

Determination of Lithium Isotope Compositions by MC-ICPMS (Thermo Finnigan MAT Neptune)

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Precise isotopic analysis of lithium by Multi Collector Inductively Coupled Plasma Mass Spectrometry (MC-ICPMS) requires simultaneous collection of ⁶Li⁺ and ⁷Li⁺ in order to overcome intensity variations, a stable mass bias and a good sensitivity. Here we report measurements made on two different Neptunes, that document a reproducibility for standards of 0.2 ‰, and 0.5 to 0.8 ‰ for chemically processed international rock standards.

The Neptune allows simultaneous measurement of both ⁶Li⁺ and ⁷Li⁺ using the moveable low mass and high mass Faraday cups on the collector array (on platforms L4 and H4, respectively). Repetitive analyses of the Li-standard L-SVEC over one year gave ⁷Li/⁶Li varying between 14.788 and 15.295. The mass bias is large, between 23 and 27 ‰ and drifts with time. However, mass bias drift on the smaller timescales is much less. Internal precision on the minute-timescale is within 0.1 ‰ (1 s.d.) and long-term reproducibility (hour-timescale) is better than ~0.2 ‰ (1 s.d.). Sensitivity varies with different sample introduction systems. The Cetac Aridus desolvating nebuliser gives a ⁷Li sensitivity of up to ~450 V/ppm, compared to ~20 V/ppm for the self-aspirating PFA concentric nebuliser combined with a quartz dual spray chamber.

Li isotope analyses on 2 international rock standards were performed to ensure the reliability of Li isotope data obtained by MC-ICPMS. These samples were first processed through a column extraction procedure to separate Li from other elements in order to obtain pure Li solutions and avoid matrix effects in the mass spectrometer. The table below shows the $\delta^7\text{Li}$ ($=[(^7\text{Li}/^6\text{Li})_{\text{sa}} - ^7\text{Li}/^6\text{Li}_{\text{st}}] - 1) \cdot 1000$) obtained from the number of samples (n) processed through the extraction procedure. These $\delta^7\text{Li}$ values were obtained using several different methodologies over a wide range of time and currently we are able to obtain a reproducibility as good as 0.5 ‰ given the drift in L-SVEC.

	$\delta^7\text{Li}$	1 s.d.	n
BHVO-1	+5.0	0.8	8
JG-2	+0.4	0.5	4

Models for chemical weathering based on U-series measured in rivers

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Chemical weathering processes are likely to respond to many environmental parameters such as uplift, climate change, or human activities. Recent studies of U-decay series in soils and rivers outline the need for time-dependent models for chemical erosion. In this contribution, we explore several possible models for erosion in order to assess recent data in a quantitative framework. As a first attempt, we have developed steady-state models for erosion which assume that the mass of weathered material is constant over time in a given watershed and that the sum of dissolved and suspended loads carried by rivers is equal to the amount of bedrock incorporated in the erosion process per unit of time.

In order to develop tractable models, we have assumed that U-series in the bedrock are initially in secular equilibrium. We have developed two types of models: (1) a box-model approach which considers the weathering material as a whole and (2) a leaching model which follows the weathering of individual particles through time. Our models use first-order weathering rates. This model also includes the adsorption of the nuclides on the solids. A correction for the contribution of deep aquifers that would be enriched in U is also considered.

With this framework, we have examined two U-series data set for rivers draining the Mackenzie basin (Vigier et al., 2001) and the Deccan traps (Vigier et al. in prep.). This model can be used to derive release rates of radioactive nuclides such as ²³⁸U, ²³⁰Th and ²²⁶Ra. The timescale of weathering can also be derived and compared with the transport time of particles within a basin. The timescale of weathering in the recently glaciated Mackenzie basin is short compared with the Deccan watersheds. Adsorption can explain (²³⁴U/²³⁸U)>1 in the suspended load from the Deccan rivers.