Researchers find evidence that suggests not all sulfur in the Earth's mantle came from meteorites

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Credit: NASA

(Phys.org) —A team of researchers from Université Paris Diderot has found evidence that contradicts the prevailing view among scientists that virtually all of the sulfur found in the Earth's mantle came from chondrites. In their paper published in the journal *Nature*, the team describes how they found differences in sulfur proportions in soil samples taken from beneath the South Atlantic sea-bed compared to those of chondrites.

The prevailing view among Earth scientists regarding the process that led to the current makeup of the planet is that most if not all of the metals that existed in the mantle were pulled inward once the core developed, leaving the mantle generally barren. Studies of rocks that have been pushed to the surface by volcanic blasts have shown, however, that there are indeed metals in the mantle. To explain this, scientists have noted that the proportion of metals to other material in chondrites (a type of meteorite) is of almost exactly the same proportion of such metals found in the mantle. Thus, it appears likely that such metals were in fact pulled from the mantle by the core but were subsequently replenished by millions of chondrites falling over millions of years onto Earth's surface and then slowly seeping into the mantle. In this new effort, the researchers suggest that the prevailing view is wrong because they have found mantle samples with different proportions of sulfur.

The researchers are basing their claim on a new type of examination of rock samples taken from mid-ocean ridge basalts from the South Atlantic Ridge. The samples were hand-picked by the team based on visual observations through a microscope. Next they were crushed and dissolved in a solution that caused the release of sulfur. Several further refinements were then performed each adding a higher degree of purification. Finally, the samples were tested for ratios of metals to other material in the original rock sample. The team found that the ratio of sulfur-34 to sulfer-32 in their mantle sample was 0.13 percent lower than that typically found with chondrites. This, they say, shows that is likely that the mantle retained some of its metals over the history of the planet, rather than giving them up to the core.

More information: Non-chondritic sulphur isotope composition of the terrestrial mantle, *Nature* (2013) doi:10.1038/nature12490, www.nature.com/nature/journal/ … ull/nature12490.html

Abstract

Core–mantle differentiation is the largest event experienced by a growing planet during its early history. Terrestrial core segregation imprinted the residual mantle composition by scavenging siderophile (iron-loving) elements such as tungsten, cobalt and sulphur. Cosmochemical constraints suggest that about 97% of Earth's sulphur should at present reside in the core, which implies that the residual silicate mantle should exhibit fractionated 34S/32S ratios according to the relevant metal–silicate partition coefficients2, together with fractionated siderophile element abundances. However, Earth's mantle has long been thought to be both homogeneous and chondritic for 34S/32S, similar to Canyon Diablo troilite3, 4, 5, 6, as it is for most siderophile elements. This belief was consistent with a mantle sulphur budget dominated by late-accreted chondritic components. Here we show that the mantle, as sampled by mid-ocean ridge basalts from the south Atlantic ridge, displays heterogeneous 34S/32S ratios, directly correlated to the strontium and neodymium isotope ratios 87Sr/86Sr and 143Nd/144Nd. These isotope trends are compatible with binary mixing between a low-34S/32S ambient mantle and a high-34S/32S recycled component that we infer to be subducted sediments. The depleted end-member is characterized by a significantly negative ?34S of ?1.28?±?0.33‰ that cannot reach a chondritic value even when surface sulphur (from continents, altered oceanic crust, sediments and oceans) is added. Such a non-chondritic 34S/32S ratio for the silicate Earth could be accounted for by a core–mantle differentiation record in which the core has a 34S/32S ratio slightly higher than that of chondrites (?34S = +0.07‰). Despite evidence for late-veneer addition of siderophile elements (and therefore sulphur) after core formation, our results imply that the mantle sulphur budget retains fingerprints of core–mantle differentiation.