Novel metalorganic compounds revealed in meteorites

A. RUF[1,2], B. KANAWATI[1], N.HERTKORN[1], Q.-Z. YIN[3], F. MORITZ[1], M. HARIR[1,2], M. LUCIO[1], S. SHILOBREEVA[4], Z. GABELICA[5], R. D. GOUGEON[6], E. QUIRICO[7], H. HAACK[8], M. GONSIOR[9], P.JENNISKENS[10], N. W. HINMAN[11] AND P. SCHMITT-KOPPLIN*[1,2]

[1]Helmholtz Zentrum München, 85764 Neuherberg, Germany, (correspondence: schmitt-kopplin@helmholtzmuenchen.de)
[2]Technische Universität München, 85354 Freising-Weih., Germany
[3]University of California, Davis, CA 95616, USA
[4]Russian Academy of Sciences, 119991 Moscow, Russia
[5]Université de Haute Alsace, 68094 Mulhouse Cedex, France
[6]Université de Bourgogne, 21000 Dijon, France
[7]Université Grenoble AlpesUMR 5274, Grenoble 38041, France
[8]Natural History Museum of Denmark, 1350 Copenhagen, Denmark
[9]University of Maryland, Solomons, MD 20688, USA
[10]SETI Institute, Mountain View, CA 94043, USA
[11]NASA Ames R.C., Moffett Field, Mountain View, CA 94035, USA

The rich diversity and complexity of organic matter found in meteorites is rapidly expanding our knowledge and understanding of extreme environments, from which the early solar system emerged and evolved. Only few metalorganic compounds have hitherto been described in the meteoritic context to date. Ultrahigh-resolving analytics, like Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR-MS), enables to probe holistically the complex chemical space to tens of thousands of different molecular compositions and likely millions of diverse structures [1].

Here, we demonstrate the occurrence and remarkable diversity of previously unrecognized organomagnesium (CHOMg) compounds within meteoritic soluble organic matter [2]. We studied 61 meteorites with different petrologic types, covering a wide range of meteorite classes. Specifically, dihydroxymagnesium carboxylates, $[(OH)_2MgO_2CR]^-$, represent a previously unreported chemical class. It's chemical properties and reactivity are discussed. A connection between the evolution of organic compounds and minerals is made, as Mg released from minerals gets trapped into organic compounds. These CHOMg metalorganic compounds and their relation to thermal processing in meteorites might shed new light on our understanding of carbon speciation at a molecular level in meteorite parent bodies. They might have contributed to the stabilization of organic molecules on a geological time scale, which emphasizes their potential astrobiological relevance.

[1] Schmitt-Kopplin et al. (2010) *PNAS* **107**, 2763–2768. [2] Ruf et al. (2017) *PNAS* **114**, 2819–2824.