Strategies for the determination of the isotopic composition of natural Uranium

J.P. BERNAL[1,2], M.T. MCCULLOCH[1], G.E.MORTIMER[1], T. ESAT[1]

[1]Environmental Geochemistry and Geochronology, Research School of Earth Sciences, The Australian National University, Canberra, ACT 0200, Australia (bernal@geology.anu.edu.au)

[2]CRC-LEME, Department of Geology, The Australian National University, Canberra, ACT 0200, Australia

One of the limits on the precision of ages using the U-decay series system is uncertainties in the ^{234}U and ^{230}Th decay constants. This is particularly true for specimens older than 350 ka. The currently accepted ^{234}U half-life of 245.5 ± 0.6 ka (Audi et al., 1997) yields an age error of ± 2 ka for samples 300 ka old, and ± 20 ka for 500 ka samples (Cheng et al., 2000).

In the present work we examine the isotopic composition of natural uranium using a Finnigan NEPTUNE multi-collector ICP-MS equipped with 9 Faraday cups, with the aim of refining the half-life of ^{234}U.

Our approach is based on the analysis of concentrated solutions (~500 ng/g) of materials with well constrained isotopic composition: two different uraninites and one gravimetric uranium standard (U-500); the latter was used to calibrate a $^{233}U/^{236}U$ double spike secondary standard (DS-2), which in turn was used to correct for mass fractionation during the analysis of the uraninites. The resulting high intensity ion beams allowed us to measure all the isotopes simultaneously using the Faraday cups in static mode. This method has the advantage that no detector dead-time corrections are necessary (in contrast to measurements carried out using electron multipliers). Furthermore, any uncertainties introduced due to fluctuations on the ion beam intensities during peak jumping analyses can also be neglected.

A discussion on the advantages of this approach, as well as its consequences on ^{238}U-^{234}U-^{230}Th geochronology will be presented. A comparison of the results obtained using this approach with previously published data will be also presented.

References

Audi G., Bersillon O., Blachot J., and Wapstra A. H. (1997) The NUBASE evaluation of nuclear and decay properties. *Nuclear Physics A* **624**(1), 1-124.

Cheng H., Edwards R. L., Hoff J., Gallup C. D., Richards D. A., and Asmerom Y. (2000) The half-lives of uranium-234 and thorium-230. *Chemical Geology* **169**(1-2), 17-33.

The Rise of Trees and their Effects on Paleozoic Atmospheric CO_2 and O_2

ROBERT A. BERNER

Department of Geology and Geophysics
Yale University , PO Box 208109, New Haven, Connecticut 06520-8109, USA

Large vascular plants, with deep and extensive rooting systems, arose and spread over the continents starting about 380 Ma during the Devonian Period. Theoretical modeling indicates that effects on atmospheric composition of the occupation of the land by large plants was twofold. First, a drop in CO_2 was brought about by plant-accelerated weathering of Ca-Mg silicate minerals. The lower CO_2 levels brought about greenhouse cooling and the deceleration of weathering, counterbalancing the acceleration of weathering by plants and resulting in the stabilization of CO_2 at lower levels.

The other effect of the rise of trees was the production of large amounts of microbially resistant lignin, leading to the increased burial, globally, of organic matter in sediments. Increased organic burial brought about further CO_2 removal and the excessive production of atmospheric O_2. Computer models of the long term carbon and sulfur cycles, based on (1) the abundance of organic C and pyrite S in sedimentary rocks, (2) the carbon and sulfur isotopic composition of seawater over Phanerozoic time, and (3) carbon isotopic analyses of fossil plants combined with new laboratory plant growth experiments (Beerling et al, 2002), indicate that levels of atmospheric O_2 during the Permo-Carboniferous were considerably higher than at present.

These plant-induced changes in the carbon cycle led to the formation during the Carboniferous and Permian periods of vast coal deposits, extensive continental glaciation due to low CO_2 (Crowley and Berner, 2001) and the presence of abundant fire adapted plants and giant insects due to high O_2. In support of the latter contention, recent laboratory experiments confirm an increase in average insect size with increasing partial pressure of O_2 (Berner et al, 2002).

References

Beerling, D. J. , Lake, J.A., Berner, R.A., Hickey, L.J., Taylor, D.W,. and Royer, DL (2002) Geochim. Cosmochim. Acta (in Press)

Berner, R.A., Beerling, D.J., Dudley, R., Wildman, R.A., and Robinson, J.M., (2002) An. Revs. Earth. Planet. Sci. (in press)

Crowley, T.J. and Berner, R.A. (2001) Science, 292, 870-872.