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Harold C. Urey
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Harold Clayton Urey was born in Walkerton, Indiana, on April 29, 1893. After graduation from high school, he taught in country schools in Indiana and Montana for three years, and then entered the University of Montana, majoring in zoology with a minor in chemistry. His first independent research project was a study of the protozoa in a slough of the Missoula River. Shortly after he graduated, the United States entered World War I, and Urey went to an industrial chemical laboratory in Philadelphia to help make war material. This experience confirmed his intention to enter academic work, and after the war he returned to the University of Montana as an instructor in chemistry for two years, and then proceeded to Berkeley for graduate work in chemistry. At this point Urey plunged headlong into thermodynamics with G.N. Lewis and the rest of the Berkeley school; his proficiency in this subject soon developed into the intuitive versatility which he used powerfully in so many different applications ever since.

Urey's doctoral research dealt with the rotational contributions to the heat capacities and entropies of gases. These effects were not understood at the time because the correct quantum mechanical formulation of the rotational partition functions had not yet been established. In spite of this Urey was able to calculate entropies for diatomic gases which agreed well with the available experimental data. This work led directly to the present methods of calculating thermodynamic functions from spectroscopic data.

In 1923 Urey went to Copenhagen to spend a year studying atomic physics with Niels Bohr, and then became instructor at John Hopkins'. In 1929 he moved to Columbia as an associate professor of chemistry. His research during those years was principally devoted to experimental and theoretical work in spectroscopy and quantum mechanics; he collaborated with A.E. Ruark to write "Atoms, Molecules, and Quanta", one of the earliest and most widely referred to books on quantum mechanics. The culmination of this phase of his career came in 1931, when his interest in regularities in nuclear structure, combined with his talents as a spectroscopist and his deep understanding of thermodynamic principles, led him to the discovery of deuterium. He was awarded the Nobel Prize in chemistry in 1934, becoming the third American chemist and sixth American physical scientist to receive this award.

Photographed by Fritz Eschen, ca 1962

For a decade Urey occupied himself with the experimental and theoretical aspects of isotopic chemistry, and became the leading authority on the subject. In 1933 he became the first editor of the Journal of Chemical Physics, a position he held until 1940 by which time it had become a major scientific journal. These were fruitful and exciting years, but in 1940 everything changed suddenly with the development of government interest in atomic fission. Urey became director of the program established at Columbia for separation of the uranium isotopes and the development of D_2O production, and he soon found himself immersed in the problems of handling UF_6 and using vacuum techniques on an unheard of scale. Urey and his colleagues developed the process of gaseous diffusion through a porous barrier as the most important method for the separation of uranium isotopes, and plants of enormous size were constructed which are still in use.

In the post-war years at the University of Chicago, Urey further developed his earlier treatment of the thermodynamics of isotopic equilibria and then turned the full force of his attention toward geochemistry and the problems of the cosmos. A.O.C. Nier at Minnesota had constructed a mass spectrometer for measuring isotopic variations in gas samples with extraordinary precision. Urey further increased the precision of this instrument and began taking the temperatures of Cretaceous belemnites by measuring the oxygen isotopic fractionation between ocean water and the carbonate precipitated by the animal. The measurement of the paleotemperatures of the ancient oceans stands as one of the great developments of the earth sciences, a truly remarkable scientific and intellectual achievement encompassing a wide variety of disciplines ranging from Urey's early biological interests to his later studies of isotopic fractionation and the history of the earth.

Chicago was at this time a world center of geochemistry, and Urey's laboratories were filled with graduate students and associates developing the new field of stable isotope geochemistry and working on problems of astrophysics, geochronology, and the origin of life. These were great and exciting years, immensely stimulated by the appearance in 1952 of Urey's book: "The Planets: Their Origin and Development", in which he constructed the first systematic and detailed chronology of the origin of the earth, the moon, the meteorites, and the solar system.

"The Planets" is a tour de force which will surely stand as one of the classics of science. In some 200 pages, Urey describes as quantitatively as possible the chemical and physical processes which governed the evolution of the solar system and the objects within it. The history of the compositional and heat flow variation within the earth, the atmospheres of the planets, the origin of life and many other problems are treated with a breadth and depth and solidity unmatched in the previous literature.

The discussion of the origin of life in "The Planets" was a short 8 pages, and it had appeared as a separate paper – "On the Early Chemical History of the Earth and the Origin of Life" (Proc Natl Acad Sci USA 38: 351–363 (1952)). This paper had a profound impact not only because it was widely read (it generated the largest number of reprint requests of any paper in Urey's career), but because Urey's ideas resulted in the first successful prebiotic synthesis of amino acids (Science 117:528–529 (1953)). His ideas about the primitive reducing atmosphere and the synthesis of organic compounds were based on his model of the formation of the solar system. He learned about Oparin after one of his seminars when someone in the audience told him about Oparin's 1938 book in which similar ideas had been proposed. However, Urey's discussion, although less detailed than Oparin's in describing the steps leading to and the nature of the first organism, was firmly grounded in thermodynamic considerations, a profound knowledge of spectroscopy and photochemistry from his own earlier work, and a deep understanding of biology from his days as an undergraduate. The Miller-Urey experiment was published without Urey's name, on his insistance. This is only one of a number of instances when Urey made sure that his co-workers received the credit they deserved. Urey's other contributions to the field of the origin of life were two review articles ["Organic Compound Synthesis on the Primitive Earth", Science 130:245–251 (1959), S.L. Miller and H.C. Urey, "Origin of Organic Compounds on the Primitive Earth and in Meteorites", J Mol Evol 9:59–72 (1976), S.L. Miller, H.C. Urey and J. Oró].

Urey left the University of Chicago in 1958 to join the faculty at the Scripps Institution of Oceanography and to participate in the development of a new general campus of the University of California (now known as UCSD). His contributions at this time were important to the development of the campus since he was able to persuade a number of distinguished scientists that the new campus was going to be an exciting place. The first building on the new campus was named Harold and Freida Urey Hall in appreciation of his and his wife's efforts in this area. This activity did not, however, diminish his scientific work. His new laboratories bulged with apparatus, and his dedication became, if anithing, more complete. His studies continued to extend from the geophysics of the solid earth, through geochemistry, to the chronology of meteorites and the solar system, and the origin of meteorites, especially carbonaceous chondrites.

Urey became involved in the space program and used his influence to ensure that as much good science was done as possible. The culmination of this work was the return of the Apollo 11 moon samples, the results of which greatly expanded our knowledge not only of the moon but the solar system as well. In later years Urey was less active because of declining health, but was still involved in a number of projects, such as the Molecular Analysis Experiment of the Viking Mars Lander, which searched for organic compounds on the Martian surface and provided a detailed analysis of the atmospheric composition of this planet. And he always remained interested in the science that others were doing. Urey will be remembered for his profound impact in a number of areas of science, as well as his helpful hand and his encouragement to other scientists.

As a token of our appreciation for Urey's interest and insight into the problem of the origin of life, we have gathered in this special issue a few papers which are representative of work being done in different laboratories in this field. These papers give an indication of some of the advances in the past three decades since Urey's ideas were tested and the origin of life became an experimental field of science. Although we do not yet understand how life began on the Earth, it can be seen from these papers that this field of research has significantly advanced, and that some of the experimental approaches used in this work could not have even been conceived at the time of Urey's contributions.

S.L. Miller and J. Oró