Fe/Mn and trace elements in layered varnish on meteorites for paleoclimate investigations

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We investigated < 25 μm layers of desert varnish on 12 meteorites recovered in the Libyan desert. The terrestrial ages of the meteorites between 2.5 and 35 ka provide maximum exposure values. Some samples show microlamination of Mn- and Fe-rich layers possibly related to dry and wet climate [1]. To get highly resolved measurements of Fe/Mn at a depth resolution of about 10 nm, we used femto- and nanosecond LA-ICP-MS. In addition, concentrations of the major elements, Co, V, Ba, Pb, and the REE were determined in the different layers at a resolution of about 1 μm and a precision of 2 - 5 %. Special settings were applied for the analyses, such as small fluence, high scan speed for low sample ablation, the Escan mode of the mass spectrometer used for fast measurements, and a mass resolution of 2000 for the separation of interferences from the ions of interest using flat top peaks. The new Mn- und Fe-rich microanalytical reference material FeMnOx-1 [2] was used for calibration.

Our results demonstrate significant variations of Mn/Fe ratios with depth (age). Low and high ratios found in varnish layers are correlated with arid and humid periods observed in North Africa [3]. Line scan analyses show high MnO and high REE contents with a typical positive Ce anomaly. A weathering zone with low MnO and negative Ce anomalies is situated beneath the varnish zone.

[1] Liu and Broecker (2013) *Geomorphology* **187**, 38-60. [2] Jochum et al. (2016), Chemical Geology, in press. [3] Dietzel et al. (2008) *Chemie der Erde* **68**, 31-43.