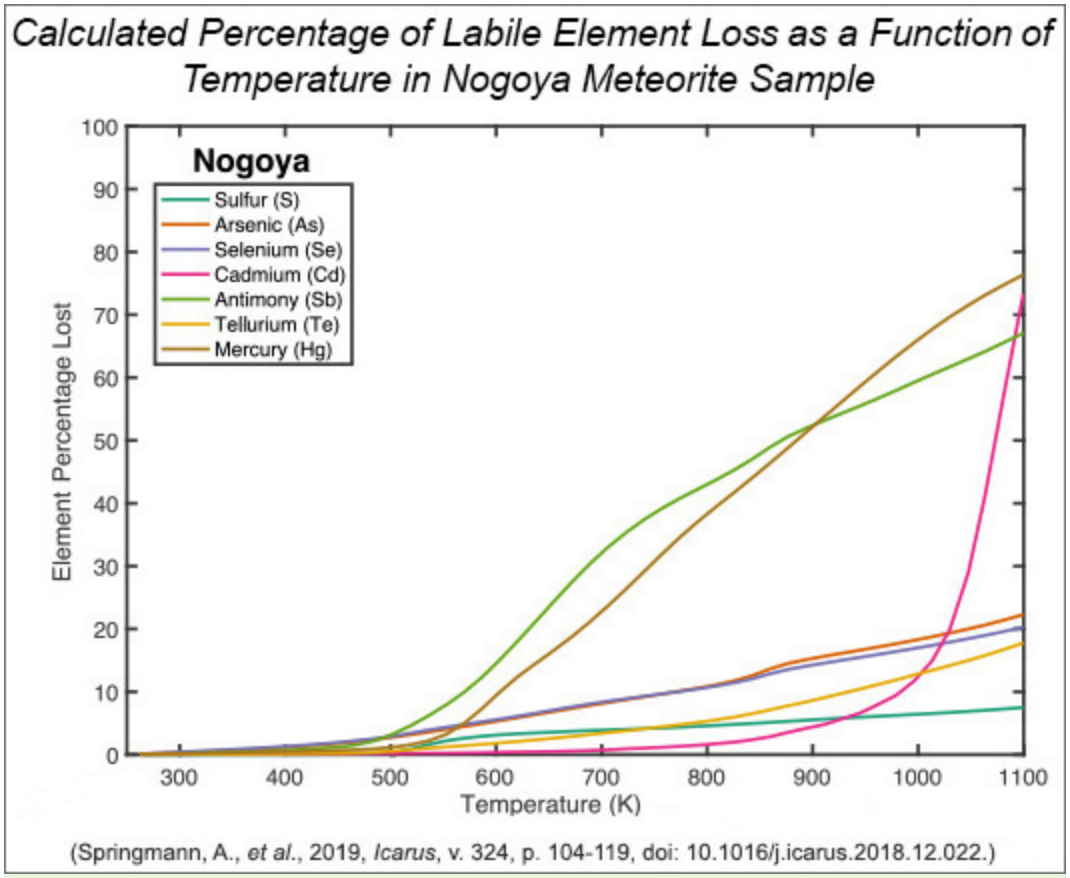
PLANETARY SCIENCE RESEARCH DISCOVERIES
CosmoSparks

Quick Views of Big Advances

Understanding Volatile Element Loss in Meteorites and their Parent Asteroids

Carbonaceous chondrite meteorites are chemically ***primitive***, meaning they are composed of ancient materials that underwent minimal heating on their parent asteroids. As chemical records of the early Solar System, these pieces of minimally processed, ancient materials are important to study to better understanding the origin, composition, structure, and development of the solid bodies that make our Solar System.

Alessondra Springmann (University of Arizona) and colleagues from Arizona, California, Michigan, Texas, Germany, and the Czech Republic report on the results of heating experiments on powders of 12 different carbonaceous chondrites (all names listed under the reference below). Designed to replicate low-temperature heating and thermal metamorphism on asteroids, the experimental data they collected allowed them to characterize the thermal release and rate of loss of ***volatile*** elements from their host-minerals. They specifically tracked seven ***labile*** elements: sulfur (S), arsenic (As), selenium (Se), cadmium (Cd), antimony (Sb), tellurium (Te), and mercury (Hg). Labile refers to volatile elements that vaporize and mobilize efficiently when heated. The plot, below, shows the loss pattern of labile elements from Nogoya, one of the meteorites analyzed by Springmann and colleagues in their experiments.



Graph showing experimental results of percentage of labile elements lost by heating of meteorite Nogoya, a CM2 carbonaceous chondrite. Nogoya was an observed fall in 1879 in

Argentina. Its type 2 classification means it has hydrated minerals. During the experiments, temperatures were ramped up from room temperature to 1173 ***K*** over 25 minutes, during which the researchers determined when the minerals released each element.

Cosmochemical research is highly relevant to ongoing missions to collect and analyze the building-block materials of our Solar System. For instance, Springmann and team explain how their experimental results relate to the handling of samples to be returned from asteroids, such as (101955) Bennu. NASA's current OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer) mission is scheduled to return regolith from Bennu to Earth in 2023. If the temperatures on Bennu are 300–400 K as predicted by previous research, and if Bennu has a composition similar to Nogoya (which is plausible), then Springmann and colleagues show that heating of Bennu samples past 400 K (e.g., during sample collection or return to Earth) would result in loss of labile elements. Mission designers took these matters seriously when developing the technology of the mission's sample return capsule and heat shield, which together will maintain the Bennu samples below 350 K to avoid thermochemical decomposition.

See Reference:

· Springmann, A., Lauretta, D. S., Klaue, B., Goreva, Y. S., Blum, J. D., Andronikov, A., and Steckloff, J. K. (2019) Thermal Alteration of Labile Elements in Carbonaceous Chondrites, *Icarus,* v. 324, p. 104-119, doi: 10.1016/j.icarus.2018.12.022. [***view abstract***]

See also:

· Bierhaus, E. B., Clark, B. C., Haris, J. W., Payne, K. S., Dubisher, R. D., Wurts, D. W., Hund, R. A., Kuhns, R. M., Linn, T. M., Wood, J. L., May, A. J., Dworkin, J. P., Beshore, E., Lauretta, D. S., and the OSIRIS-REx Team (2018) The OSIRIS-REx Spacecraft and the Touch-and-Go Sample Acquisition Mechanism (TAGSAM), *Space Science Reviews,* 214:107, doi: 10.1007/s11214-018-0521-6. [***open access article***]

Data links from the Meteoritical Database:
Orgueil (***CI***)
Murchison (CM)
Murray (CM)
Nogoya (CM)
Cold Bokkeveld (CM)
Kainsaz (CO)
Ornans (CO)
Isna (CO)
Allende (CV)
Vigarano (CV)
Mokoia (CV)
Grosnajav(CV)

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