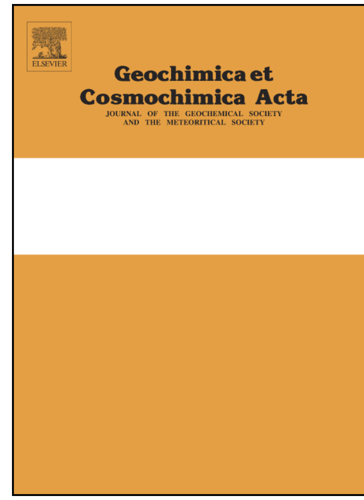
Accepted Manuscript



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PII: S0016-7037(13)00582-6
DOI: http://dx.doi.org/10.1016/j.gca.2013.10.026
Reference: GCA 8504

To appear in: *Geochimica et Cosmochimica Acta*

Received Date: 12 July 2013
Accepted Date: 16 October 2013

Please cite this article as: Meier, M.M.M., Schmitz, B., Lindskog, A., Maden, C., Wieler, R., Cosmic-ray exposure ages of fossil micrometeorites from mid-Ordovician sediments at Lynna River, Russia, *Geochimica et Cosmochimica Acta* (2013), doi: http://dx.doi.org/10.1016/j.gca.2013.10.026

Cosmic-ray exposure ages of fossil micrometeorites from mid-Ordovician sediments at Lynna River, Russia.

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Submitted 11.07.2013. Revised version submitted 01.10.2013.

Abstract

We measured the He and Ne concentrations of 50 individual extraterrestrial chromite grains recovered from mid-Ordovician (lower Darriwilian) sediments from the Lynna River section near St. Petersburg, Russia. High concentrations of solar wind-like He and Ne found in most grains indicate that they were delivered to Earth as micrometeoritic dust, while their abundance, stratigraphic position and major element composition indicate an origin related to the L chondrite parent body (LCPB) break-up event, 470 Ma ago. Compared to sediment-dispersed extraterrestrial chromite (SEC) grains extracted from coeval sediments at other localities, the grains from Lynna River are both highly concentrated and well preserved. As in previous work, in most grains from Lynna River, high concentrations of solar wind-derived He and Ne impede a clear quantification of cosmic-ray produced He and Ne. However, we have found several SEC grains poor in solar wind Ne, showing a resolvable contribution of cosmogenic ^{21}Ne. This makes it possible, for the first time, to determine robust cosmic-ray exposure (CRE) ages in these fossil micrometeorites, on the order of a few hundred-thousand years. These ages are similar to the CRE ages measured in chromite grains from cm-sized fossil meteorites recovered from coeval sediments in Sweden. As the CRE ages are shorter than the orbital decay time of grains of this size by Poynting-Robertson drag, this suggests that the grains were delivered to Earth through direct injection into an orbital resonance. We demonstrate how CRE ages of fossil micrometeorites can be used, in principle, to determine sedimentation rates, and to correlate the sediments at Lynna River with the fossil meteorite-bearing sediment layers in Sweden. In some grains with high concentrations of solar wind Ne, we nevertheless find a well-resolved cosmogenic ^{21}Ne signal. These grains must have been exposed for up to several 10 Ma in the regolith layer of the pre-break-up L chondrite parent body. This confirms an earlier suggestion that such regolith grains should be abundant in sediments deposited shortly after the break-up of the LCPB asteroid.

1. INTRODUCTION

1.1. Traces of the L chondrite parent body break-up

Traces of the disruption of the L chondrite parent body (LCPB) asteroid 470 Ma ago have been