PLANETARY SCIENCE RESEARCH DISCOVERIES
CosmoSparks

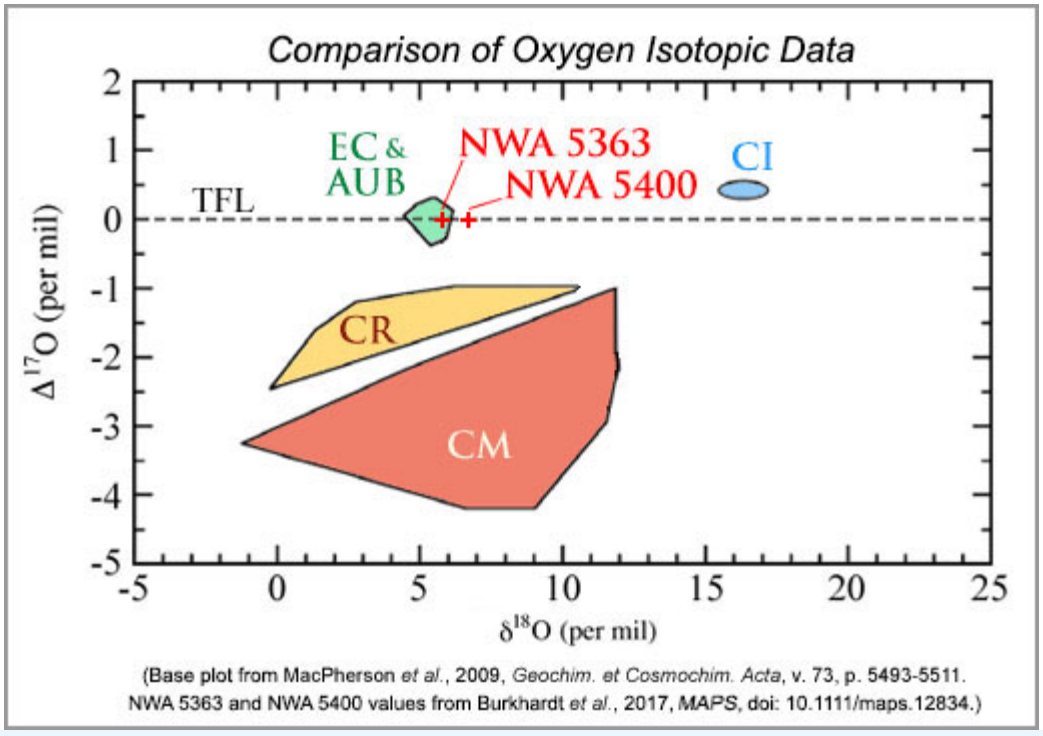
Quick Views of Big Advances

More on the Building Blocks of Planet Earth

If our planet grew from the kinds of materials we study in our meteorite collections, which one(s) exactly are the building blocks of Earth? Our planet's ***differentiation*** and inaccessible components make it impossible to measure its bulk composition—we cannot probe directly for the answer. So, cosmochemists measure ***isotopic*** abundances in meteorites to build a case for explaining the isotopic composition of bulk Earth.

Decades of painstaking work by cosmochemists have found the likely candidate building blocks to be ***chondrites***, with enstatite chondrites taking the lead, though that is not corroborated by all isotopic data. Hence, detailed studies have revealed no single chondrite group or mix of known chondrite groups to be identical compositional twins to the probable bulk Earth.

When scientists found a pair of ***achondrite*** meteorites, NWA 5363 [Data link from ***Meteoritical Database***] and NWA 5400 [Data link from ***Meteoritical Database***], with oxygen isotopic values indistinguishable from Earth values, they wanted to know if these samples may be compositional twins to Earth or, at least, tell us more about the makeup of the materials in the Earth-forming reservoir.



(Base plot from MacPherson *et al.*, 2009, *Geochim. et Cosmochim. Acta*, v. 73, p. 5493-5511.
NWA 5363 and NWA 5400 values from Burkhardt *et al.*, 2017, *MAPS*, doi: 10.1111/maps.12834.)

This plot shows oxygen isotopic data for meteorites compared with Earth. The dashed line labeled TFL is the terrestrial fractionation line, and represents Earth. The colored fields show where meteorite groups plot. EC & AUB are enstatite chondrites and ***aubrite achondrites***. CR, CM, and CI are chemical groups of carbonaceous chondrites. (PSRD has shown this plot before in ***Kaidun--A Meteorite with Everything but the Kitchen Sink***.) Meteorites NWA 5363 and NWA 5400, studied by Burkhardt and colleagues, have been added to the plot as two red plus symbols; these two samples have oxygen isotopic values indistinguishable from Earth values. But researchers have found that other isotopic signatures of NWA 5363 and NWA 5400 are different from Earth values.

An international team of scientists led by Christoph Burkhardt (University of Chicago and Westfälische Wilhelms-Universität Münster, Germany) conducted a compreshensive study of the petrography, elemental chemistry, and multiple isotopes of NWA 5363 and NWA 5400. Turns out that oxygen isotopes are very informative, but they don't reveal the entire, complicated geologic history of the samples.

The team collected major and trace element data and isotopic data (O, Ca, Ti, Cr, Ni, Mo, Ru, and W) for NWA 5363 and NWA 5400, and isotopic data for additional chondrites and terrestrial standards. They conclude that NWA 5363 and NWA 5400 are similar enough to be considered paried samples derived from an early-formed, partially differentiated, achondrite asteroid. Importantly, they found nucleosynthetic isotopic anomalies in Ca, Ti, Cr, Mo, and Ru (due to reactions inside stars such as ***r-process*** and ***s-process***), which means that the meteorites are not Earth's isotopic twins; they are not samples of the materials in the Earth-forming reservoir. The NWA 5363/NWA 5400 parent-body was not similar to Earth.

Are NWA 5354 and NWA 5400 compositional twins to Earth? No. But "no" is as important to realize as "yes." The work by Burkhardt and colleagues has shown again how comprehensive analyses add to the breath and depth of knowledge of extraterrestrial materials. If chondritic materials plus other materials combined to make Earth, the search for those other materials continues.

See Reference:

· Burkhardt, C., Dauphas, N., Tang, H., Fischer-Godde, M., Qin, L., Chen, J. H., Rout, S. S., Pack, A., Heck, P. R., and Papanastassiou, D. A. (2017) In Search of the Earth-forming Reservoir: Mineralogical, Chemical, and Isotopic Characterizations of the Ungrouped Achondrite NWA 5363/NWA 5400 and Selected Chondrites, *Meteoritics & Planetary Science,* early view, doi: 10.1111/maps.12834. [***view abstract***.]

See also:

· Taylor, G. J. (August 2010) New View of Gas and Dust in the Solar Nebula. *Planetary Science Research Discoveries.* ***http://www.psrd.hawaii.edu/Aug10/gas-dust-Oisotopes.html***

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