OBITUARY

George W. Wetherill (1925–2006)

Geochemist, planetary scientist and astrobiologist.

Theories of the origin of the Solar System are necessarily uncertain, as the experiment that led to its formation cannot be repeated. But in the past few decades, our idea of how Earth and the other planets of the Solar System came to be has advanced from highly speculative musing to a true scientific theory with a firm base in hard facts. George W. Wetherill, who died on 19 July, was a leader in this effort to explain Earth's origins.

Wetherill was born in Philadelphia, Pennsylvania, on 12 August 1925. After service in the Second World War, during which he taught the principles of radar at the Naval Research Laboratory in Washington DC, he studied at the University of Chicago, receiving a PhD in nuclear physics there in 1953. He then moved to the Department of Terrestrial Magnetism at the Carnegie Institution of Washington, where he began work on the first major challenge of his career: how to date geological samples precisely.

At that time, the department's physicists, led by Merle Tuve, were exploring diverse subjects in Earth science, including the use of radioactive decay to date the point of crystallization of terrestrial rocks. In this environment, Wetherill was able to estimate for the first time the half-life of the extremely long-lived radioactive rubidium isotope ^{87}Rb by determining the rate at which ^{87}Rb must have decayed since its rocks formed — an age obtained independently by measurements of uranium decay. That meant that rocks could be dated precisely through the relative abundance of rubidium and its decay product, strontium. Together with potassium–argon dating, this technique allowed precise ages to be determined from a far wider range of rocks, such as granites, that did not contain the rarer uranium ores.

Wetherill was also able to bring clarity to data on the lead isotopes that, as decay products of uranium, had puzzled geochemists for years with their discordant ages. Wetherill developed the concordia diagram as a reliable means of obtaining precise crystallization ages, as well as evidence for later metamorphic disturbances, from uranium–lead isotopic ratios. The diagram found immediate, lasting acceptance among geochemists, and Wetherill's injection of modern physics into geochemistry opened up the new field of radiometric geochronology.

In 1960, partly to avoid the domineering Tuve, Wetherill accepted the offer of a professorship at the University of California, Los Angeles, where he undertook his second great challenge: understanding the orbital

dynamics of asteroids and comets, and the likelihood that they might hit Earth. The switch in focus from laboratory geochemistry to theoretical calculations of orbits was entirely consistent with Wetherill's lifelong desire to work only where he could make a significant contribution to solving great outstanding problems.

Here too, he met with success, determining the precise chance that a body orbiting in the asteroid belt between Mars and Jupiter would end up on a collision course with Earth. These calculations provided a strong indication that meteorites found on Earth originated in the asteroid belt. Thus, laboratory measurements of the elemental and isotopic composition of meteorites provided information on the make-up of bodies elsewhere in the Solar System that were otherwise inaccessible to detailed analysis. Wetherill also showed that the highest-velocity fragments of bodies hitting Mars might be launched on orbits that would intersect that of Earth, a prediction spectacularly verified by the discovery of dozens of martian meteorites on Earth.

Wetherill returned to the Department of Terrestrial Magnetism at Carnegie as its director in 1975. He was a fine director, but treated it as a part-time post. Anyone approaching him in his office would inevitably find him scanning a computer printout or a screen detailing the latest results of his own research, and he would only reluctantly divert his attention to departmental business. If it was a really serious matter, he would spin his ever-present pencil lengthwise between his fingers as he considered what to do. His first response to any request was invariably 'no'. But if one troubled to come back a second time, he would view the matter as important enough to perhaps reconsider the request. On the whole, the staff liked having a director who was more interested in doing his own work than in interfering with theirs.

At Carnegie, Wetherill embarked on his third major task — clarifying the origin of Earth itself. Here, he built on the pioneering work of the Soviet scientist Victor Safronov, whose 1969 monograph on planet formation had become widely available in a translated version only in 1972. Wetherill adapted his calculations of the orbital dynamics of asteroids to compute the evolution of small, randomly colliding rocky bodies orbiting the early Sun. Using so-called Monte Carlo methods and increasingly powerful digital computers, he showed that a swarm of hundreds of lunar-mass bodies could form

one or two Earth-mass planets (that is, Venus and Earth), and a few smaller rocky planets (Mercury and Mars), orbiting at roughly the observed distances from the Sun.

This process would probably also involve one or two Mars-mass bodies hitting the growing Earth. If such a giant impact occurred off-centre, a spray of hot mantle would be placed in Earth orbit. That debris would later coalesce into the Moon. This neat solution eliminated problems that had bedevilled previous theories of lunar origin, and, like the concordia diagram, the giant-impact theory rapidly found widespread acceptance.

Wetherill continued his research after retiring in 1991, calculating how terrestrial planets might form around other stars, and showing that Earth-like planets could form with masses several times that of Earth. If that is so, the extrasolar planets of less than ten Earth masses so far discovered might be just the high-mass outliers of a host of Earth-like worlds, with significant implications for the existence of life elsewhere in the Universe. Many details remain to be explored theoretically and tested by observations of other planetary systems, but this could be Wetherill's greatest legacy: a scientifically robust, universal theory of the formation of habitable, Earth-like planets.

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