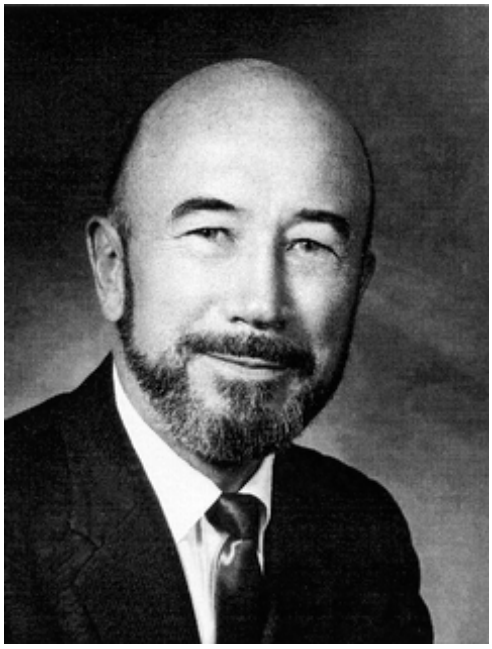

Photo by Karl Gene

Preston Cloud

September 26, 1912 — January 16, 1991

By John C. Crowell

PRESTON ERCELLE CLOUD, JR., eminent biogeologist, paleontologist, and humanist, has left a significant and diverse legacy that cuts across scientific and humanitarian disciplines. As an historical geologist he contributed more than any other single scientist to understanding the evolution of the atmosphere, oceans, and crust of the earth and to understanding the concurrent evolution of life. His work and vision emphasized complex interrelationships through the whole 4.5 billion years of earth history involving the interplay of biological, chemical, and physical processes. His deep delving through these researches led him to a special appreciation of the place of humankind within this evolving environment. He worked diligently to focus attention on the restricted carrying capacity of our planet and for human intelligence to recognize that population increases, limited material and energy resources, and the intergrown complexities of the life-web demand appreciation and action now before the activities of humans lead the planet into calamity. He was a member of the Academy for thirty years and served on its Council and Executive Committee and as chairman of the Geology Section. In many ways he contributed both to the Academy's welfare and to its service to the nation and the world through wise and informed leadership on National Research Council projects.

In October 1989 I asked Cloud at a relaxed lunch what he considered his most important work. He replied that his forte had been in seeing the larger connections between processes to events, particularly as they affected early biospheric evolution. He felt that his model of the primitive earth (from 1968 on), connecting biospheric, atmospheric, hydrospheric, and lithospheric evolution, had been challenged, tested, and validated in all significant elements and that it is now widely accepted as the best-available approximation. He recognized in 1968 that free oxygen first began a significant atmospheric accumulation about 2 billion years before present, setting the stage for eucaryotes, and first rose to levels supportive of metazoan evolution about 700 million years before present. He perceived (as early as 1948) that the Metazoa first evolved and rapidly diverged into phylum-level categories during the first 200 million years or less of Phanerozoic time. He was also an early and continuing contributor to discussion and legislation concerning preservation of the human habitat and the converging problems of population growth, management of natural resources, and deterioration of the environment.

Pres Cloud, the name his friends used, was born in West Upton, Massachusetts, on September 26, 1912. He was the third of seven children of Preston Ercelle and Pauline L. (Wiedemann) Cloud; his father was an engineer-draftsman. His wife, a genealogist, traced his ancestry to William Cloud, who was given land by colonist William Penn in 1683. During high school, from which Cloud graduated in 1929, his family lived in Waynesboro, Pennsylvania. Pres was especially attracted to the outdoors and followed Boy Scouting right through to the Eagle rank. After high school he enlisted as a seaman in the U.S. Navy for three years and was bantam-weight boxing champion of the Pacific Scouting Force. Following discharge in California in 1933, he spent several months hiking and working his way back to his home in the East. The Great Depression was in full swing, so Cloud was unable to enter a university as a daytime student. Instead, he went to Washington, D.C., where he attended night school at George Washington University, taking a full load and supporting himself by odd jobs during the day. One of his professors of geology, Ray S. Bassler, was also curator of geology at the U.S. National Museum. Bassler arranged employment for Cloud at the museum, first as a man-of-all-work. Soon Cloud showed scientific interest and skills, so he became a preparator in the paleontology laboratory of the museum, working for G. Arthur Cooper, an outstanding expert on Paleozoic fossil brachiopods. Cloud's interest in research paleontology was launched, and Cooper invited Cloud to join him as junior author on a paper

dealing with Devonian brachiopods from Illinois, published in 1938. Although Cloud worked full-time at the museum during the day, he completed work for a bachelor of science degree in geology in four years and was elected to Phi Beta Kappa. (In 1990 George Washington University invited him to present the 1991 Distinguished Alumnus Address, but, sadly, his death intervened.)

Cloud entered Yale University graduate school in geology in 1937 and supported himself largely as a fossil preparator. For his doctoral dissertation he completed in three years a major systematic monograph on a group of Paleozoic brachiopods, under the direction of C. O. Dunbar, and was awarded the Ph.D. degree in 1940. The work was awarded the A. Cressey Morrison Prize in Natural History by the New York Academy of Sciences and was published by the Geological Society of America as Special Paper 38 in 1942. Cloud enjoyed the summer of 1939 as field assistant to A. Lincoln Washburn on Victoria Island in western Arctic Canada. Washburn's work, also a dissertation undertaking, when published, contained a contribution on the stratigraphy and paleontology by Cloud. After receiving his Ph.D. Cloud taught for a year at the Missouri School of Mines in Rolla but then returned to Yale University to continue work on brachiopod evolution as a Sterling Research Fellow (1941-42).

World War II was under way, and Cloud was soon called to the U.S. Geological Survey for work within the wartime Strategic Minerals Program. He joined a field party studying manganese deposits in Maine during the summer of 1941 and then became chief of party for bauxite investigations in Alabama. D. L. Peck, director of the U.S. Geological Survey, wrote in a letter dated January 29, 1991, that while Cloud was examining clay pits alone, "his method was to tie a rope to a tree and lower himself into the pit, leaving at day's end by walking up the wall and taking his rope with him. This created quite a stir among the locals who suspected that this person of slight stature, emerging from holes in the ground, must certainly be a Japanese spy in their midst." He was then assigned to work with V. E. Barnes of the Texas Bureau of Economic Geology in a study of the Ellenburger Limestone of the Lower Paleozoic sequence in central Texas. This stratigraphic unit, an important subsurface reservoir for oil in nearby regions, required precise mapping and investigation of the stratigraphy and paleontology. Barnes writes (June 19, 1991) of these times when they worked together: "Pres was persistent and dedicated to accuracy in all that he did. For example, in establishing measurable stratigraphic sections, frequent offsets along the bedding were needed to reach better exposed strata. On one of these offsets, Pres was crawling along a bed through a dense juniper thicket, and came face to face with a huge rattlesnake. Pres was not easily bluffed: after a few minutes of staring at each other, the rattlesnake crawled away." The experiences made Cloud a first-class field stratigrapher and thoughtful student of carbonate rocks and their depositional environment. The Ellenburger studies led to several significant publications and convinced Cloud that ancient carbonate rocks could only be understood through investigation of similar deposits forming today.

In 1946 Cloud accepted a position as assistant professor of paleontology and curator of invertebrate paleontology at Harvard University, but he resigned in 1948 to return to the U.S. Geological Survey as chief of party to map and investigate the geology of Saipan in the Mariana Islands in the western Pacific. Several important publications resulted, dealing with coral reefs and the geology and ecology of this modern carbonate environment, including early comments concerning the geochemical processes involved. During this time he published the then-controversial theory that multicelled and complex organisms evolved rapidly from many different ancestors since early Phanerozoic time, about 700 million years ago. He produced evidence to show that when the oxygen level climbed over the next 80 million to 100 million years these early organisms expanded into a host of vacant ecological niches. They demonstrated evolutionary opportunism.

For ten years (1949-59) Cloud was chief paleontologist at the U.S. Geological Survey in Washington, D.C. During this interval he guided the growth of the Paleontology and Stratigraphy Section from twelve professional scientists, two clerks, and two technicians to a group of forty-five professionals and a total staff of about 120. His leadership reflected his conviction that paleontology had a dual function: to provide a basis for the essential chronology of geological strata and to document the evolution of life on earth. I. G. Sohn wrote (in a letter dated January 29, 1991) of these times: "Pres recruited young paleontologists and built what we considered to be the largest unit of specialists in paleontology in the world under one roof. He read every manuscript submitted for publication, and made valuable constructive suggestions. He always complimented good work, and never criticized any of us in public, although he could be brutally frank in private. He made it unequivocally clear to each of us that we had to complete our assigned task in publishable form." Cloud instigated weekly "brown-bag" lunches for his colleagues and brought in outside geologists to join in informal and stimulating discussions and usually on an announced topic. All paleontologists were expected to attend. Moreover, able young scientists, newly arrived, learned much about the service and functioning of the museum when they were assigned to serve a half-year as "assistant to the chief" to keep track of the flow of fossils into the museum and reports and publications flowing out. These practices greatly improved the esprit of the group and its visibility and service to the scientific and general community.

During this decade of administration Cloud continued research and publication of results of new and previous studies. He organized his time very efficiently and maintained a closed-door policy for much of the day and then opened it widely at other announced times so he would be available to his colleagues. Many evenings he worked until midnight and frequently on weekends. According to legend, he used slip-on shoes so that he would not waste time in lacing! He also organized occasional field trips to nearby areas so that his colleagues could enjoy the social fun of field excursions and a bit of science along the way. In 1952 he took leave and participated in a reconnaissance study of the petroleum resources of northern Spain.

Cloud's studies in the Pacific had shown him that work in present depositional environments was required, so he investigated the Great Bahamas Banks on marine expeditions in 1955 and 1956. He was instrumental in moving the U.S. Geological Survey from studies of the land only to studies of the sea floor and in organizing the program in marine geology. After stepping down as chief paleontologist of the survey, Cloud turned to the seas and oceans in earnest. He saw that there was a critical gap: active oceanographic institutions were concentrating their investigations on the deep ocean and the Survey should study the continental shelves and coastal zones. This required stimulating interest among Survey managers and generating support within the National Research Council and with congressional contacts so that legislation and support were forthcoming for Survey investigations beyond the shoreline. This program is responsible for much of what we now know about the U.S. continental shelves and coastal zones, including Alaska. It plays a key role in the appraisal and development of offshore petroleum and minerals.

In 1961 Cloud accepted appointment as chairman of the Department of Geology and Geophysics at the University of Minnesota. He recognized that many disciplinary approaches are required in understanding the earth and its history and so organized the School of Earth Sciences at that university. This school, of which he became the first head, included his department, the Minnesota Geological Survey, and the Limnological Research Institute. Up to this time, Cloud's personal research had largely concentrated on the last 600 million years of earth history and its life. He now began to concentrate primarily on the complex problems of understanding the interacting processes that shaped the first 85 percent of the history of our planet. He developed his own techniques in paleomicrobiology and blended them with the methods and results of geochemistry and field geology toward the goal of reconstructing the past. These led him to appraise the levels of oxygen and carbon dioxide through time and to consider the buffering systems and geochemical sinks that affect atmospheric composition and the sequestration and recycling of carbon. For the remainder of his life he concentrated on studies of the pre-Phanerozoic record and the evolution of life. He personally examined key outcrops around the world, such as those in southern Africa, South America, Siberia, China, Australia, and North America. He worked on all continents except Antarctica but managed to visit that continent a few years ago as a perceptive tourist. On excursions he always joined local geologists, experts in the regions, and enjoyed thoroughly the experiences of such fieldwork, especially the socializing with his colleagues in the evenings around campfires.

Cloud's scientific writings illuminated many subjects. "Two features set his papers apart from the ordinary: painstaking attention to empirical detail coupled with intellectual boldness in interpretation. Without the first, no claim about the earth can be taken seriously. In the absence of the second we will not see farther, even when perched atop a mountain of data."[1] In pursuit of his ultimate goal of understanding the evolution of the biosphere as well as he could, Cloud studied the story revealed by specific sequences of strata and in so doing unlocked understanding of many associated processes and products. For example, banded iron formations about 2 billion years old tell much about the geochemistry of ancient oceans and the conditions surrounding their deposition and subsequent alterations. The origin of these important ores has long intrigued mining geologists, and Cloud's scope of outlook contributed to understanding both their genesis and the geochemical processes in very ancient seas. His approaches, anchored in investigating enigmatic strata perceptively and then in reasoning to broader environmental interpretations, disclosed much concerning the origin of carbonates, the conditions prevailing when siliceous rocks were laid down in the company of primitive microorganisms, and in documenting their change through time from unicellular to complex organisms. Cloud concluded that the slow increase in oxygen in the atmosphere and hydrosphere had indeed left a decipherable record. His inventiveness led him to publish the first electron micrographs of isolated pre-Phanerozoic microbes and show that cellular differentiation was under way by 2 billion years ago. He joined with Soviet paleontologists and confirmed their view that stromatolites displayed useful variations in pre-Phanerozoic stratigraphy.

Cloud was a true founder and leader in the burgeoning field of pre-Phanerozoic studies. Because the record is piecemeal, only a holistic approach to understanding the first 85 percent of earth history is feasible. Cloud concluded that the earliest Paleozoic metazoan record when fossils become abundant was less an accident of an incomplete record in strata previously and actually a display of evolutionary opportunism related to the availability of new ecological sites and conditions. The Metazoa descended from many ancestors, probably starting when there was sufficient oxygen available about 680 million years ago. Life cells with nuclei came along between 1.3 billion and 2 billion years ago, perhaps when the oxygen level dipped slightly. Free oxygen first began to accumulate on earth about 2 billion years ago, mainly as the result of biological activity. Life cells with nuclei came along during the next several hundred million years. Before these times there were intervals when banded iron formations were laid down, mainly owing to the activities of microbial life. In fact, indirect evidence implies that oxygen-producing microbial life was present when the oldest-known sediments were laid down, about 3.76 billion years ago. This history of the earth as now viewed is nicely portrayed diagrammatically on the front end-papers of Cloud's life-summative book, *Oasis in Space* (1988).

Cloud was a stickler for accuracy in nomenclatural concepts and was eloquently outspoken before international commissions on the distinctions between time and rocks and other matters. For example, he saw a need for erecting a new geologic period (the Ediacarian) before the Cambrian Period. This is a period with a physical and biological record indicating closer relations to the Phanerozoic than to conditions prevailing before.

In 1965 he joined the University of California, Los Angeles, as professor of biogeology, jointly with the Institute of Geophysics and the Department of Geology, of which, at the time, I was chairman. The UCLA faculty was convinced that interdisciplinary approaches were essential in understanding the earth, both at present and during past eons. The geophysicists at the Institute led the way in accepting a paleontologist! Three years later Cloud transferred to the Santa Barbara Campus (UCSB) and served actively on the faculty until 1979, both as professor and professor emeritus. On the UCSB campus he established a "clean lab" for the study of ancient life, a facility in part set up by NASA to examine moon and other extraterrestrial material for evidences of life activities. In 1969, upon examining some of the first samples brought back from the moon, Cloud determined that the moon was devoid of life. This lab, formally dedicated as the Preston Cloud Laboratory, is a separate building adjacent to the Department of Geological Sciences, where research continues on pre-Phanerozoic life and history. From 1974 to 1979 Cloud was again a member of the U.S. Geological Survey based in Santa Barbara and continued as a strong and wise scientific influence on the UCSB campus. He advised and conferred with students and colleagues and regularly attended talks and seminars, regardless of the topic. At these he inevitably asked searching questions and many times hosted evening discussions in his home afterwards. He participated enthusiastically on departmental field trips and even went to areas where the rocks were of no special interest to him. His concern over the welfare of our planet as a human habitat and his deep knowledge of environmental interplays provided us with sound advice as we organized a Program in Environmental Studies at UCSB. Cloud was indeed a special influence in my own life over the twenty-five years we were colleagues. I owe much to lunchtime discussions that guided my thinking concerning paleoclimates and tectonics as well as organizational matters.

Cloud was widely sought as a public speaker and symposium participant on the subjects of resources, the human future, and the primitive earth, and he gave many lectures a year. He was one of the few speakers I have known who could read a lecture with a natural and seemingly extemporaneous intonation and therefore say exactly what he wished to say! He organized, chaired, and participated in several invitational symposia on emerging scientific opportunities that have had seminal influence: the Shelter Island Conference on Paleoecology (1956), the Woodring Conference on major biological innovations and the geologic record (1961), the Laramie Conference on Pre-Cambrian History (1970), the Rubey Conference on Crustal Evolution

(1973), and others. He also contributed his thoughts while serving on several visiting committees to universities throughout the nation. In his later years Cloud went away from Santa Barbara on extended visits, such as to accept a Luce Professorship of Cosmology at Mount Holyoke College and a Queen Elizabeth II Senior Fellowship at Canberra, Australia. During these visits he continued to work and write. His life was truly characterized by remarkable intellectual energy and an ability to organize and concentrate on the task at hand.

Along the way Cloud continuously reflected upon the bearing of his increasing knowledge of the history of the earth to problems facing humankind and to our understanding of the environment around us. He was the prime motivator and organizer of several influential studies, including at least three undertaken by the National Research Council. As chairman of the Committee on Resources and Man, he saw through to publication the volume *Resources and Man*,[2] which brought together authoritative chapters written by leading ecologists, resource and energy specialists, demographers, and others. This book, with an introduction and set of recommendations primarily written by Cloud, has been widely used as a text or reference book in universities and has guided many environmental students and professionals along thoughtful paths. Later Cloud organized the Committee on Resources and the Environment and steered it toward fruitful objectives--the eventual long report (completed under the chairmanship of B. J. Skinner) has been particularly influential on U.S. energy and mineral policies. His efforts in these directions involved testimony before and preparation of materials for various congressional committees and panels, including the Joint Economic Committee of both houses of Congress, for which he prepared a statement on the mineral raw materials and national welfare (1976). Early on Cloud saw the importance of understanding the long evolution of the earth's climate throughout geologic time in approaching problems of climate change in the near future, especially those changes anticipated as industrial society burgeons. As a consequence of this vision, Cloud saw through to publication the report titled *Geological Perspectives on Climate Change*, which in turn has stimulated the preparation of additional NAS-NRC studies.

Cloud's research therefore led him directly from studies of the long record of life and environmental factors that influence it to reports that have aided the guiding of societal and governmental policy. His list of diverse publications exceeds 200 titles. These include not only scientific papers and policy reports but also books of appeal to the serious nonspecialist. He assembled a collection of previously published papers by many authors in *Adventures in Earth History*.[3] This book is held together by enlightened essays, written by Cloud, that show the relation of each specific contribution toward our goal of understanding the whole. And he wrote *Cosmos, Earth, and Man*,[4] which thoughtfully places man into his tiny spot in the universe.

More recently Cloud wrote *Oasis in Space: Earth History from the Beginning*,[5] which is a comprehensive work of synthesis and reflection aimed at perceptive intellectuals and university students. It is a documented history of the earth and life on it as we now understand them and an impressive capstone to his remarkable scholarship. Only Cloud could have written it. We are fortunate that he placed on paper this distillation of his understanding for all of us, specialists and generalists alike. The book points to the uniqueness of our planet and our dependence on very special circumstances and events over 4.5 billion years. It is intercalated with wise and informed comments concerning the nature of science, of geology, and of the future. Cloud was above all an interdisciplinary and holistic scientist but also a specialist in several fields. He moved from discipline to discipline as he perceived new challenges or saw new data and approaches emerging that bear on arriving at understanding the biospheric history of the earth. In many ways he was driven to spread the excitement of science and the need for humankind to wake up to its place within the universe. He felt that all should realize, as he states in *Oasis* (pp. 14-15), "We are made of star stuff, processed through supernovae, concentrated from the contracting solar nebula, spun into biochemical aggregates with a difference, and graced, during our tenure here, by the ability to imagine, to conceptualize, to hypothesize, to create science, poetry, music, and works of art and technology." He leaves a deep influence upon a vast and diverse assemblage of scholars, both scientists and humanists, who have read his works or listened to his lectures or who have, as I, discussed matters of earth history with him personally. He has indeed left an influence upon educational and governmental policy across the world.

Pres shared his life with three wives, who worked closely with him on his scholarly activities and immensely enhanced his achievements. He met Mildred Porter of the Peabody Museum at Yale University while he was a graduate student. They were married when he moved to Rolla, Missouri, and she shared with him experiences during the war years in Alabama and Texas and then returned with him to Harvard University. When Pres left Harvard and joined the U.S. Geological Survey, they were divorced. During his time in Saipan, he met and later married Frances Webster. They had two daughters, Karen and Lisa, and a son, Kevin. Pres and Fran were divorced in 1965. Following his move to Santa Barbara, Pres met Janice Gibson whom he married in 1972. They made their home in Santa Barbara, where together they raised her three children: Morgan, Dante, and Amanda De Lucia. Pres took great pleasure in the companionship and accomplishments of his children and stepchildren, especially as he relaxed more in his later years. In October 1990, a few months before he died, a group of his friends, family, and colleagues from across the nation met in Santa Barbara for a surprise party on the occasion of the publication of a special volume of the *American Journal of Science* dedicated to him (titled "Proterozoic Evolution and Environments"). He took special and humble pleasure in this honor. Most of his life he profited from vigorous health, unusual energy, and the ability to focus his intellect on problems and work at hand. During his last few years, however, his body began to fail owing largely to the inroads of amyotrophic lateral sclerosis. Despite this, Cloud's strong will and work habits of a lifetime carried him on with no sign of diminished intellectual activity. He died at home on January 16, 1991.

IN PREPARING THIS MEMOIR I was very much helped by Mrs. Jan Cloud and Mrs. Fran Cloud and by permission to read before publication a memorial written by John Rodgers for the American Philosophical Society, which has also been published by the Geological Society of America. Letters from Cloud's colleagues at different times over the years also aided me, especially those of Jack Dunlap, Virgil Barnes, Ean Zen, Ellen Moore, Dallas Peck, Greg Sohn, Pete Palmer, Tom Dutro, Link Washburn, Reuben Ross, and many many others.

NOTES

[1] A. H. Knoll. *American Journal of Science*. 290-A(1990):vi, vii.

[2] National Research Council. *Resources and Man* (San Francisco: Freeman and Company, 1969).

[3] National Research Council. *Geological Perspectives on Climate Change* (Washington, D.C.: National Academy of Sciences, 1978).

[4] *Cosmos, Earth, and Man* (New Haven, Connecticut: Yale University Press, 1978).

[5] *Oasis in Space: Earth History from the Beginning*. (New York: Norton and Company, 1988).

HONORS AND DISTINCTIONS

1941
A. Cressey Morrison Award in Natural History, New York Academy of Sciences

1956
Rockefeller Public Service Award Honorary Fellow, Paleontological Society of India

1959
Distinguished Service Award and Gold Medal, U.S. Department of Interior

1961
Member, National Academy of Sciences

1969
American Academy of Arts and Sciences

1971
Paleontological Society (of America) Medal

1973
American Philosophical Society Lucius Wilbur Cross Medal, Yale Graduate School
Corresponding Member, Geological Society of Belgium

1975
Fourteenth A. L. DuToit Memorial Lecturer (and first American), Royal Society of South Africa and affiliated societies

1976
Penrose Gold Medal, Geological Society of America

1977
Walcott Medal, National Academy of Sciences

1980
Foreign Member, Polish Academy of Sciences

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