

Anders E. Origin, age, and composition of meteorites.
Space Sci. Rev. 3:583-714, 1964.

This paper attempts to review all significant evidence on the origin of meteorites, drawn from chemistry, physics, mineralogy, metallography, and astronomy. Chondrites are direct condensates from the solar nebula rather than chance conglomerates of rubble. All meteorites formed in a few small, asteroid-sized bodies; most probably a minor subclass of asteroids that cross the orbit of Mars. One of these bodies, the parent body of Lchondrites, was disrupted in a major collision 400 million years ago. [The *SCI*® indicates that this paper has been cited over 315 times since 1964.]

Edward Anders
Enrico Fermi Institute &
Department of Chemistry
University of Chicago
Chicago, IL 60637

August 28, 1978

"This paper is a manifestation of Parkinson's Law ("Work fills the time available"). It was intended to be a short and superficial review, but, being my first project during a sabbatical year at the University of Bern, it grew from the intended 20 pages to a monstrous 132.

"Actually, the time was ripe for a book-length review on meteorites. Excellent chemical, isotopic, and mineralogical data had been accumulating since the late 1940s, and had led to important but fragmentary insights into the history of the solar system and the chemical elements. What was needed was a comprehensive synthesis that tied together data from different disciplines.

"As I pored over the data I had diligently collected, I began to see new, previously unobserved trends. For example, the abundances of many volatile elements in the three classes of carbonaceous chondrites were in the fixed ratio 1:0.5:0.3, suggesting that a volatilerich material was being progressively diluted by a volatile-free material. A similar trend was faintly visible in other meteorite classes. It struck me that this trend followed beautifully from John A.

Wood's petrographic model, which regarded chondrites as mixtures of two condensates from the solar nebula: micron-sized smoke that had collected its share of volatiles, and millimetersized droplets that had not. We now had a model that brought order into a mass of unrelated data and was able to make testable predictions.

"Similar insights awaited me when I scrutinized other kinds of data. Lchondrites, the most abundant class of stony meteorites, had systematically shorter K-Ar and especially U-He ages than did other meteorite classes. The shortest ages, clustering around 400 million years, tended to correlate with symptoms of shock and reheating. Apparently, a major impact 400 Myr ago had left its imprint on all Lchondrites, and so these meteorites must all have been in a single body at that time. It seemed startling that a single body should be privileged to supply one-third of the meteorites falling on Earth, when there were so many others: thousands of asteroids and millions of comets. This paradox led me to the idea that only a few asteroids in special, Marscrossing orbits might be the source of meteorites.

"Writing this paper was a Sisyphean struggle, because each new insight made some earlier section obsolete. As my wife occasionally reminds me, I worked all 31 days of December, but it was worth the effort, because the ideas developed in this paper influenced my research program for years to come.

"The main reason for the high citation count may be the heavily interpretive nature of the paper. On a number of issues, it provided either the first or the last word. The first as a provocative idea that was either destroyed, further developed, or occasionally confirmed by later workers. The last not in the sense of a definitive treatment, but as the last nail in the coffin of a dead issue, followed by a decent and hence quotable obituary. Three publishers offered to publish the paper in book form, but I declined because the tone was too partisan for a book. However, after I reach my scientific menopause, I may tone down and expand this review into a book.