Iron isotope signature of the inner solar system

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Not much is known about the iron isotope composition of the terrestrial planets, and how this signature was acquired during early solar system evolution. We therefore analysed 24 samples from the Earth, Moon, Shergotty-Nakhla-Chassigny (SNC) meteorite group, likely to come from Mars, and the eucrite meteorite group, believed to sample the asteroid Vesta. Our multiple collector inductively coupled plasma mass spectrometry (MC-ICP-MS) measurements of Fe isotope composition of samples representing the petrological variability of these four planets give the same indistinguishable iron isotope composition within ±1.5 ε^{57}Fe/^{54}Fe units, with the exception of terrestrial granite samples. This inner solar system value is on average about one epsilon unit above the IRMM-14 international Fe isotopic standard. Such a constant iron isotope composition, compared to the mass-independent heterogeneity found in presolar grains and Ca- and Al-rich refractory inclusions (CAI) of the Allende meteorite, implies a thorough homogenising process that occurred early in solar system history, probably while iron was still in the gaseous form. It also shows that the contrasted redox state, volatile content, core sizes and condition of core formation of the four planets studied had no sizeable influence on the Fe isotopic signatures. This constant iron isotope composition contrasts with oxygen and chromium isotopic variability and can help to set further constraints on their generation. The heaviest iron isotope compositions (ε^{57}Fe/^{54}Fe up to 5 units above the inner solar system figure) are found for largely mantle-derived granites with the strongest hydrothermal overprint. S-type granites derived from remelting of crustal material show only marginal deviations compared to the inner solar system value. This result illustrates that the Fe isotope compositions do not display the same mechanisms as other tracers like oxygen isotopes and appear to be a complementary tool to study terrestrial crust-mantle differentiation.

Stable isotope geochemistry of the Siberian traps

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O-, H- and C-isotope studies were carried at the basic intrusions, flood basalts, explosive pipe, hidrothermal carbonates and carbonatite-like rocks, related to ~250 m.a. trap magmatic province of the Siberian platform.

The $\delta\,^{18}$O values of the intrusive traps**,** occurred among Cambrian deposits of deeply eroded part of platform are in mantle limits (5.4± 6.0‰). In contrast to them the range of $\delta\,^{18}$O values (3.4± 13.7‰) in the Norilsk-1 (N-1) and Talnakh (T) Cu-Ni-Pt-ore-bearing trap intrusions is many times higher than in the uncontaminated mantle rocks (fig. 1). A correlation between O-isotope composition of intrusive rocks and their hosts is recognized: N-1, surrounded by hydrothermally altered basalts ($\delta\,^{18}$O up to –0.8‰), depleted, and T, situated among Devonian and Permian sedimentary rocks, enriched in ^{18}O due, probably, to high-T postmagmatic hidrothermal interaction with surrounding rocks. Low δ D values (-94÷ -137‰) suggest atmospheric origin of thermal waters. The interaction of weakly mineralized Lower-Talnakh intrusion with their hosts was not so active.

The $\delta\,^{18}$O values (5.7± 6.7‰) of the less altered samples of flood basalts at south slope of Putoran Plato are close to that of the interior layers of intrusions. Predominant part of basalts, however, enriched in ^{18}O (up to 9.2 ‰) due, probably, to low-T postmagmatic alteration. In contrast to basalts, aglomerates and tuffs, packed in and ignimbrite-like rocks associated with volcanic pipes of r. Podkamennaya Tunguska have decreased $\delta\,^{18}$O values (up to – 0.1‰). Complete with geologic evidences this suggests hydromagmatic origin of pipes. Associated with traps high-T (400-1000° C according to Ca-Mt O-isotope thermometry) carbonatite-like rocks differ strongly from typical carbonatites by $\delta\,^{13}$C (-2.75± 1.5‰) and $\delta\,^{18}$O (16.0± 2.5‰) values. This rocks were formed, probably, as result of hydrothermal redeposition or, sometimes, melting of sedimentary carbonates.