standard reference materials are in excellent agreement with previous studies, further highlighting the reliability and analytical capabilities of our technique. We measured the thorium isotopic ratios of three different thorium standards by MC-ICPMS. The three standards (Th-1, Th-2 and Th-3) were mixed by HU-1 and NBS ^{232}Th standard, with the $^{230}\text{Th}/^{232}\text{Th}$ ratios from 10^{-4} to 10^{-6} . The mean measured atomic ratios, $^{230}\text{Th}/^{232}\text{Th} = 2.1227 (\pm 0.0024) \times 10^{-6}$, $2.7246 (\pm 0.0026) \times 10^{-5}$, and $2.8358 (\pm 0.0007) \times 10^{-4}$ for Th-1, Th-2 and Th-3 (95% confidence levels), respectively. Using this technique, the following standard samples were dated by MC-ICPMS. Sample RKM-4, collected from Babardos Kendal Hill terrace, was used during the first stage of the Uranium-Series Intercomparison Project (USIP-I). Samples 76001, RKM-5 and RKM-6 were studied during the second stage of the USIP program (USIP-II). Sample 76001 is a laminated flowstone, collected from Sumidero Terejapa, Chiapas, Mexico, and samples RKM-5 and RKM-6 are from the Babardos III terrace and the lower terrace (6 to 10m) of Curacao, respectively. China RCM GBW04412 was also analyzed. The ages of the five standard samples mentioned above are 197970 ± 1590 yr BP, 47520 ± 220 yr BP, 129300 ± 650 yr BP, 130830 ± 550 yr BP, and 86940 ± 300 yr BP for samples RKM-4, 76001, RKM-5, RKM-6 and GBW04412, respectively. The results are consistent with the data of the same samples analyzed in Institute of Global Environmental Change, Xi'an Jiaotong University and Department of Earth Sciences, University of Minnesota, USA within errors, which suggests that the technique in our lab is reliable.