5.0.P05

Determination of Pb isotope ratios using multiple collector ICP-MS and Tl normalization

X.X. HE, X.K. ZHU, C. YANG, S.H. TANG AND J.J. CHAI

Institute of Geology, CAGS, Beijing, 100037 China (hexuexian@cags.cn.net)

It is difficult to collect highly accurate and highly precise data for the isotope. Unlike other isotopes, such as Nd and U, Pb has no constant isotopic ratio for correction. Application of double or triple Pb spike could bring new problems, such as expensive spikes or complex calculations. Combination multiple collector ICP-MS with Tl normalization may solve the problems and has a clear advantage. Pb isotope ratio measurements of NBS 981 and NBS 982 were made. We used NBS 982 to correct mass fractionation coefficient and $^{205}Tl/^{203}Tl$, and NBS 981 to check reliability of the method.

Experiment

100 samples of NBS 981 and 40 of NBS 982 were dissolved in 2% HNO_3. The solutions were prepared with SRM 997 Tl, with Tl added at various Tl /Pb ratios, from ~0.05 to 20. We used a new generation multiple collector plasma source mass spectrometer produced by Nu Instruments Ltd. Samples were introduced by a nebuliser. Hg interference was low enough to be neglected.

Results

We used an exponential law and Todt [4] data of NBS 982 to determine the exponential fractionation factor β. It varied from ~ -1.5 to -1.7. A plot of β vs mass gave parallel β lines, but there was no correlation with average mass that differed from other results [3]. Correlation of other β with $\beta_{208/206}$, gave equations with high relationship: $\beta_{207/206}=1.0154\beta_{208/206}$; $\beta_{208/204}=0.9978 \beta_{208/206}$; $\beta_{207/204}= 0.999\beta_{208/206}$; $\beta_{206/204}= 0.9746 \beta_{208/206}$. The exponential law requires β should be invariant with mass. Assuming $\beta_{205/203}$ equal to $\beta_{208/206}$, other β of Pb could be connected with $\beta_{205/203}$ of Tl according to upper equations. $^{205}Tl/^{203}Tl$ value of SRM 997 is argued just like Pb. Despite 2.3871 of $^{205}Tl/^{203}Tl$ is certificated value, it is not satisfactory for normalization[1-3]. When assuming $\beta_{205/203}$ of Tl be equal to $\beta_{208/206}$ of Pb and using $^{208}Pb/^{206}Pb$ of 1.00016 in NBS 982, we could obtain $^{205}Tl/^{203}Tl$ equal to 2.388661±0.000008(2 σ). Using modified β and 2.388661, the isotope ratios in NBS 981 were identical within error to others[1-4]. Our data showed that there was no evidence for Tl/Pb ratio effect in measuring.

Our results demonstrate that high-accurate and high-precise Pb isotope ratios can be obtained using a modified Tl isotope ratio and modified β.

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Long-term reproducibility of the Durango fluorapatite "age standard" and error reporting in (U/Th)-He chronometry

R.E. CLAYTON[1], A. CARTER[2], A.J. HURFORD[1] AND G. BATT[3]

[1] Department of Earth Sciences, University College London, Gower Street, London WC1E 6BT (r.clayton@ucl.ac.uk; t.hurford@ucl.ac.uk)
[2] School of Earth Sciences, Birkbeck College, University of London, Malet Street, London WC1E 7HX (a.carter@ucl.ac.uk)
[3] Department of Geology, Royal Holloway, University of London, Egham, Surrey TW20 0EX, UK (g.batt@gl.rhul.ac.uk)

Recognition that apatite (U/Th)-He chronometry can provide important constraints on low-temperature histories of rock samples from a range of geological environments has resulted in a number of dedicated He extraction lines being built in laboratories across the world. As He thermochronometry has evolved it has become common practice to assess machine performance by testing the reproducibility of the widely available Durango apatite (Cerro de Mercado, Mexico), effectively used as an age standard. Here, we report reproducibility of (U/Th)-He analyses of Durango apatite over a 14 month period on a Patterson Instruments He extraction line and a Micromass *Isoprobe* multicollector ICPMS. The Durango data also provide an important way of building an assessment of long-term performance into the error calculation on routine sample age determinations and provide the means for quantitative interlaboratory comparison. We have used a split of a Durango crystal used at Caltech (supplied by K. Farley). Data were obtained from 42 Durango runs such that He, U and Th abundance varied between 0.14-7.5 ncc, 0.01-0.38 ng, 0.09-8.08 ng, respectively. In all measurements the U/Th ratio is between 0.05-0.07 which compares well with previous concentration measurements (U = 9 ppm, Th = 160 ppm, U/Th = 0.06). A linear regression through the He-U and He-Th data yields R^2 of 0.98 and 0.96, respectively. Applying a weighted mean and error to the data (n = 42) yields an age of 31.0 ± 1.8 Ma and lies within error of previous age estimates for Durango (e.g. 32.1 ± 1 Ma, Farley, 2000). Alternatively, by taking the arithmetic mean and 2 standard errors of the mean yields an age of 31.6 ± 1.2 Ma. Irrespective of the approach in quoting error, the data are in good agreement with the accepted age of the Durango apatite. In applying age errors to unknowns, we currently assign the more rigorous weighted mean and error as providing the best estimate.

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