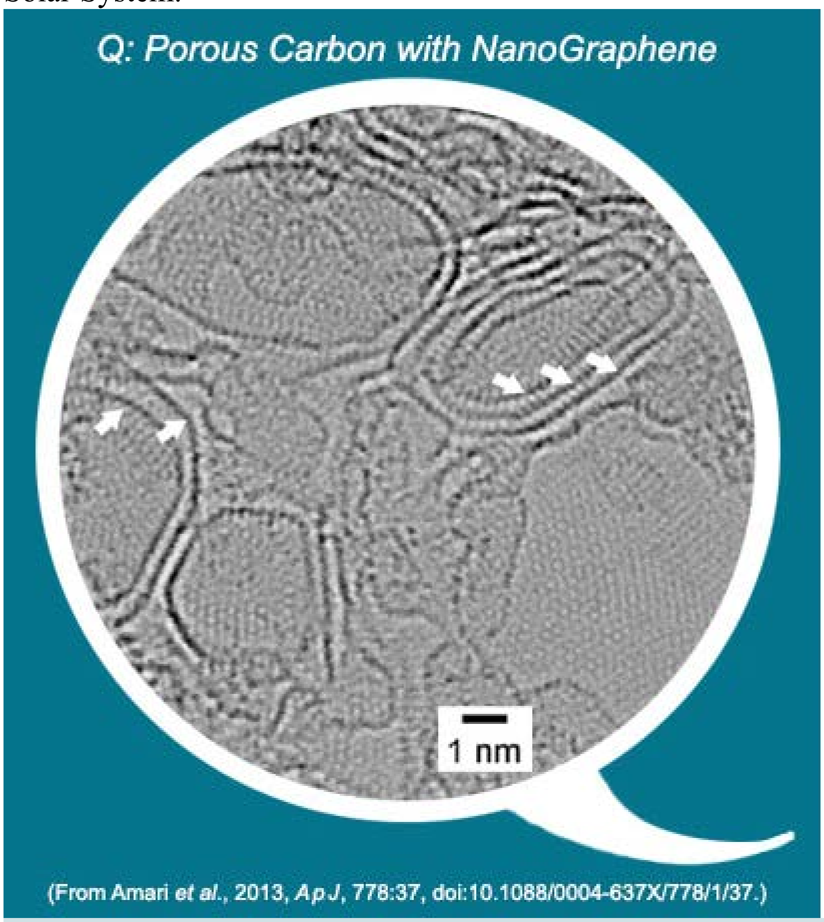
Investigating Q and Noble Gases in Meteorites

With laboratory precision, researchers are isolating and analyzing something called Q in primitive meteorites in an attempt to better understand the isotopic composition of the solar nebula and early Solar System.



High-resolution aberration-corrected scanning transmission electron microscopy (STEM) image shows planar carbon ring structures inside graphene platelets in Q from acid-resistant residue of the Saratov meteorite. Arrows indicate curled edges of graphene platelets.

Sachiko Amari (Washington University, St. Louis, Missouri), Jun-Ichi Matsuda (Osaka University, Japan), Rhonda Stroud (Naval Research Laboratory, Washington, DC), and Matthew Chisholm (Oak Ridge National Laboratory, Tennessee) focused their nano-scale analyses on an acid-resistant residue recovered from a multistep process of dissolving a sample of the Saratov chondritic meteorite [***Data link*** from the Meteoritical Bulletin] with mixtures of HF, HCL, acetone, and isopropanol. Such painstaking work to separate and study the Saratov residue was necessary to track down Q. The term Q, coined in a 1975 publication by Roy Lewis and others, designates a phase or component that carries most of the heavy noble gases (argon, helium, krypton, neon, xenon) found in all types of meteorites. Cosmochemists consider the Q-gases may be trapped vestiges of the noble gases in the solar nebula at the time solid bodies were first forming.

Previous work determined Q most likely consists of carbon, as do the other carriers of noble gases in meteorites identified as diamond, silicon carbide, and graphite. The Saratov meteorite contains Q but lacks the other carriers making it ideal for this study. Amari and coauthors used a variety of high-resolution analysis techniques, including aberration-corrected scanning transmission electron microscopy (see image) to reveal Q is a type of porous, amorphous carbon with rings of graphene lacking long-range order. They also identified chromite in their samples, but it is not a carrier of Q-gases. Amari and colleagues suggest Q-gases could be carried in one or more of the nanoscale graphene arrangements in the porous carbon. They note, however, that they did not detect Q-gases in situ making it difficult to (1) identify a definitive, specific atomic microstructure of carbon and (2) simply reject the possibility that Q may be an undetected rare, crystalline phase.

Amari and colleagues determined the elemental abundances of all five noble gases and isotopic abundances of neon, argon, and xenon in three fractions of acid-resistant residue from Saratov. The xenon concentration, 2.1 x 10^{-6} cm^3 STP g^{-1}, in one of these fractions is the highest ever obtained in Q-rich materials. They also determined $^{20}Ne/^{22}Ne$ to be 10.36 ± 0.43, which, because of the uncertainty, is consistent with all previously known values of this ratio in Q-rich fractions from other meteorites. A big issue remains whether the noble gases in Q are archives of nebular (as favored by Amari and co-authors) or presolar history (see review in the McSween and Huss book *Cosmochemistry*), assuring that work will continue on this captivating component called Q.

See Reference:

· Amari, S., Matsuda, J.-I., Stroud, R. M., and Chisholm, M. F. (2013) Highly Concentrated Nebular Noble Gases in Porous Nanocarbon Separates from the Saratov (L4) Meteorite, *The Astrophysical Journal,* 778:37, doi: 10.1088/0004-637X/778/1/37. [***NASA ADS entry***]

Also see:

· Lewis, R. S., Srinivasan, B., and Anders, E. (1975) Host Phase of a Strange Xenon Component in Allende, *Science*, v. 190, p. 1251-1262. [***abstract***]

· McSween Jr., Harry Y. and Huss, Gary R. (2010) *Cosmochemistry,* Cambridge University Press, 549 p. [***book link***]

· Stroud, R. M., Chisholm, M. F., Amari, S., and Matusda, J.-I. (2012) Aberration-corrected STEM of Q-rich Separates from the Saratov (L4) Meteorite, *75th Annual Meteoritical Society Meeting,* #5229. [***abstract***]

Written by Linda M. V. Martel, Hawai‘i Institute of Geophysics and Planetology, for ***PSRD***.

HOME

[***About PSRD*** | ***Archive*** | ***CosmoSparks*** | ***Search*** | ***Subscribe***]

[***Glossary*** | ***General Resources*** | ***Comments*** | ***Top of page***] ***Share***

April 2014

http://www.psrd.hawaii.edu

psrd@higp.hawaii.edu