

REE abundances in CAIs from Rumuruti chondrites

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Introduction

Ca,Al-rich inclusions (CAIs) are the oldest objects known in our solar system (~4.56 Ga; [1]). Recently, CAIs from Rumuruti (R) chondrites were studied in great detail [2-4] but only limited trace element data [5] exist. The latter are important to reveal information on the formation processes of individual CAIs. So far, the rare earth element (REE) abundances of 16 inclusions have been determined by LA-ICP-MS.

Samples and Analytical Techniques

Sixteen randomly selected CAIs from the R chondrites NWA 753 and 1476 as well as Dar al Gani 013 described by [2-4] were measured with a ThermoFisher Element 2 single collector ICP-MS coupled to a laser ablation (New Wave 193 nm excimer system) unit. NIST SRM-612 was used as an external standard and BCR2-G for additional verification of precision and accuracy of the analyses. Data was processed with Glitter using Ca or Mg as internal standard (EPMA data by [4]).

Results

The CAIs show REE enrichments typically between ~5 and ~30 × CI for most elements. Four inclusions were found that exhibit fractionated patterns similar to Group II [e.g., 6]. The other twelve patterns are generally flat (Groups I (2 inclusions), III (1), V (4); [e.g., 6]) with variable abundances of the most volatile REEs (Eu, Yb) or display flat patterns with negative Eu anomalies (5 inclusions). The two CAIs of Group I have almost chondritic REE abundances.

Discussion

The REE patterns can be explained by different processes, including fractional condensation and (in)complete equilibrium condensation from a gas of solar nebula composition. However, distillation might also be a mechanism to account for the depletions of the volatile elements observed.

[1] Amelin *et al.* (2002) *Science* **297**, 1678-1683. [2] Rout & Bischoff (2008) *MAPS* **43**, 1439-1464. [3] Rout *et al.* (2009) *GCA* **73**, 4264-4287. [4] Rout *et al.* (2010) *Chemie der Erde* **70**, 35-53. [5] Horstmann *et al.* (2010) *MAPS* **45**, A84. [6] Mason & Martin (1977) *Smiths. Contr. Earth Sciences* **19**, 84-95.

Employment of the nanoscaled-SIMS in soil science

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The NanoSIMS technique is needful for investigating soils systems which are inevitable structurally heterogeneous down to submicron scale. Clay minerals, iron oxides, aluminium (hydr)oxides and charcoal are considered as major components controlling the formation of soil interfaces and aggregates which are relevant for the sorption of organic matter.

The high lateral resolution achieved with the NanoSIMS 50L instrument makes possible elemental localisation at such small spatial ranges and offers inside views into the complex elemental structural architecture of soil samples.

Allowing the simultaneous detection of up to 7 ion species by NanoSIMS it is possible to obtain information about elements characteristic for the coexistent soil constituent phases: organic matter (carbon, nitrogen, sulphur) and minerals (oxygen, silicon, aluminium, iron). Accurately measuring these organic matter-minerals associations has the need of solving isobaric mass interferences.

The good transmission at high mass resolution power of the nano-scaled SIMS technique is necessary to image processes playing an important role in soil science and taking place at small spatial scales and low concentrations in soils.

We discuss the employment of the NanoSIMS 50L instrument at TU München in soil science. We have explored the potentials of this new technique for the study of model compounds (clay minerals, iron, aluminium (hydr)oxides and charcoal) of incubated mixtures of known composition, i.e. artificial soils.

We present examples of mass interferences occurring in soil investigations solved by the NanoSIMS technique. At mass number 43 high mass interferences are occurring which are given from elements associations like ¹²C³¹P, ²⁷Al¹⁶O, ¹²C¹⁶O¹⁵N, ³⁰Si¹²C¹H. Their differentiation needs an MRP of about 16000. By choosing the right beam deflection in front of the detector it is possible to measure these masses independently.