Underestimation of the authigenic fraction of Cu and Ni in organic-rich sediments and particles

P. Böning[12]*, H. Fröllje[12] and H.-J. Brumsack[1]

[1]ICBM, University of Oldenburg, 26129 Oldenburg, Germany (*correspondence: p.boening@icbm.de)
[2]Max-Planck Research Group for Marine Isotope Geochemistry, 26129 Oldenburg, Germany

Organic-rich sediments from marine environments typically show authigenic enrichments in Ni and Cu. However, the exact determination of the authigenic metal level is difficult given the considerable level of the lithogenic metal background. The authigenic metal level can be estimated according to $M_{auth} = M_{total} - (M/Al_{background} \cdot Al_{total})$ while M = metal of interest and Al = aluminum. Alternatively, a metal enrichment factor (EF) is calculated according to EF = M/Al_{total} / $M/Al_{background}$. Both techniques rely on the appropriate use of the M/Al ratio of the lithogenic background. For the latter, the M/Al ratio of average shale or crust is widely applied as lithogenic background in marine geochemistry. Here, we show that the authigenic level of Cu and Ni in sediments and particles (upwelling areas of Peru, North and South Chile, Gulf of California, Norwegian Kyllaren fjord and German Wadden Sea) is significantly underestimated when using the M/Al ratio of average shale or crust as lithogenic background. The correlation between Cu/Al and Ni/Al with organic carbon in the samples indicates the apparent M/Al ratio of the background, which is 2-4 times lower than the M/Al ratio of shale or crust. A prerequisite for our technique is high linearity and high quality of correlation ($r^2 \geq 0.8$) otherwise the lithogenic background cannot be exactly determined. The resulting higher authigenic level of Cu and Ni underlines their use as productivity indicators in modern and paleo records while the enrichment of Cu and Ni shifts from moderate to high if it is assessed via EFs.

The stable chromium isotopic composition of Lunar basalts

P. Bonnand[12]*, I.J. Parkinson[13] and M. Anand[45]

[1]Department of Environment, Earth and Ecosystem, The Open University, Milton Keynes, UK.
[2]Department of Earth Sciences, University of Oxford, Oxford, UK (*correspondence: pierre.bonnand@earth.ox.ac.uk).
[3]Bristol Isotope Group, School of Earth Sciences, Unversity of Bristol, UK.
[4]Department of Physical Sciences, The Open University, UK.
[5]Department of Earth Sciences, The Natural History Museum, UK.

Planetary formation has been widely studied using major-element constituents of planetary mantles [e.g. 1]. The Moon's formation is a highly debated topic and it has been proposed that the Moon is the result of a Mars-sized impactor which collided with the proto-Earth [2]. Non-traditional stable isotopes have been used to try to understand the formation of the Moon and its differentiation [e.g. 3].

Chromium isotopes are fractionated during core formation and differences in Cr isotopic composition between meteorites and the Earth's mantle suggest that light Cr isotopes have been preferentially partitioned into the metal fraction [4]. Lunar samples are characterised by a lack of nucleosynthetic anomalies for Cr isotopes [5].

In the absence of samples from the Moon's interior and in order to better constrain the lunar mantle composition and understand its formation we report stable chromium isotopic composition for a suite of low-Ti and high-Ti mare basalts. We find resolvable Cr isotopic variations within the lunar sample suite but no clear differences between low-Ti and high-Ti basalts. There is no correlation between δ^{53}Cr and δ^{18}O. However, Cr isotopes seem to be correlated with Mg# and TiO_2 content which suggest that Cr isotopes are fractionated during magmatic differentiation on the Moon. The more primitive samples have Cr isotopic composition similar to the Earth's mantle.

These results suggest that the terrestrial and lunar mantles have similar stable Cr isotopic composition. This implies that processes responsible for the difference in isotopic composition between the Earth's mantle and chondritic material occurred before the formation of the Moon.

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