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This Week's Citation Classic®

Heymann D. On the origin of hypersthene chondrites: ages and shock effects of black chondrites. *Icarus* **6**:189-221, 1967.
[Enrico Fermi Institute of Nuclear Studies, University of Chicago, IL]

X-ray diffraction analysis of the mineral olivine in black chondrites shows that these meteorites have been shocked from a few hundred kilobars to perhaps 1.5 Mbar peak pressures. Age determinations show that most of the black chondrites have a common "degassing" date of 520 ± 60 Myr, which is probably the date of shock. [The *SCI*® indicates that this paper has been cited in over 160 publications.]

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In 1963 I had left the FOM-Laboratory for Mass-Spectrometry in Amsterdam to join Edward Anders at the University of Chicago as a research assistant. Ed was then, and still is, a rich source of ideas for research on extraterrestrial matter, which, in 1963, meant meteorites. When I arrived, Ed's group numbered two: one graduate student and one research assistant.

Ed had purchased an inert-gas mass spectrometer that was installed in a room at the Fermi Institute so small that we concluded that no person heavier than 150 lbs could possibly work there! The spectrometer was an instrument with a glass envelope through which He readily diffused. Before every He measurement, I would check the "diffusion" rate. One morning, the rate was orders of magnitude larger than normal. I suspected a leak but could not find one. After several hours of frustration, R.N. Clayton casually asked whether the rupturing of the liquid He bubble chamber in the basement that night had caused any trouble....

Our first collaborative research was on the Canyon Diablo iron meteorite.[1] Although I am "first author" of this paper, the initial ideas had really come from Mike Lipschutz and from Ed.

It was Ed who also suggested the topic for the next "substantial research." He had made a comprehensive study of meteorites[2] and had found that the U, Th-He, and K-Ar ages of black chondrites were uncommonly young (most stony meteorites are older than 4.0 AE). He suggested that I look into this issue more carefully. Together, we began to enlarge the collection of black hypersthene chondrites.

For me, the experimentalist, the switch from iron meteorites to stony meteorites was good news. The samples were melted in vacuum. For the iron meteorites, we used a molybdenum crucible lined with an alundum crucible because Fe, Ni, and Mo form low-melting alloys. However, the corrosion of the molybdenum crucibles was fierce, and on occasion, the Al_2O_3 crucible would crack, with the inevitable consequence of burning a hole in the Mo crucible. With the stony meteorites, we could use a bare Mo crucible.

So now we had the raw data, including ^{4}He and ^{40}Ar. For the deduction of ages, we assumed the average U, Th, and K contents of this class of meteorites. The ^{4}He contents had to be corrected for gas produced by cosmic rays via ^{3}He and the "widely accepted" ^{4}He/^{3}He production rate of 4.0. The result was young ages, but still an alarming scatter and nothing like a single event.

One day, I playfully decided to plot the raw ^{4}He and ^{3}He contents against one another. What the heck could I lose? The overwhelming majority of the data fell on a straight line having a slope 5.2 ± 0.3 (the new production ratio) with a positive ^{4}He intercept, which, after another correction, corresponded to a U, Th-He age of 520 ± 60 Myr.

Now for a few things that did not go so smoothly. I had absolutely no experience in metallography. Fortunately for me, Betty Nielson was still around to explain what I was seeing in a reflected light microscope. And this was my first tangible, long paper in English. Ed thought that the language and particularly my spelling were fine but that the organization of the paper was atrocious, and he kept badgering me to do better. Thanks, Ed!

I can only guess why my paper is so frequently cited. First, the research was done on a fundamental and substantial topic in meteoritics. Second, it related, presumably, to impacts on the parent bodies of stony meteorites. Third, the results demonstrated that significant planetary processes in the solar system had occurred as recently as about 600 Myr ago. And fourth, the study was an example of a "new generation" of research using combined techniques, i.e., X-ray diffraction, metallography, and inert-gas mass spectrometry.

A few years later, G.J. Taylor continued this research on a broader collection of chondritic meteorites.[3,4]

1. **Heymann D, Lipschutz M E, Nielson B & Anders E.** Canyon Diablo meteorite: metallographic and mass spectrometric study of 56 fragments. *J. Geophys. Res.* 71:619-41, 1966. (Cited 55 times.)
2. **Anders E.** Origin, age, and composition of meteorites. *Space Sci. Rev.* 3:583-714, 1964. [See also: **Anders E.** Citation Classic. *Current Contents/Physical, Chemical & Earth Sciences* 19(11):14, 12 March 1979.]
3. **Taylor G J & Heymann D.** Shock, reheating, and the gas retention ages of chondrites. *Earth Planet. Sci. Lett.* 7:151-61, 1969.
4. ————. Electron microprobe study of metal particles in the Kingfisher meteorite. *Geochim. Cosmochim. Acta* 34:677-87, 1970.

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