Researchers find Earth composed of different materials than primitive meteorites

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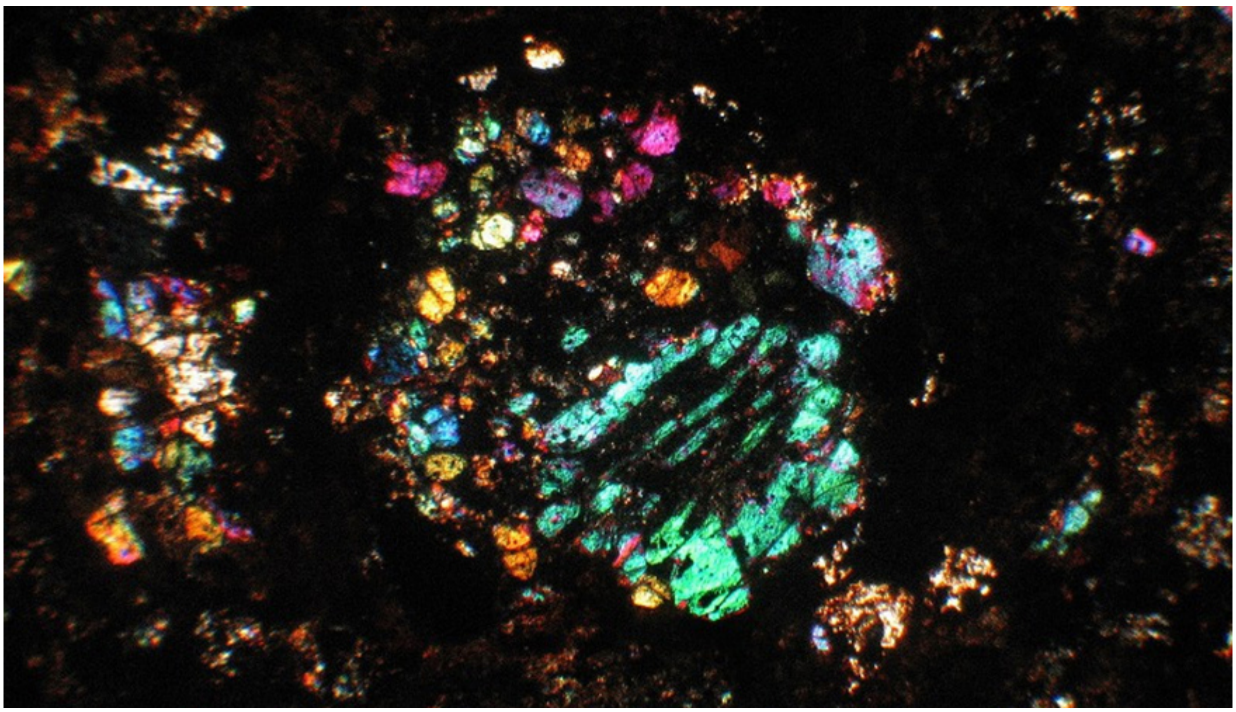

An independent compound chondrule consisting of barred olivine and porphyritic olivine section in the meteorite NWA 2372 CK4. Image courtesy of John Kashuba. Credit: Lawrence Livermore National Laboratory

Scientists from Lawrence Livermore National Laboratory (LLNL) have found that, contrary to popular belief, the Earth is not comprised of the same material found in primitive meteorites (also known as chondrites).

This is based on the determination that the abundance of several neodymium (Nd) isotopes are different in the Earth and in chondritic meteorites.

A long-standing theory assumes that the chemical and isotopic composition of most elements in the bulk silicate Earth is the same as primitive meteorites.

However, 10 years ago it was discovered that rocks on the surface of the Earth had a higher abundance of 142Nd than primitive meteorites, leading to a hypothesis that Earth had either a hidden reservoir of Nd in its mantle or inherited more of the parent isotope 146smarium (Sm), which subsequently decayed to 142Nd.

Using higher precision isotope measurements, the team found that differences in 142Nd between Earth and chondrites (non-metallic meteorites) reflected nucleosynthetic processes and not the presence of a hidden reservoir in the Earth or excess 146Sm.

"The research has tremendous implications for our fundamental understanding of the Earth, not only for determining its bulk composition, heat content and structure, but also for constraining the modes and timescales of its geodynamical evolution," said Lars Borg, LLNL chemist and co-author of a paper appearing in the Sept. 15 edition of *Nature* .

The team suggests that the Earth formed from material that was slightly more enriched in Nd produced by the a slow neutron capture process during the creation of asymmetric giant branch (AGB) stars.

The team's ultimate goal was to determine whether the magnitude of radiogenic (produced by radioactive decay) Nd correlated with Nd produced in nucleosynthetic environments such as supernova or AGB stars.They used large sample sizes (about 2 grams) to obtain higher precision Nd and Sm isotope data for a comprehensive set of meteorites including 18 chondrites, the ungrouped primitive achondrite NWA 5363 and a Calcium-Aluminum-rich inclusion (CAI) from the Allende meteorite (the largest carbonaceous chondrite ever found on Earth).

"This research may provide a new means for assessing processes that affected solid material in the disk, as well as for identifying genetic relationships among planetary bodies," Borg said. "It calls into question a fundamental tenant of geochemistry that the composition of the Earth is precisely represented by the composition of primitive meteorites."

Other scientists include collaborators from the University of Chicago and Westfalische Wilhelms-Universitat Munster in Germany.

Neodymium is a powerful magnetic element used in compact electric motors. A Toyota Prius uses 1 kg in its electric motor magnets. Although neodymium is classifed as a rare earth element, it is fairly common, no rarer than cobalt, nickel and copper and is widely distributed in the Earth's crust.

More information: C. Burkhardt et al. A nucleosynthetic origin for the Earth's anomalous 142Nd composition, *Nature* (2016). DOI: 10.1038/nature18956

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