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NOTABLE SCIENTISTS

A TO Z OF Earth Scientists

ALEXANDER E. GATES

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Facts On File, Inc.

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PREFACE

HOW THE EARTH SCIENTISTS WERE CHOSEN

A to Z of Earth Scientists was originally intended to include only Earth scientists who have made contributions to our understanding of the Earth since World War II, with emphasis on those who are currently active or were recently active. It was intended that there should be a relatively even distribution across the subdisciplines as well as geographically, although it was realized from the outset that there would be more American scientists included. However, many of the society and government agency awards are named in honor of previously active Earth scientists so many of them are included as well.

Research for this book showed that there is very little biographical information available for currently active Earth scientists. There is basic information on employment, awards, and date of birth available for most living individuals in the volumes *American Men and Women of Science.* The American Geological Institute's Bibliography of Geology also contains their publications. The information on their contributions to the Earth sciences, however, is very difficult to obtain and commonly must come from award citations from societies, if available. In many cases, the only information available is that on web sites and even that is usually scant. As a result, information had to be solicited directly from the Earth scientists to be included in the book. In some cases, it took several solicitations to obtain the information and in others, because of a lack of response, the individual could not be included in the book. As a result of the exhaustive amount of effort required in research, unavailability of information, and a major change in the structure of the book during writing, the list of biographies changed radically during the writing of the book and is generally shorter than planned. The choices may almost seem arbitrary and capricious to some readers. The number of biographies could easily be doubled to include those who deserve recognition for their contributions to Earth science. Language problems made it especially difficult to obtain information on scientists outside of the United States. In no way should the final list of Earth scientists included in this book be construed to indicate that these are the only people who made contributions to the field or that their contributions are of greater importance than many other exceptional scientists in the profession. The hope is that this book will be popular enough to warrant a second edition in which many more deserving Earth scientists might be included.

This book is intended for people in high school, early college, and perhaps at a more advanced level of study. There are many technical terms that are briefly explained where possible.

In many cases, they are not explained at all. It is recommended that if the reader has not attended at least an introductory course in Earth science (physical geology) that an Earth science (geologic) dictionary be kept handy.

Acknowledgments

This book would not have been possible without the contributions of many people. I first and foremost wish to thank the many Earth scientists who agreed to be included in the book and who sent biographical data. Many of them reviewed early drafts of their biographies and suggested changes that improved the accuracy of the book. Many also sent photographs that are included with their biographies. A special thanks to Arthur Sylvester who voluntarily opened up his rogues' gallery of photographs to me, many of which appear in the book. James Skehan, S.J., similarly provided me with several photographs of East Coast geologists which I otherwise would not have obtained. Joseph McGregor of the U.S. Geological Survey in Denver was helpful in providing excellent photographs of geologists in a very short time.

In addition to obtaining information directly from the participants, there were several other great sources. The American Geophysical Union provided biographical information directly to me, in addition to that which is available over its web site. Much information was obtained from published material from the Geological Society of America, the Mineralogical Society of America, the Geological Society of London, the Paleontological Society, the Society for Exploration Geophysicists, and the Geochemical Society. The librarians at the Dana Library at Rutgers University in Newark, New Jersey, were extremely helpful and even more patient during the writing of this book. Veronica Calderhead and Ann Watkins were especially helpful, although most of the staff were very cooperative. The search engine google was used extensively in the locating of biographical material.

The progress in the writing of this book was memorable to say the least. Frank K. Darmstadt, senior editor at Facts On File, Inc., was extremely patient and understanding. The project could easily have collapsed if not for his willingness to adjust as unexpected situations arose. My agent, Max Gartenberg, deserves recognition for his patience, as well. If it were not for Gayle Martinko's urging to undertake the project, and agreeing to serve as coauthor at the outset, the book would not have been completed. Finally, I wish to thank my son, Colin Gates, who pitched in and compiled all of the information for the appendices when I ran into time problems. Thanks also to Maxine, Jasper, and Tom for putting up with their dad always having his nose in the computer.

INTRODUCTION

In the 19th century, Earth science was king; it was deemed the most attractive and of highest potential of all sciences by the *New York Herald* and *Knickerbocker Magazine* in the 1830s. One-fourth of all scientists in the United States between 1800 and 1860 were Earth scientists, and they charted the direction of American science. JAMES DANA from Yale University was their leader and considered on a par with Charles Darwin in terms of respect and prestige. He virtually controlled the American Association for the Advancement of Science, which was the premier scientific society of the time. Even at the end of the century the newly established U.S. Geological Survey was headed by some of the most influential scientists in the country, like John Wesley Powell, G. KARL GILBERT, and CHARLES D. WALCOTT. The Geological Society of America, the premier society of the Earth sciences, was founded in 1888.

The 20th century saw the rise of the other sciences and decline of the Earth sciences in comparison. They were influential at the beginning of the century when the quest for oil by an adventurous group called wildcatters brought great fame and fortune. The Rockefeller fortune was built in this industry with the establishment of the mammoth Standard Oil Company. Even President Herbert Hoover was an Earth scientist. In World War I, the famous Earth scientist ARTHUR L. DAY averted a major American crisis of a critical shortage of optical glass for the war effort through an ingenious and concerted effort. This work, however, was only marginally related to Earth science research.

Earth scientists played prominent roles in the World War II effort, but generally not for their specialties. DAVID T. GRIGGS developed methods to conduct aerial bombing missions using radar guidance. Before that, bombing was done by purely visual methods. A. FRANCIS BIRCH was the lead scientist on the Hiroshima bomb (Little Boy) team and even helped load the bomb onto the *Enola Gay.* HARRY H. HESS and SIR EDWARD C. BULLARD developed methods to virtually eliminate the threat of both mines and submarines to ships. Although these and many other Earth scientists were instrumental in the war effort and many observations were made that would later help with interpretations, few direct breakthroughs in the science were realized as they were in other sciences like physics and medicine.

In the late 1950s through the 1960s, Earth sciences again drew public attention with the documentation of the plate tectonic theory. The idea that the solid Earth below our feet was actually moving boggled the imagination. Again, some of the most influential scientists in the world were Earth scientists like Harry Hess, J. TUZO WILSON, and ROGER REVELLE, among others, and they were involved in this revolution. This powerful

concept has been referred to as the "glue that holds geology together" because it resulted in the rapidly radiating subdisciplines of the Earth sciences being drawn together. Plate tectonics was the mechanism by which they could be interrelated. It still drives much of the solid Earth research that is done some 40 years later.

The cold war that was in full swing at the time of the plate tectonic revolution also involved Earth scientists. In order to monitor nuclear tests, a worldwide seismic monitoring network was established. Earth scientists like FRANK PRESS, INGE LEHMANN, and LYNN R. SYKES became as much diplomats as they were scientists, serving on numerous top-level international advisory boards. They were even involved in treaty negotiations. Other Earth scientists like ARDEN L. ALBEE, DON U. WISE, CARL E. SAGAN, and WILLIAM R. MUEHLBERGER got involved in the space race. They served in high-level capacities to ensure the success of NASA's Apollo lunar missions.

Overlapping this exciting period of revolution in the Earth sciences came a societal crisis that only Earth scientists could solve. In 1973, the Arab oil embargo sent the country into a crisis that would dominate the next decade. Record numbers of students were entering the Earth sciences in colleges, and once again the Earth sciences topped the lists of the best career choices in popular magazines like *Time* and *Newsweek.* Earth scientists could write their own ticket to outstanding careers in the petroleum industry. This interest and funding led to numerous new developments and Earth scientists discovered enough new petroleum reserves to rescue the country from the crisis. Earth scientists like ALBERT W. BALLY and GERALD M. FRIEDMAN figured prominently in these efforts.

In the early 1980s, however, energy supplies became abundant and with only a few perturbations have remained so ever since. Exploration for petroleum reserves declined dramatically and the Earth sciences went into the doldrums. Although vital contributions were made in the areas of environmental science by scientists such as CRAIG M. BETHKE and SUSAN L. BRANTLEY and climate change research by WALLACE S. BROECKER, JOHN IMBRIE, and SIR NICHOLAS J. SHACKELTON, the image of Earth science declined and has remained behind the scenes. Fields such as biotechnology, particle physics, and material sciences have taken center stage. It is for this reason that this book was written at this time.

The Entries

Entries in *A to Z of Earth Scientists* are arranged alphabetically by surname, with each entry given under the name by which the Earth scientist is most commonly known. The typical entry provides the following information:

Entry Head: Name, birth/death dates, nationality, and field(s) of specialization.

Essay: ranging in length from 750 to 1,500 words, with most averaging around 1,000 words. Each contains basic biographical information—date and place of birth, family information, educational background, positions held, prizes awarded, etc.—but the greatest attention is given to the scientist's work. Names in small capital letters within the essays provide easy reference to other scientists represented in the book.

In addition to the alphabetical list of scientists, readers searching for names of individuals from specific countries can consult the Country of Birth appendix. The Country of Major Scientific Activity appendix lists scientists by the countries in which they conducted their work and research. The Field appendix cites them by the area of Earth science in which they were most notable. The Index lists page references for scientists and scientific terms used in the book. Finally, the Chronology lists entrants by their birth and death dates.

Indeed, Earth science is largely responsible for sparking the scientific revolution of the 20th century. In addition, no matter how many marvelous technological breakthroughs we have made, this Earth is still the only place we have found thus far that is able to sustain life. We must therefore keep its importance in proper perspective in this fast-paced world. Earth scientists are still making important contributions to society, far beyond what is imagined by the general public. If this book can in some small way help to bring recognition to these Earth scientists, then it will be deemed a success.

A

☒ Albee, Arden L.

(1928–)
American
Geochemist, Metamorphic Petrologist

When Earth scientists write and publish a research paper, they hope it is successful. The definition of success varies by the individual, but if at least 200 people read the paper and 50 or more cite it in other research papers, then most would consider the paper to be a success. In 1968, Arden L. Albee and his student A. E. Bence published the paper, "Empirical Correction Factors for the Electron Microanalysis of Silicates and Oxides," whose methods are still employed by geologists an average of 300 times per day. In the late 1960s, new analytical procedures allowed scientists to quantitatively analyze the chemistry of individual minerals. The electron microprobe bombards individual mineral grains with a focused stream of high-energy electrons. The individual atoms in the minerals give off X rays upon impact, which are then received by detectors. The data that the detectors supply is then converted into weight percent of an oxide of the element and then into an exact mineral formula. Chemical reactions can be precisely determined with these data in contrast to the purely qualitative chemical reactions that preceded this technique. Bence and Albee devised the correction factors needed to convert counts on an X-ray detector into oxides and minerals. Those corrections are programmed into likely every single electron microprobe in the world. Electron microprobes are used on a daily (and nightly) basis at most universities that operate them. That number includes essentially all of the large universities in the world. Albee supervised the electron microprobe facility at California Institute of Technology.

Arden Albee's interest in the electron microprobe is as a tool for his research on regional metamorphism. While with the U.S. Geological Survey, Albee performed regional geologic mapping in Vermont, Colorado, and Maine. After leaving the USGS, he continued his work in northern Vermont, west Greenland and the Death Valley area of California. The goal of his research is to understand the conditions under which these metamorphic rocks formed. To accomplish this goal, he analyzed the partitioning of elements among minerals as well as with theoretical thermodynamics.

Albee has a second research career studying extraterrestrial rocks. He was an investigator of the Apollo lunar samples for many years. As a result, he became chief scientist for NASA's Jet Propulsion Laboratory from 1978 to 1984, which is operated by the California Institute of Technology. He was project scientist for the Mars Observer Mission that was launched in September, 1992, but with which contact was lost in Au-

gust, 1993. He is still mission scientist for NASA's Mars Global Surveyor Mission. Albee's role in this work is not only to help plan the scientific objectives of the mission but also to design and implement instrumentation. His paper, "Development of a Miniature Scanning Electron Microscope for In-Flight Analysis of Comet Dust," in 1983, is an example of such instrumental work. He directed the design of the equipment that analyzes the rocks in situ on Mars including an onboard scanning electron microscope. He is also involved in developing the remote sensing equipment that is used to map the surface of Mars from the spacecraft. Albee is a member of the U.S.–Russian Joint Working Group on Solar System Exploration that governs the scientific cooperation on joint missions including the International Space Station.

Arden L. Albee was born in Port Huron, Michigan, on May 28, 1928. He spent his childhood in Michigan. He received his undergraduate and graduate education at Harvard University, where he earned his bachelor of arts, master of science, and doctor of philosophy degrees in geology in 1950, 1951, and 1957, respectively. Albee worked for the U.S. Geological Survey as a field geologist-petrologist during his graduate studies and until he joined the faculty at California Institute of Technology, where he remains today. He served as the dean of Graduate Studies from 1984 to 2000. Albee is married, has eight children and 13 grandchildren, and lives in Altadena, California.

Albee has been very active professionally, producing numerous papers in international journals, professional volumes, and governmental reports. He is an author of some of the most important papers in the field of metamorphic petrology, analytical techniques, and space exploration. He has also been of great service to the profession. He served on numerous advisory committees and project review boards for NASA. He also served as chair for a number of working groups on Martian missions. He is the recipient of the NASA Medal for Exceptional Scientific Achievement for this service to space exploration. Albee has been an officer and/or editor for a number of professional societies and organizations, including the Geological Society of America, Mineralogical Society of America, and the American Geophysical Union. He has served as associate editor for the *Annual Reviews of Earth and Planetary Sciences* since 1979.

☒ Allègre, Claude

(1937–)
French
Geochemist

After establishing an outstanding career in the Earth sciences, Claude Allègre became one of the few scientists to participate successfully in governmental policy. Claude Allègre is the architect of the subdiscipline of isotope geodynamics. This area involves the study of the coupled evolution of the mantle and continental crust of Earth through a multi-isotopic tracer approach. These radiogenic isotopes include such systems as strontium, neodymium (and samarium), lead, xenon, argon, helium, osmium (and rhenium), and thorium. The studies provide evidence for very early degassing of volatile elements and compounds from Earth with limited subsequent mixing between the upper mantle and the lower mantle. They also show that the atmosphere was primarily formed early in the history of the Earth with only volumetrically small additions since. Helium and neon were trapped in the Earth's interior and have been escaping at a slow rate ever since. He geochemically modeled the early solar system, the early evolution of planets and the formation of meteorites in his paper, "Cosmochemistry and the Primitive Evolution of Planets," among others. This cosmochemical research is the reason that Allègre was chosen by NASA to participate in the Apollo lunar program. In that role, he was among the first scientists to determine the age of the Moon.

With regard to the visible part of the Earth, his paper "Growth of the Continents through Time," in which he uses isotopic evidence to address the topic, exemplifies Claude Allègre's research. Once isotopes are removed from the open whole-Earth system into a closed continental system, they evolve separately. Allègre's best-known research is on the Himalayan mountains, both in terms of structural and geochemical evolution of the Asian crust. However, in considering the isotopic systematics produced by erosion of the continental crust, he also looked at Africa and South America. The other main area of research that Allègre has undertaken is to apply his considerable physics and mathematical background to scaling laws of fractures, earthquakes, geochemical distributions and energy balance which mathematically relates sizes to distributions.

Claude Allègre is probably best known by the public for his extensive governmental work. He is currently the minister for National Education, Research and Technology for France, where he has created quite a controversy by attempting to overhaul the public educational system. Certainly, it takes plenty of prior policy work to be appointed to such an important position. Allègre served as a member of the Socialist Party Executive Bureau, a National Delegate for Research, and a special adviser to the first secretary of the Socialist Party. He was a member of the European Parliament, a city councilman of Lodeve, and a member of the Languedoc Roussillion Regional Council.

Claude Allègre was born on March 5, 1937, in Paris, France. He attended the University of Paris, where he studied physics under Yves Rocard as well as geology, earning a Ph.D. in physics in 1962. He was an assistant lecturer in physics at the University of Paris from 1962 to 1968 before accepting a position as assistant physicist with the Paris Institut de Physique du Globe. He has been the director of the geochemistry and cosmochemistry program at CNRS (French National Scientific Research Center) since 1967. Allègre joined the faculty at the University of Paris VII in 1970, a position he retains. In 1971, he was appointed as director of the Department of Earth Sciences, a position he held until 1976. He was then named the director of the Paris Institut de Physique du Globe from 1976 to 1986. In 1993, he was named as a member of the Institut Universitaire de France (Denis Diderot University). Allègre was recently granted a leave from his academic position to serve as minister for National Education, Research and Technology for France. Over the years, Allègre has held several visiting scientist positions on an international basis. He was a White professor at Cornell University, New York, a Crosby Professor at Massachusetts Institute of Technology, and a Fairchild Professor at the California Institute of Technology, in addition to positions at the U.S. Geological Survey, Denver; the Carnegie Institution of Washington, D.C.; University of California at Berkeley; and at Oxford University, England. Claude Allègre is married with four children.

Claude Allègre is an author of more than 100 scientific articles in both English and French. Many of these papers are seminal studies on the evolution of the Earth, especially using isotopic evidence. They appear in respected international journals. He has also written 11 books spanning the range from widely adopted textbooks to science and policy topics, even to popular books. In recognition of his scientific contributions, Allègre has received numerous honors and awards. He is a member of the U.S. National Academy of Sciences, the American Academy of Arts and Sciences, and the French Academy of Science, as well as an officer of the Legion of Honor. He received the Crafoord Prize from the Swedish Royal Academy of Science, the Goldschmidt Medal from the Geochemical Society (U.S.), the Wollaston Medal from the Geological Society of London, the Arthur L. Day Medal from the Geological Society of America, the Gold Medal from CNRS (French National Scientific Research Center), the Arthur Holmes Medal from the Eu-