complex natural rock systems as a function of pressure and temperature. The marriage of the electron probe to high P-T investigations of natural rock systems gives us the capacity to solve many of the most fundamental problems of petrology. I hope in the future that more and more petrologists will use this capacity.

I would like to emphasize at this point that I am not in any sense attempting to detract from the value of investigations in simple systems. Such investigations are absolutely indispensable for the detailed understanding and interpretation of petrological and mineralogical equilibria, and our present knowledge in these fields is mainly based upon results in simple systems. In my own case, all the ANU work on phase transformations at pressures above 100 kb has been carried out in simple systems. The point I am making is that these two types of investigations are complementary and that the one is rarely complete without the other.

Mr. President, these are exciting days for the experimental petrologist. We now have the capacity to reproduce under controlled conditions in the laboratory the entire range of P-T conditions existing in the mantle down to a depth of about 600 km. Soon, we will be probing still deeper. We have already learned a great deal about the different kinds of phase transformations—both solid-solid and solid-liquid, which largely control the constitution of the mantle down to 600 km, and the origin of magmas. But this is merely the top of the iceberg. Who knows that the next 10 years will bring?

Thank you for your reception and particularly to Dr. Mason for his generous introduction.

THE AMERICAN MINERALOGIST, VOL. 53, MARCH-APRIL, 1968

# MEMORIAL OF HENRI BUTTGENBACH

**February 5, 1874–April 29, 1964**

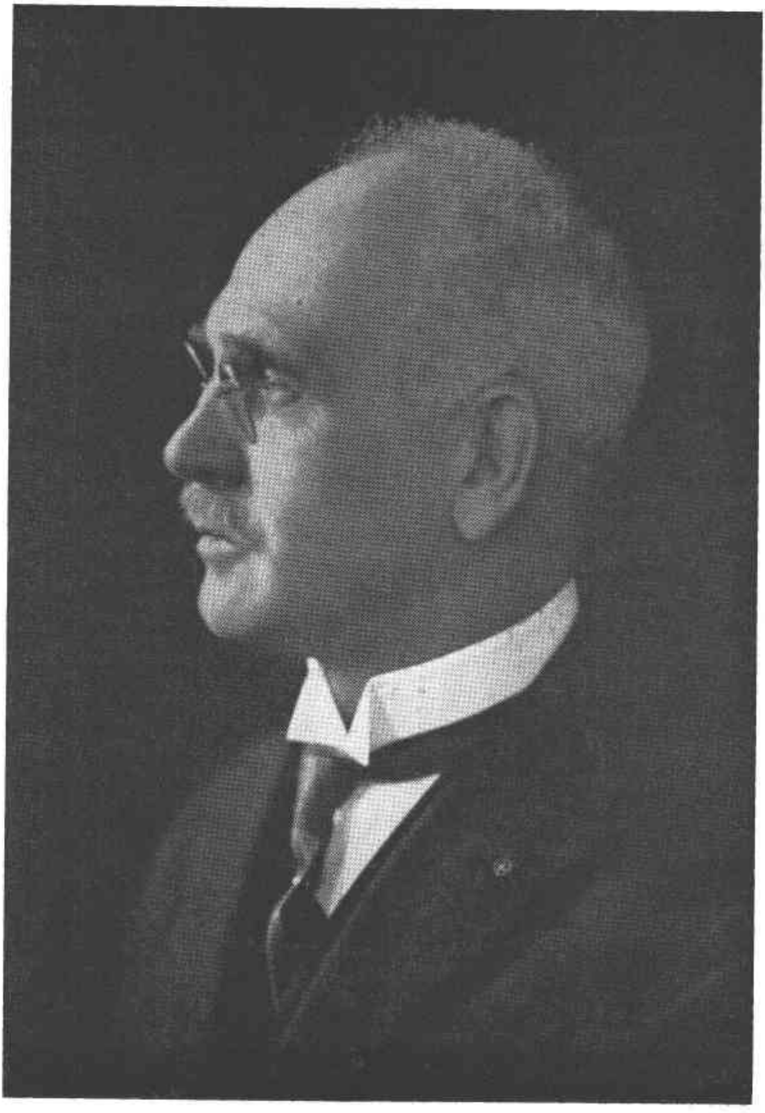
J. MÉLON, *Institut de Cristallographie et de Minéralogie, Université de Liège, Liège, Belgium.*

Henri Jean François Buttgenbach was born at Ensival, Province Liège, Belguim, on February 5, 1874, the son of a practicing physician. He died at his home in Woluwe-Saint-Pierre, near Brussels, on April 29, 1964, having passed his 90th birthday. He is survived by his widow, one daughter, and one son.

His career spans over half a century. He enters the University of Liège in 1892, where he registers as a pre-engineering student. His first academic degree is that of *Candidat Ingénieur* (1894). Fascinated by the study of minerals, he then assiduously attends the lectures of Giuseppe Cesàro, who takes an interest in him and in 1895 gives him an appointment as his student-assistant. While serving in this capacity, Buttgenbach switches from engineering to science and is granted the degree of *Candidat en Sciences* in 1896. He remains an assistant until 1899. During this year he takes a scientific trip to Mexico. Shortly afterwards, without waiting to complete his regular course of studies, he sails for America, visits Baja California and travels over the Andes along the border between Argentina and Chile. His work then takes him all the way to Sumatra. Buttgenbach's work in central Africa begins in 1902. Landing at the mouth of the Zambezi after a long sea voyage, he goes up the river to Lake Nyasa, reaches Lake Tanganyika, then crosses to Lake Mweru, and at last arrives at Kambove in the Katanga. There he meets a delegation of the Tanganyika Concessions, a group interested in copper and gold prospecting. In 1906 Buttgenbach studies the gold deposits of the Kilo-Moto region, in the northeastern part of the Congo. From this very year dates the founding of the Union Minière du Haut-Katanga, at which time Buttgenbach is made a member of the board. From 1907 to 1912 he serves as *administrateur-délégué*. His second voyage to the Katanga takes place in 1911. He then undertakes a series of mining explorations in many lands—USA (Florida), Argentina, Dutch Indies, North Africa, and South Africa—and takes an active part in the study of their mineral resources. In this connection his work on lead, in Tunisia, and on phosphates, in Florida and in Morocco, can be singled out.

In spite of his time-consuming industrial activities, Buttgenbach never loses his deep interest in scientific problems and he publishes many papers and memoirs on minerals from diverse localities. In 1921 his memoir on Belgian sulfides, chlorides, fluorides, and oxides earns the prize of the Royal Academy. This is the year when his former professor Cesàro retires. By this time Buttgenbach has firmly established his reputation as a mineralogist and he is chosen to succeed his illustrious master. His appointment decree is dated October 17, 1921. For 24 years he will teach crystallography, mineralogy, and the petrography of igneous rocks to future scientists and engineers. Emeritus as of 1945, he makes two more journeys to Africa, one in 1947, the last one in 1956.

As can be seen by perusing the list of his publications, Buttgenbach's most important works are concerned with Belgian and Congolese minerals. He can rightly be called the Father of Congolese Mineralogy. From 1904 on, rare is the year when he does not publish one or more papers on deposits, localities, minerals or rocks from the Congo. On the other hand many of his studies are also devoted to Belgian minerals. And so, he be-



*Henri Buttgenbach*

comes eminently qualified to write the definitive monograph on the species of the two countries. His book on the Minerals of Belgium and the Belgian Congo, which appeared over twenty years ago (1947), to this day remains a standard reference work. Buttgenbach has described several new minerals. Some of them, on re-examination by modern methods of investigation, turned out to be varieties of previously known species: cesàrolite (=coronadite), katangite (=chrysocolla), berthonite (=bournonite). Droogmansite, found only once, still awaits confimation. Bialite is probably a magnesian tavistockite, but fourmarierite (1924) and thoreaulite (1933) stand as valid species. Buttgenbach was the first to recognize the identity of kipushite with arakawaite and that of varlamoffite with souxite. Buttgenbachite, the mineral that bears his name, is a Congolese species named in his honor by Schoep in 1925.

Most of the books he wrote are textbooks. In addition to the one cited above, special mention should be made of this treatise entitled *Les Minéraux et les Roches, études pratiques de cristallographie, pétrographie et minéralogie*, first published in 1917. The success of this book has indeed been enormous: it has gone through eight editions, the last one (1953) written jointly with J. Mélon, and for over forty years it has remained the main practical treatise on mineralogy and crystallography in the French language.

Buttgenbach had devoted a large amount of time and effort to the organization of a mineralogical museum. He had the great sadness of seeing the major part of his beautiful collections destroyed as a result of enemy action in 1944. Two years later, as his successors started rebuilding his Institute, he was deeply moved by the generosity of American and Canadian mineralogists, who shipped beautiful mineral specimens to Liège to replace the losses (and whose example was followed by mineralogists of other countries).

Buttgenbach was a member of numerous scientific societies: Académie royale des Sciences, des Lettres et des Beaux-Arts de Belgique, Académie royale des Sciences d'Outre-mer, Académie des Sciences coloniales de France, Société géologique de Belgique, Société belge de Géologie, d'Hydrologie et de Paléontologie, Société royale des Sciences de Liège, Société française de Minéralogie et de Cristallographie, Mineralogical Society of America, Mineralogical Society (London), Association des Ingénieurs sortis de l'Ecole de Liège (A.I.Lg). He was elected president of the Geological Society of Belgium eight times.

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# MEMORIAL OF PENTTI ESKOLA

**January 8, 1883–December 6, 1964**

TOINI MIKKOLA, *Geologinen Tutkimuslaitos, Otaniemi, Finland.*

December 14, 1964, at the funeral ceremony of Pentti Eskola, arranged by the State to this great son of Finland, we Finnish geologists, his pupils, sensed deeply the end of an era. Pentti Eskola had always been a part of our world.

The life work of Pentti Eskola has already been related by his friends and colleagues in several papers. His long life, devoted day after day to intense research, led to important discoveries which still form the basis for the development of geology in many fields. His doctoral thesis "On the petrology of the Orijärvi region in southwestern Finland" introduced the theory of magnesia metasomatism. His studies on Norwegian eclogites concerned reactions in the solid state under high pressure. The period Eskola spent in Norway was significant to him in many ways for his contacts with Norwegian geologists, particularly V. M. Goldschmidt, were fruitful and the foundation of his mineral facies theory was laid there. Convinced that rocks and mineral associations are governed by the laws of chemistry and physics, Eskola planned experiments at the Geophysical Laboratory in Washington, D. C. One might say that Eskola's expectations were 30 years ahead of the instrumentation of his time. Yet, the phase equilibrium of the silicates of strontium and barium was the result of his studies in Washington. Human contacts again, from those years in Washington, such as his friendship with N. L. Bowen, were most rewarding. The experiments carried out by Bowen and his collaborators supported Eskola in his conviction that true granitic magmas existed. Eskola admitted that it was Bowen who made him a magmatist. In Finland, Eskola began his academic career, where he held the Chair of Geology and Mineralogy at the University of Helsinki from 1924 to 1953. The Precambrian bedrock of Finland, its evolution and petrology, became his main field of study. His lifelong devotion to that subject attained its peak in the *Precambrian of Finland*, published in 1963, itself a token of enduring strength, and in a way the scientific will of an aged giant to his younger colleagues.

Pentti Eskola, son of a landowner, was born on the estate which for more than 300 years has belonged to the same family: In 1640 another Pentti Eskola was its owner. Both Pentti Eskola and his wife Mandi Wiiro were always deeply conscious of their common background in the solid farming stock in southwestern Finland. They used their local dialect with great skill and pride. One had the impression that nothing less than perfection was their aim in the preciseness of thought and expression, even when telling jokes. When translating or writing textbooks for Finnish readers, Eskola created many terms, choosing some from the rich vocabulary of his local dialect. This expanded and improved terminology in the Finnish language as a tool for geologists and mineralogists is part of the great inheritance left by Pentti Eskola, generally not known outside of Finland.

*Pentti Eskola*

At school young Pentti Eskola studied Greek and Latin, later a great asset in coining new terms. To prove that he had not forgotten these early loves he told us the following episode. At a conference in the USA he met a Greek colleague who spoke excellent French, but knew less English. Eskola again read French without difficulty, but preferred to speak English. In search of a common language they landed on Greek, Eskola using the Homeric vocabulary, the Greek colleague speaking his modern tongue. After ten days they accidentally found out that they both had an excellent command of German.

At the Institute of Geology, Eskola's door was open to students at any time and his hours of consultation lasted in that sense from morning until night. The audiences at his lectures included both students and advanced colleagues. Eskola did not express himself in a dramatic or a showy way. He was too humble, genuine and straightforward for any kind of exaggeration. Yet sometimes he rose to such burning intensity that his very words and the atmosphere remain vivid in our memory.

At home the Eskolas led a simple and warm family life. The maid had her meals at the same table, and the play of his young children in his study was for Eskola inspiring human background music. Students were often invited to parties in their home. Sometimes Eskola's passion for Latin and Greek led him to prepare a translation of some particular classical poem which he then followed with the original text in ringing cadence. Even on his hospital bed, paralyzed and nearly blind he still recited his beloved elegiac pentameters. Discussions at his home gatherings often took most unexpected turns, for any small item could initiate a lively discussion on problems and their solutions. Curiosity of mind was keenly appreciated by Eskola. Acting as opponent at the public criticism of an academic dissertation he once quoted from Sinclair Lewis's *Arrowsmith* and said to the young respondent: "I think I have seen in you—of that curiosity—a little." A touch on the shoulder with the blade of Eskola's verbal sword.

Life, its origin on our globe and its mysteries fascinated Eskola. The form of a weed root on his farm once made him sit wondering a couple of hours in the middle of his gardening. Life and the responsibility of man were the great questions of Eskola's later years. The correspondence between three men, Eskola, a clergyman and a younger man, fatally ill, was published later. These books and those in which Eskola told the story of geological evolution to the public, *The Changing Earth* (Muuttuva maa), *In Search of World Outlook* (Maailmankuvaa etsimässä) gave him an audience far beyond the circle of geological colleagues. I may end this with Pentti Eskola's own words:

"On the other hand, the further we advance in understanding Nature, the more evident it is how restricted are our possibilities in solving the final riddles. It is this realization that keeps man's mind the more humble the further he penetrates into comprehension and inventions."

During his lifetime Pentti Eskola received many honors. He was awarded the Gustav Steinmann, Leopold von Buch, Penrose, Wollaston and Friedrich Becke medals. He held the honorary degree of doctor from the universities of Oslo, Padua, Bonn and Prague. He was an honorary member of numerous scientific societies, among them the Mineralogical Society of America. He was Honorary President of the Geological Society of Finland, which established the Pentti Eskola gold medal in his honor. In 1964 Eskola was awarded, together with Arthur Holmes, the Vetlesen prize.

A comprehensive biography by Vladi Marmo with selected bibliography by Marjatta Okko appeared in *C.R. Soc. Géol. Finlande* **37**; also *Bull. Comm. Géol. Finlande*, **218**, 1965.

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# HUGH ALEXANDER FORD, ESQ. C.M.G.

**July 26, 1885–March 11, 1966**

GRACE G. DEARBORN, *146 Lincoln Street, Newton Highlands, Massachusetts 02161.*

Hugh Alexander Ford, former British Consul General at Boston, and for many years a leading collector and dealer in fine mineral specimens, died in New York City, March 11, 1966, after a lingering illness. A memorial service was held in St. Paul's Cathedral, Boston, Massachusetts, April 24, 1966.

He was born in London, July 26, 1885, the son of the late Lt. Col. Alexander Elles Ford, and Emeline Ross.

He entered the consular service of Great Britain in September 1910 and served as Vice Consul and later as Acting Consul General in Philadelphia from 1910–1914; he was transferred to New York, back to Philadelphia and thence to Boma in the Congo, to Baltimore, and then to Colon, Panama where he was in charge of the Legation until 1927. In the period 1927–30, he was Acting Consul at Lyons, France, then Consul General in Monrovia, Liberia until 1930. He was transferred to Lourenco Marques in 1930 and finally to Boston in 1933. While at his Boston post he received the Silver Jubilee medal from George V in 1935 and the C.M.G. 8 years later. In 1943, George VI graciously appointed him a

"Companion" of The Most Distinguished Order of Saint Michael and Saint George, an honor awarded diplomats for meritorious work in foreign countries.

He was an accomplished linguist speaking French, German, Portuguese, Russian, and several African dialects.

His interest in minerals was aroused early when he received a fine galena crystal from Cumberland and a polished smoky quartz barrel from Switzerland on his 5th birthday. Through the years, he built up a magnificant private collection. Although he had an outstanding collection here in the U. S., the greater part of his collection was lost during the bombing of Bristol, England in 1940, where it was housed in the home of his uncle, Roger Ford.

He was always happy to give unstintingly of his time to curators of museums. The collection of The Academy of Sciences in Philadelphia was the first in America that he worked with. In 1922, the Maryland Academy of Sciences by an Act of the Legislative Committee, commissioned him curator of mineralogy for the Academy. While stationed at Boston, he worked for many years with Professor Palache of Harvard in the development of the magnificent Harvard mineral collection.

When he retired from the consular service, he went to Canada to reenter this country as an immigrant. Having been away from England for 35 years, with most of his old friends and relatives gone, he decided to stay in the United States.

Ford, always a busy, active man, decided to "make his avocation his vocation." He became one of the outstanding dealers, in fine mineral specimens in the U. S. His place at 110 Wall Street, New York City, was as well-known abroad as in this country. Through him numerous splendid specimens were secured for many of the leading museum and university collections throughout the world, including the British Museum of Natural History, The Smithsonian Institution, Harvard University, Columbia University, the American Museum of Natural History in New York, Cranbrook Institute and many others.

He was a Fellow of the Mineralogical Society of America; a member of The Mineralogical Society of Great Britain; a Life Member of the Société Francaise de Minéralogie et de Cristallographie. He was one of the first supporters of and contributors to the periodical "Rocks and Minerals" founded by the late Peter Zodac. Ford was also one of the founders of The Boston Mineral Club, and a prominent member of the New York Mineralogical Club.

Hugh Alexander Ford will long be remembered not only for his long and faithful service in the diplomatic corps of a great country, but by the many mineralogists, both here and abroad, who had the good fortune to

*Hugh Alexander Ford*

be associated with him professionally or personally and whose institutions profited from his advice and interest in their collections.

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# MEMORIAL OF RICHARD PERCIVAL DEVEREUX GRAHAM

**June 14, 1880–July 29, 1965**

JOHN S. STEVENSON, *Department of Geological Sciences, McGill University, Montreal, Quebec.*

Richard Percival Devereux Graham, Professor Emeritus of Mineralogy at McGill University, died July 29, 1965, at his home in Outremont, Quebec. He was one of a small group of devoted teachers and research workers who helped to advance mineralogy in Canada in the early years of its development.

Dr. Graham was born in County Kildare, Ireland, in 1880 but spent his childhood in India where his father was a British army officer. He later attended Oxford University, graduating with an Honours A.B. degree in chemistry and mineralogy in 1905. While at Oxford he served as assistant to Sir Henry A. Miers, and was largely responsible for the arrangement of the Mineral section of the Oxford University Geological Museum.

He came to McGill University in 1905 as Assistant Professor of Mineralogy in the Department of Chemistry. Concurrently with his teaching, he continued his studies in mineralogy, receiving his M.Sc. and D.Sc. degrees from McGill. In 1926 he was appointed Professor in the Department of Geology, and continued in this capacity until 1950, when he retired at the age of seventy. During this long period all McGill students of geology and mining received their training in mineralogy from Dr. Graham, and he is remembered by his many students as a patient and devoted teacher who imparted a respect and appreciation for minerals. To him, minerals were objects of such great interest that they seemed to come alive in his hands as he held up a particularly beautiful example of crystal twin or ore mineral for his students to observe. After his retirement, the R. P. D. Graham Scholarship Fund and Medal was established by his former students in his honor; awards are given annually to deserving undergraduates in geological sciences or mining engineering interested in mineralogy.

Early in his career, Dr. Graham developed a great interest in studies with the reflecting goniometer when he was a student at Oxford. After he

*Richard Percival Devereux Graham*

came to Canada, he specialized particularly in precise goniometric measurements of crystal faces.

While at McGill, Dr. Graham was active in developing the mineral collection at the Peter Redpath Museum, and the quality of its material from many quarries and mines long since worked out or inaccessible is due largely to his efforts. His keen interest in pseudomorphs is reflected in the fine collection of typical and unusual examples which he built up at the Museum.

His long and productive period of research is indicated by his many scientific papers. Two of his publications describe new minerals: yukonite, a hydrous arsenate of calcium and lead (jointly with J. B. Tyrrell) in 1914, and ferrierite, a zeolite from British Columbia, described in 1919.

Although his studies were mainly in the field of mineralogy, he was a geologist with broad interests. Between 1909 and 1913 he did pioneering work investigating the geology of the Queen Charlotte and other islands along the coast of British Columbia, and the adjacent mainland. Later he conducted field studies in various parts of Ontario and Quebec.

After his retirement from McGill he was Technical Editor of the Bulletin of the Canadian Institute of Mining and Metallurgy, a post he filled with distinction for twelve years. Failing health led to his final retirement at the age of 82, three years before his death.

Golf was his principal avocation, and for several seasons, until shortly before his final illness, he was a regular player on the Mount Royal course. His partner was frequently Dr. R. D. Gibbs, a botany professor many years his junior, who recalls that despite rainy weather or extreme heat, Professor Graham was always keen to finish the round, demonstrating the enthusiasm and determination that had been so useful to him during his earlier years of field work.

Dr. Graham is survived by his wife, the former Violet Thompson Nash; a daughter, Mrs. P. Daughtrey, and two grandsons.

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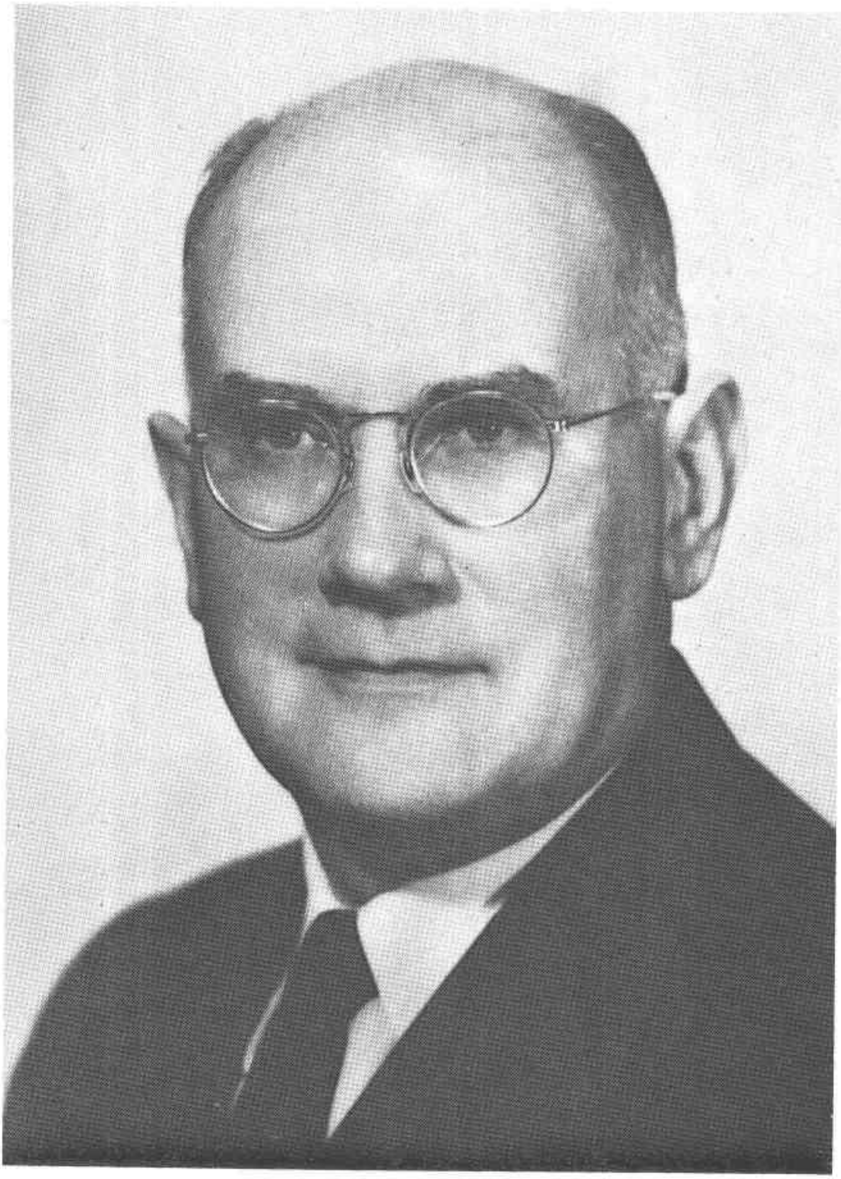
# MEMORIAL TO OLIVER RUDOLPH GRAWE

**November 26, 1901–March 22, 1965**

Walter D. Keller, *University of Missouri, Columbia, Missouri 65201.*
Garrett A. Muilenburg, *12 Vichy Road, Rolla, Missouri*
AND
Samuel P. Ellison, Jr., *University of Texas, Austin, Texas.*

Oliver R. Grawe was striken suddenly and unexpectedly by a heart attack on March 22, 1965, while preparing for his day's teaching and research at the University of Missouri at Rolla (formerly the Missouri School of Mines and Metallurgy). He is survived by his wife, Sarah Catharine Hillard Grawe, whom he married in December 1941, his son, Oliver Rupert Grawe, at Rolla, Missouri, and his mother, Mrs. Charlotte Grawe, St. Louis, Missouri. "Ollie" Grawe, as he was known to his many and professional friends, was a stalwart example of uncompromising scientific integrity in both his teaching and research. His high academic standards will not be easily replaced at the University of Missouri at Rolla.

He was born in St. Louis, Missouri, November 26, 1901, the son of Louis C. and Charlotte (Sommerkamp) Grawe. He attended St. Louis, Missouri, public schools and was graduated from high school in 1918. He completed his Bachelor of Arts degree in chemistry and mathematics in 1922, and a masters degree in geology in 1924 at Washington University in St. Louis. He won the Garder Fellowship awarded by the Division of Geology and Geography of the National Research Council in 1924 and began graduate work at the University of Iowa. He received his Doctor of Philosophy degree from the University of Iowa in 1927.



*Oliver Rudolph Grawe*

He began his teaching career as an instructor in geology and mineralogy at the Mackay School of Mines, University of Nevada, in 1926. In 1928 he joined the faculty of the Missouri School of Mines and Metallurgy as an assistant professor. He was promoted to associate professor in 1935, to professor in 1947, and senior professor in 1957. He served as chairman of the Department of Geology from 1945 to 1957.

His many professional and scientific honors include fellowship in the Mineralogical Society of America, Geological Society of America, and American Association for the Advancement of Science. He was a member of the American Chemical Society, American Association of Petroleum Geologists, Society of Economic Geologists, American Institute of Mining and Metallurgical Engineers, National Association of Geology Teachers (President of the Central Section), American Society of Engineering Education, Missouri Academy of Science (twice Chairman of the Geology Section), and was organizer and first president of the Association of Missouri Geologists. He was a member of Phi Kappa Phi, Phi Beta Kappa, Sigma Xi, Sigma Gamma Epsilon, and Gamma Alpha. He was included in *Who's Who in America, American Men of Science, Who's Who in Engineering, Who's Who in Education, Who's Who in Missouri,* and *Who Knows What.*

He maintained a keen interest in community and campus affairs, including helping several organizations of foreign students with their activities. He was active in the Methodist Church and indulged in growing fine roses in his garden as a hobby. He also was an expert photographer.

Dr. Grawe taught courses in mineralogy, petrology, ore deposits, economic geology, X-ray crystallography, and geochemistry. Students knew him best in the elementary mineralogy course which was taught with strict rigor and attention to details. He was so dedicated to his teaching profession that he repeatedly attended summer conferences to study advanced methods to bring his own teaching up to date. Although his background of education came during the time of "classical" mineralogy he advanced himself by self-training to maintain competence in the application of mineralogy to geologic problems. His remarkably accurate report on pyrite deposits of Missouri done during many summers working in the field for the Missouri Geological Survey, stands as a monumental treatise. He was a leader in mineral thermometry and published a rather complete mineral thermometer in 1937. The continued study of mineral thermometry led to the publication of three important papers on mineral paragenesis in the Tri-State Lead and Zinc district. His reports on the manganese deposits of Missouri and the strontianite and witherite that is associated with the southern Illinois fluorite are examples of thorough investigations. He was a leader in the quantitative determination of rock and mineral color from color dictionaries. His brief but succinct statements about color blindness among mineralogy students are classics.

He had a continuing intense interest in mineralogy and crystallography as important parts of the engineering curriculum. He was the active liaison by which a large endowment from the McNutt estate of San Antonio, Texas, reached the University of Missouri at Rolla. In the summer of 1964, he received a McNutt Research Award to expedite the compilation of all available data on the mineraology of Missouri. He had been granted a sabbatical leave effective September 1965, to complete the study and prepare the manuscript of this lifetime of research on Missouri minerals.

His popularity with students and appreciation by them loomed highest years after graduation. Then they found he had taken the long view for them by insisting they attend to the business of learning so as to meet the demands of their careers. He set a living example for the many young mineralogists, geologists, miners, and engineers who were fortunate enough to have been in his classes. Thus, he was a teacher who had the virtues of a product of the old school but who had self-tooled himself to the new advances in his science—this kind of man is truly missed and is not easily replaced.

He was known as a tough teacher and at one time on his laboratory door was this statement, "Don't complain if I criticize you because if you are worth criticizing you are worth teaching."

Friends from all over the world have contributed to an Oliver R. Grawe Memorial Student Loan Fund at the University of Missouri at Rolla. The fund is in memory of Ollie's 37 years of distinguished teaching at Rolla.

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# MEMORIAL OF ARTHUR HOLMES

**January 14, 1890–September 20, 1965**

Doris L. Reynolds, *Bedford College, University of London.*

With the death of Arthur Holmes in London on 20th September, 1965, the world lost a great geologist who had won international fame through a wealth of outstanding contributions to his science, and had stimulated and fostered earth sciences by a world-wide correspondence. Arthur Holmes will be sadly missed by friends of almost every nationality.

Holmes retired from the Regius Chair of Geology and Mineralogy at the University of Edinburgh in 1956 because of ill health, and devoted himself to writing the enlarged Edition of *Principles of Physical Geology* which he happily saw published in 1964. In this book alone Holmes left a massive Memorial. He was a shy and retiring man who enjoyed meeting fellow geologists in his home, but shrank from social occasions and publicity. Always youthful in outlook, a bold thinker and a prodigious writer, Holmes contributed about 180 scientific papers and Memoirs and five books, not to mention innumerable reviews and popular scientific articles. As Dr. Campbell Smith once remarked, it might almost be said that he began to write as soon as he could read. As a University student he was earning by reviewing scientific articles, and when he was only 21 the results of his first research were published.

Holmes was an outstanding teacher and stimulating lecturer whose past students hold positions within countries that encompass the earth. This geological community includes innumerable practising geologists as well as those who have become distinguished, for, as one of them has written, "It was not the least part of Holmes' genius that he could fire his less brilliant students with some of his own enduring enthusiasm for his science."

Holmes was born at Hebburn, near Newcastle-on-Tyne, January 14, 1890. His parents were of modest means, his father being a cabinet-maker, so that Arthur, their only child, started life with no monetary advantages. As a schoolboy he was fascinated by the date 4004 B.C. which according to a marginal reference in most English Bibles of the time, was the date when the world was created. At Gateshead High School this interest in the age of the earth was further stimulated when, on the advice of his Physics Master, he read Kelvin's *Popular Lectures and Addresses*. From these he learned of the long controversy between Lord Kelvin (Professor of Natural Philosophy at the University of Glasgow, 1846–99) and the geologists. Starting from the assumption that the earth was a cooling globe, Kelvin's (1895) final estimate was that not more than 40 million years could have elapsed since the molten earth solidified. Geologists, on the other hand, guided by the uniformitarian principle, required a much longer span of time to allow for slow earth processes like denudation.

When in 1907, Holmes, with the aid of a scholarship, entered Imperial College, London, he was fired with enthusiasm when he learnt that R. J. Strutt (later Lord Rayleigh), his Professor of Physics, had already found the rocks of the earth's crust to be richer in radioactive elements than was necessary to counterbalance the heat lost by cooling. Here was the complete answer to Kelvin, for the earth could no longer be regarded as a simply cooling globe. Furthermore, during Holmes' first year as a student, Boltwood (1907), following a suggestion of Rutherford and using a rough estimate of the rate of production of lead from uranium, made the first calculations of the ages of analysed uranium minerals. Holmes had intended to qualify as a physicist, but here was ample reason for combining geology with physics, so in 1909 he sat and successfully passed the B.Sc. examination in physics and mathematics, and continued under Professor Watts' guidance to study geology, in which he graduated A.R.C.S. in 1910. Thus Holmes equipped himself to be the complete

*Arthur Holmes*

answer to Kelvin's lament that so many geologists regarded the general principles of physics as alien to their subject.

During his third year as a student Holmes eagerly began research work in Strutt's laboratory, determining the ratios of lead to uranium in minerals from the Oslo area. By comparison with Boltwood's results he found that the ratio was nearly constant for minerals of the same age. The results of this work were published in the *Proceedings of the Royal Society* in 1911, being presented by Strutt during Holmes' absence in Mozambique. Two years later Holmes' first book, *The Age of the Earth* was published, and subsequently appeared in two further editions in 1927 and 1937. During these early years Holmes' investigations followed one another in rapid succession and concerned lead as the end product of radium and thorium, and the terrestrial distribution of radium, culminating with the important recognition, jointly with R. W. Lawson, a friend since boyhood, that the widespread element potassium is "as an emitter of radio-thermal energy in rocks, . . . in aggregate, of the same order of importance as uranium or thorium."

Henceforth, the application of radioactivity to geological problems became a perpetual concern of Holmes, and included many aspects of earth science. He made repeated attempts to determine the age of the earth, the figure for which gradually increased from 100 million years, thought to be an extravagent estimate in his student days, through 2,000 million years prior to World War II, to 4,500 million years, now regarded as a minimum age. He also made repeated attempts to construct a Phanerozoic time scale by plotting radiometric dates, as they were determined, against the cumulative maximum thickness of the sedimentary rocks of the various systems from the base of the Cambrian upwards. As Holmes himself pointed out, "The value of this method in balancing errors is shown by the remarkable coincidence that his earlier estimates of Phanerozoic time (1914) and his latest (1957) were both about 600 million years, the round figure now in general use." But to this must be added that the "remarkable coincidence" also owed much to Holmes' geological acumen in recognising reliable data. It was a happy thought, and gave Holmes much pleasure, when the *Geological Society of London*, in 1964, expressed appreciation of the value of his geochronological investigations by dedicating to him a volume on *The Phanerozoic Time-Scale*, with a very pleasing foreword by Prof. F. H. Stewart.

Holmes' interest in the application of radioactivity to geological problems also included the thermal history of the earth and earth movements. He was the first (1928) to suggest and illustrate convection currents within the substratum, a hypothesis of which Vening Meinesz later became the protagonist. Holmes regarded convection currents as a method of heat transference, and he suggested that they were the principal cause of earth movements, including continental drift. Holmes, indeed, was among the first to accept continental drift as a reality. Even in 1944 when the first edition of his *Principles of Physical Geology* was published, it was somewhat daring to include a chapter on continental drift, as can be judged from Reginald Daly's remark, in a review of the book, that "for this boldness he will doubtless be chastised." This boldness has been amply justified by the wealth of palaeomagnetic evidence recently accumulated by geophysicists, and fortunately in time for Holmes to include in the recent revised edition of his book.

Other highlights of Holmes' application of radioactivity to the solution of geological problems were his attempts, first for Africa and subsequently for India, to read the sequence of orogenic belts from the patterns they form on geological maps, and to date the closing stage of each orogenic belt radiometrically. This method pioneered the application of radiometric dating to the deciphering of the history of the early Precambrian; it stimulated an avalanche of geochronological investigations. Indeed, Dr. Cahen and Dr. Snelling in their recent (1966) book on *The Geochronology of Equatorial Africa*, dedicated to the memory of Arthur Holmes, drew attention to the fact that in 1948 when Holmes first suggested the method in relation to Africa, there were only 25 radiometric ages on which to rely, whereas in 1966 there were 550 radiometric determinations for Equatorial Africa alone.

Arthur Holmes was equally outstanding in the petrological field. Among his field and petrochemical studies of British rocks, his name will always be associated with the sills and dykes of the north of England. Holmes clearly separated these intrusions into two suites, dated by the helium method: the Whin sill and related dykes of late Carboniferous age, and the tholeiite dyke swarm of Tertiary age. His petrological books, *The Nomenclature of Petrology* (1920, second edition 1930) and *Petrographic Methods and Calculations* (1921, second edition 1930) were used by decades of students, and rare second-hand copies of the latter are still eagerly sought.

Early in 1911, Holmes, together with his friends E. J. Wayland and A. Wray, joined an exploring party organised by Memba Minerals Ltd., to make a detailed survey of the virgin territory of Mozambique. Holmes' diary of the time throws sidelights on his excitement at being offered the princely sum of £30 a month—danger money because there were cannibals in part of the territory to be investigated—and on his recognition that "it will prove one of the best openings into the geological profession that one could have." How true this was, for knowledge and experience gained in Mozambique provided a foundation for all Holmes' future work, and gave him a lasting love for Africa. Attacks of malaria, however, culminating in blackwater fever, perhaps fortunately, left him unfit for active service throughout World War I.

Among a variety of papers on the geology and geography of Mozambique, written on Holmes' return, the *Pre-Cambrian and Associated Rocks of the District of Mozambique* (1918) is outstanding for its modern look as a study of granitisation. Holmes suspected that biotite gneiss, associated with gneissic granite, limestone and mica-schist, resulted from reaction between granite magma and argillaceous rocks, in the guise of mica-schist. To check this idea he determined the radium contents of the biotite-gneisses and gneissose granites and their respective biotites and, in accordance with his hypothesis, he found that they all fell between the corresponding determinations for granite and mica-schist. The hypothesis, however, was frowned upon as speculative and the paper appears to have been ignored.

Much of Holmes' important petrological work concerns the potash-rich lavas of the western rift valley of Uganda. E. J. Wayland, who had been his companion in Mozambique, eventually became Director of the Geological Survey of Uganda and he invited Holmes to collaborate, on the petrological side, with A. D. Combe who was carrying out the field work in Uganda. These two collaborators never met and, though in different continents, they worked harmoniously together, Combe's meticulous field notes always providing answers to Holmes' questions. Holmes' petrological descriptions of the Uganda rocks and petrogenetic interpretations formed the subject matter of an outstanding Memoir filled with new ideas, and of many papers, in all of which Dr. H. F. Harwood, an Imperial College friend and famous rock analyst, collaborated by analysing the rocks. At the time when the Memoir was written it was unusual to have more than two or three chemical analyses, so that the wealth of chemical data highlights this work as a pioneer petrochemical investigation.

Holmes' care over details, an unusual attribute for one who could think so clearly on the grand-scale, is well illustrated by three mineralogical surprises that he recorded from the potash-rich lavas of Uganda. The first was the discovery of kalsilite, a previously unknown potash-rich equivalent of nepheline. The second was the discovery of xenoliths of quartzite and vein quartz in various stages of vitrification, but the glass was neither fused silica nor a solution of silica in the enclosing lava: it had the composition of pitchstone or granite. The third and perhaps greatest mineralogical surprise was the discovery of granite xenoliths showing various stages of replacement by leucite.

Holmes held a variety of posts. In his youth, from 1912 to 1920, he taught geology at Imperial College, but finding no possibility of earning more than £100 a year he decided to try his lot in the economic field, and in 1921 he went to Burma to become chief geologist to the Yoma Oil Company where Dr. Dudley Stamp, who afterwards became a celebrated geographer, was his assistant. In 1924 he returned to academic life, and built up a new department of geology at the University of Durham, and here he held the post of Professor of Geology until 1943. In 1943 he was appointed Regius Professor of Geology and Mineralogy in the University of Edinburgh, where he remained until his retirement in 1956.

The many honours bestowed upon Holmes witness the esteem in which he was held. These include the Murchison Medal of the Geological Society of London (1940); the Penrose Medal of the Geological Society of America (1956); the Wollaston Medal of the Geological Society of London (1956); the Fourmarier Medal of the Royal Academy of Belgium (1957); Hon. LL.D., Edinburgh 1960; the Macdougall-Brisbane prize of the Royal Society of Edinburgh (1965). In 1964 he received the supreme award, the Vetlesen Prize, "for scientific achievement on a clear understanding of the Earth, its history or its relation to the universe."

Holmes was also elected to many learned societies: Foreign Honorary Member American Academy of Arts and Sciences (1934); Correspondent Geological Society of America (1936); Honorary Member Royal Geological Society of Cornwall (1937); Corresponding Member Geological Society of Belgium (1946), Honorary Member (1956); Honorary Member Belgian Society of Geology, Palaeontology, and Hydrology (1947); Foreign Member Royal Swedish Academy of Sciences (1947); Foreign Member Geological Society of Stockholm (1952); Foreign Member Academy of Sciences, Institute of France (1955).

Arthur Holmes was one of those exceptionally gifted people who, in modern jargon, bridge the two cultures. His love and knowledge of literature and his interest in philosophy lay at the root of his easy mastery of his language, and his ability to write simply and clearly about highly complex ideas. He found great joy and relaxation in music, and was a skilled pianist. He is sadly missed by his wife Doris, and by his son of a former marriage, Geoffrey (United Nations), and by four grandchildren.

A complete bibliography of Arthur Holmes appeared in the Foreword to the Phanerozoic Time-Scale: A Symposium published by the Geological Society of London in 1964.

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# MEMORIAL OF ADOLPH KNOPF

**December 2, 1882–November 23, 1966**

Robert G. Coleman, *U. S. Geological Survey, Menlo Park, California.*

Adolph Knopf died on Nobember 23, 1966, in Palo Alto, California following a short illness. He was born at San Francisco, California, December 2, 1882. All of his early youth was spent in the San Francisco Bay area and for him the best recollections of this time were those of the family ranch situated in the coastal mountains near Woodside and facing the San Andreas rift valley. All of his formal academic training was provided by the University of California at Berkeley and it was here that he was strongly influenced by Professor Andrew Lawson. The Geology Department at Berkeley must certainly have been a stimulating environment at that time, as here was the scene of new ideas, outstanding teachers, and able students such as Esper Larsen, Jr., and Waldemar Schaller.

On receiving his B.S. (Mining Geology) degree in 1904, he followed his interests in mining geology and quickly made his ideas known by publishing several papers on California ore deposits. The description of silica-carbonate rock in the paper *Alteration of Coast Range Serpentine* still stands as a definitive paper on this problem. In the field season of 1905, he started his career with the U. S. Geological Survey as geologic aide to Louis M. Prindle in Alaska. In the fall of 1906, he accepted a full-time job with the Survey and moved to Washington, D. C. The decision to join the U. S. Geological Survey was influenced by Professor Lawson who felt that field work was essential to the development of a research geologist. The Alaskan Division of the Survey at that time consisted of 10 to 11 men under the direction of Alfred H. Brooks, and it was said that this was the best geologic group in the Survey at that time, and had a high *esprit de corps*. The young geologist from Berkeley assigned to Alaska must have been a pleasure to his supervisor, Mr. Brooks. The record clearly shows that the six field seasons spent in Alaska were extremely productive with approximately 20 reports published, including completion of his Ph.D. in 1909. These early reports were written in a masterly fashion with clear attention to mineralogic and petrologic details as related to regional and local geologic facts. Adolph Knopf's approach to geology was gained at Berkeley, but firmly established in those first six Alaskan field seasons. The careful documentation of two new minerals, *paigeite* and *hulsite*, was not an end in itself, but important to the origin of the pyrometasomatic tin deposits of the Seward Peninsula,

*Adolph Knopf*

Alaska. The skillful blending and documentation of all observations and facts in these early Alaskan reports still provide the basis for modern geologic work as evidenced by C. L. Sainsbury's 1962 discovery of beryllium at Lost River [*U. S. Geol. Survey Cir.* **479,** Beryllium deposits of the western Seward Peninsula, Alaska (1963)].

Knopf's talent as a field geologist did not go unnoticed in the Geological Survey and in 1911, Waldemar Lindgren, then Chief of the Metalliferous Section, assigned Adolph Knopf to a very important study of the Boulder batholith, Montana. This was a great inspiration for him as described in his own words, "*I was given also a field assistant, Henry G. Ferguson, something I had never had during my five years service on the Alaskan Division, and to have attained this high privilege gave a great lift to the morale of a young aspiring geologist.*" This period must have been one of high scientific adventure to be associated with Lindgren and others such as F. L. Ransome, Louis C. Graton, William H. Emmons, and Joseph B. Umpleby, who had been given the opportunity to study the important ore deposits of the western United States. During 1911–1920, as part of Lindgren's plan, Adolph Knopf carried out a prodigious number of studies on ore districts, and each of these documented by a published report. These experiences had by now provided him with that imponderable storehouse of knowledge necessary for every geologist to embark on the more difficult problem of geologic synthesis. The new series of U. S. Geological Survey Professional Papers on the western ore districts and articles in *Economic Geology* were evidence of new ideas and concepts relating source, structural control and timing of pyrometasomatic deposits to igneous intrusions.

During 1910–1920, the U. S. Geological Survey salaries fell substantially behind the universities and industry. At this time Adolph Knopf was asked to make a survey of the salary structures of the leading universities of the eastern seaboard. His findings showed that the Survey salaries were nearly one-half those of the universities. This situation influenced him and his colleagues to leave the Survey and take up teaching. Knopf went to Yale, Emmons to Minnesota, Graton to Harvard, and Lindgren to M.I.T. This was the beginning of the most distinguished part of his career. Maintaining his close relationship with the Survey, he guided many of his students into work with the Survey much the same way his early career was molded by Professor Lawson at Berkeley. This was a fortunate relationship as the Geological Survey was provided a large group of extremely able students who were later to exert an important influence on the quality of the Survey program. This scientific replenishment was sometimes jokingly referred to as the "Yale Ascendancy"; needless to say, the salaries of the Survey must have improved in the meantime.

Adolph advanced rapidly in the academic environment of Yale, becoming Full Professor in 1923, then Silliman Professor 1937, Sterling Professor 1938, and Director of Graduate Studies 1933–1951. The first decade of his stay at Yale was marked by continued summer field work with the Geological Survey culminating in the classic paper "*The Mother Lode System of California.*" Ability to carry out broader geologic synthesis and unusual talent as a writer led to collaboration on a physical geology textbook with his colleagues at Yale, Chester Longwell and Richard Flint, Associate Editorship of American Journal of Science, and numerous reviews on the literature within the field of petrology.

Adolph Knopf placed geologic time as an extremely important parameter in the exercise of geologic research. His association with Boltwood at Yale aroused his interest in the then developing radiometric methods of measuring time and in 1925, he was appointed to the committee on the *Measurement of Geologic Time* of the National Research Council. Although he did not carry out research in this field, he was extremely astute in the evaluation of such research within the framework of classic geology. His discussion on the origin of primary lead ores following Arthur Holmes' concept that ore-lead had no genetic connection with crustal magmas was a truly eloquent dissent using geologic reasoning. Later mass spectrometric analyses on ore leads supported Knopf's concept. In the years that followed, bringing more and more complex radiometric measuring techniques, he carefully evaluated these and interjected a mature geologic voice of reason on these laboratory results.

During the 1940's, his brilliance as a truly outstanding geologic mind was rewarded by election as member of the National Academy of Science, Vice-President of the Society of Economic Geologists, and President of the Geological Society of America. During this time of responsibility to various societies and teaching, he still remained a prolific researcher and writer. The review papers on Petrology 1888–1938, 50th Anniversary Volume, Geological Society of America, Pyrometasomatic Ore Deposits, Lindgren Volume, and Geosynclinal Theory, Presidential Address, Geological Society of America remain classics in American geology.

On his retirement from Yale University in 1951, he returned to California and continued his teaching and research at Stanford University as Visiting Professor and then Consulting Professor up to his death in 1966. His presence at Stanford had the same magic touch with those students working under him as it had at Yale. Even during the final ten years of his life, he continued to fill in the gaps on the Boulder batholith history and finalized these ideas in his presidential address to the Peninsula Geological Society in 1956. His was a career that changed the course of geologic research in America and left with his associates a heritage of research attitude still alive in the minds of men he had trained so well. The Geological Society of America recognized these qualities of an outstanding teacher and researcher by presenting him the Penrose Medal in 1960.

As a man he was kind, considerate, and benevolent with all those he came in contact. The modesty and warmth he generated was in contrast to his critical and analytical mind that tolerated no compromise in things scientific. He was a modest man and felt uncomfortable in the spotlight of attention. His retiring nature was best exemplified by his reluctance to seek large research grants to carry out his later field work even when such finance was readily available. These characteristics, along with his continued independence of thought and action in his own research, clearly marked him as a gentleman scholar. Many of his former students became fast friends because of his continued interest and encouragement in their individual careers. He was always willing to help his students and their personal problems were of concern to him. The association with his students was one of his great pleasures in life and his involvement in the making of their scientific character was one of his great contributions. Even though he was the epitome of the distinguished professor with his tall, erect body and somewhat stern face, he had a wonderful sense of humor that provoked levity into the most serious discussions or situations.

In 1910, he married Agness Dillon and from this union four children were born; the oldest, a daughter, died as a baby. His wife provided a fine home and family life, but she was a victim of the 1918 influenza epidemic. Eleanor Bliss had been a member of the U. S. Geological Survey since 1912 and was working with the Survey in Washington, D. C. at that time. In 1920, she became Adolph Knopf's wife. This was a fortunate union as Eleanor brought laughter and gaiety into his life, along with an equally active scientific mind. From 1920 onward, he had the constant companionship of Eleanor, both in the field and in the laboratory. To think of one without the other is not possible and even though the published record shows no collaboration, each strongly influenced the other with ideas and concepts. Since both were authorities in separate but overlapping fields, their scientific labors in the field and laboratory were exchanged in such a fashion that the final product of each had been improved by the other. Their impact of friends and colleagues was always stimulating and a visit with them meant exploring scientific ideas; this always left one feeling as though he had had an interesting experience and also a challenge to those ill-conceived geologic ideas.

Petrology, ore deposits, mineralogy, geologic mapping, geochronology, and general geology have been strengthened, changed and advanced by Adolph Knopf, for here was a scientist that provided concise well-elucidated accounts of his investigations. The generosity and humility with which he passed on his hard-won knowledge to his students has provided us with several generations of geologists advancing the science of geology by his inspiration.


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# MEMORIAL OF ARTHUR LINDO PATTERSON

**July 23, 1902–November 6, 1966**

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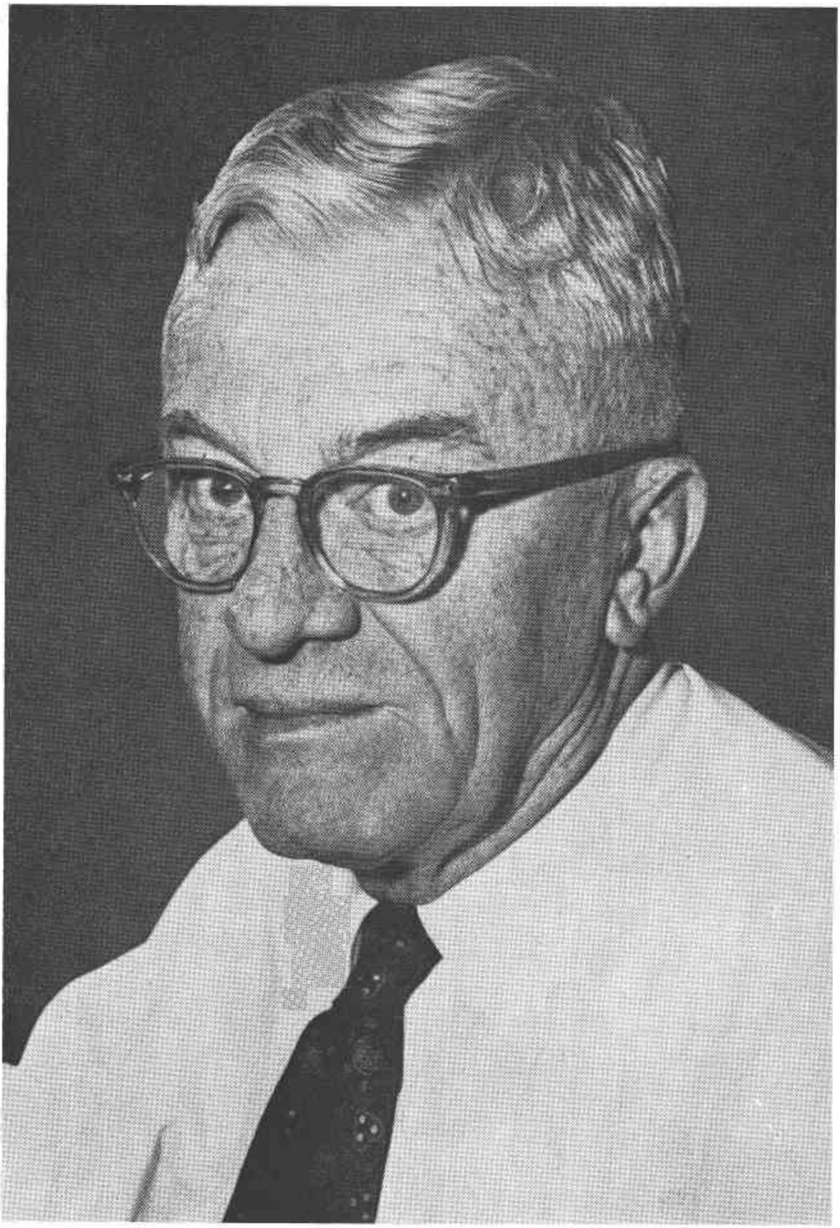
Arthur Lindo Patterson died November 6, 1966. He left empty a place in the field of crystallography that will never be filled. His fundamental contributions opened the way to the success of modern crystal-structure analysis, and his name, associated with the Fourier series method he discovered in 1934, has become an operative word to every scientist working with crystal structures. His personal reminiscences of his years in crystallography, published in *Fifty Years of X-ray Diffraction* (1962), give the reader a glimpse of the personality that raised Patterson so high in the regard of his colleagues; the selected quotations in the following paragraphs are from those recollections.

Born in Nelson, New Zealand, July 23, 1902, he moved to Montreal, Canada, while still in elementary school, and was sent to Tonbridge School in England to complete his secondary education. He came back to Montreal to attend McGill University, where he majored in physics and mathematics, receiving a B.Sc. in 1923 and, in 1924, an M.Sc. for research on the production of hard X-rays by interaction of radium $\beta$ rays with solids. Of this period, he comments "I had taken a Second Class Honours B.Sc. degree in 1923 and only one who has attended a British or Colonial University can realize the depth of ignominy attached to such a thing. This disgrace was correctly ascribed by my professors to too many friends in Montreal and an addiction to skiing, bridge, and dancing and other related activities."

Despite the "disgrace," he was awarded a Moyse Traveling Fellowship for the years 1924–26, and he chose to go to the Royal Institution in London where he built his own X-ray equipment and studied space-groups and structure analysis methods under the benevolent eye of W. H. Bragg and in association with such young scientists as Astbury, Bernal and Lonsdale, among others. In 1926 he received a National Research Council Fellowship which he held for two years. The first year he spent in Dahlem, Germany, with the group at Herzog's Institute headed by Hermann Mark, studying problems concerning X-ray diffraction patterns of cellulose.

It was at this time that he first became acquainted with the Fourier transform and some of its possibilities. Because of his interest in the newly published, now classic paper by Davisson and Germer (*Nature* **119,** 558–560, 1927) on the diffraction of electrons by nickel, he dared to disagree with von Laue's treatment of the subject at a colloquium, and he describes the episode as follows: "Most of the Professors in Germany valued their dignity very highly and to have disagreed with them in public would have been suicidal. Von Laue was not this way at all and said that I apparently knew more about the paper than he and asked me to review it. This I did, so scared that the first line I drew on the blackboard came out dotted. After the session, von Laue invited me to come out to his home a day or so later, when we had about three hours of discussion, first about electron diffraction, and then about the work on particle size and on the Fourier interpretation of the reciprocal lattice which I was trying to do in Berlin. Thereafter he was very friendly to me and I was able to see him frequently during the rest of my stay in Berlin."

In 1927 Patterson returned to McGill University, where he obtained



*Arthur Lindo Patterson*

his Ph.D. in 1928. During this period he was concerned with research into the nature of the cyclohexane hexols. The background reading he did at this time convinced him that X-ray diffraction would someday be of importance in supporting biochemistry. It was, in fact, the Patterson function that proved to be a key factor in solution of structures such as haemoglobin, myoglobin, lysozyme, and ribonuclease. From 1929–31 Patterson joined the Division of Biophysics, Rockefeller Institute for Medical Research, New York, and in 1931 he moved to the Johnson Foundation for Medical Physics, Philadelphia. However, his desire to continue study of Fourier transform theory proved compelling, and in 1933, he decided to take his savings to support a year's independent research at M.I.T., using laboratory facilities made available by B. E. Warren. The year stretched into three, a situation he ruefully acknowledges by the comment "I didn't really understand about depressions and did not contemplate three years out of a job." However, the associations with Norbert Wiener, Bert Warren, and many others provided the stimulation and intellectual climate that led him to the discovery of the Fourier series later known as the Patterson series (although to him it always remained the $F^2$-series).

As he describes the event, ". . . I noticed that the mathematical form of the theory given by Debye and Menke [for X-ray scattering from liquids] would be identical with that of the Faltung if the integrations over random orientation were left out and the randomness of choice of origin was left in. What was immediately apparent was that the crystal contained atoms and that the Faltung of a set of atom-like peaks was very special in that it would consist of a set of atom-like peaks whose centers were specified by the distances between the atoms in the crystal . . . all this [discovery] happened on a Tuesday, and Friday was the deadline date for the Washington spring meeting (1934) of the American Physical Society. An abstract had to be prepared in a hurry . . ."

It was characteristic of Patterson that he studied the series carefully before preparing a long paper on the subject, and also that he should later freely admit his annoyance with himself at "missing the beautiful extension of the method made by Harker" [*J. Chem. Phy.* **4**, 381 (1936)], commenting "I guess that I really could not get out of the plane."

Although he received fellowship offers from two universities in 1935–36, acceptance would have meant a change of field, and he was pleased when, in 1936, an assistant professorship in physics at Bryn Mawr College near Philadelphia was offered to him "with the express purpose of developing X-ray analysis in parallel with the wider interests of Walter Michels in the solid state." In 1935 he married Elizabeth Lincoln Knight, a research scientist in biochemistry, whom he first met during the years at the Rockefeller Institute, and the move to Bryn Mawr in 1936 proved a happy one for both. In the thirteen years at Bryn Mawr College Patterson was able to combine research and teaching successfully, completing work initiated at M.I.T. on particle-size line broadening, and beginning his study of homometric structures. He and Michels collaborated in writing a first-year college physics textbook, *Elements of Modern Physics*. During the war years, Patterson carried out research on wave phenomena for the U. S. Naval Ordnance Bureau, receiving in 1945 the Meritorious Civilian Service Award for work on submarine warfare. That same year he became a citizen of the U.S.A.

In 1949 he accepted an offer from Dr. Stanley Reimann of the Institute for Cancer Research, Philadelphia, to head an X-ray diffraction group studying compounds of biological interest. The remaining years of his life were happily spent setting up the laboratory, training young scientists, supervising new research while continuing his own research on Fourier analysis, writing fundamental articles for such publications as *International Tables for Crystallography*, and welcoming a constant flow of scientists from all over the world who found their way to his laboratory. His last conscious hours were spent in his laboratory; a massive cerebral hemorrhage struck as he left with his wife and colleagues for lunch on November 4, and he never regained consciousness. At a memorial service, held on November 8, scientists from as far away as Michigan and Oklahoma and from all points of the Eastern seacoast assembled, despite the necessarily short notice, to pay tribute in Friends' style to a beloved colleague and teacher, and to find some comfort in the music of Beethoven played by a quartet from the Philadelphia Orchestra.

Patterson belonged to and actively participated in numerous scientific societies. He was elected Fellow of the Mineralogical Society of America in 1947, having joined the Society in 1944. He was a Fellow of the American Physical Society, of the Institute of Physics of Great Britain, of the Physical Society of London, and of the New York Academy of Sciences. He was a member and one of the principal founders of the former American Society for X-ray and Electron Diffraction (ASXRED), for which he served as vice-president in 1947 and president in 1948. His vision and influence helped lead to the formation of the American Crystallographic Association in 1949 by merger of the Crystallographic Society of America with ASXRED, and it is a measure of his indifference to collection of titles that he initiated insertion of a clause in the new society's constitution barring from office anyone who had previously been an officer in one of the merging societies. He was also a member of the Société Française de Minéralogie et de Cristallographie, of the American Association of University Professors, the American Association of Physics Teachers, and the Franklin Institute. He served on numerous committees, delegations, and commissions.

Something of Patterson's personality is revealed in the few quotations chosen for use in this Memorial: his sense of humor, modesty, enthusiasm, love of research, and generosity towards the contributions of others. His teaching and example conveyed vividly the sheer joy and excitement that can be associated with research. He never missed an opportunity to encourage young scientists, not only by a word of praise or an interest in their work, but also by treating those with whom he was in contact as personal friends, giving them opportunities to meet older scientists and participate in discussions at a level that might otherwise not have been possible to them for many years. Although the temper that went naturally with his red hair became calmer in later years, it still appeared on occasion, usually sparked by some injustice or unnecessary stupidity. He was always a valiant proponent of the ability of women in science, and he did what he could to prevent any kind of illogical discrimination, retaining only that based on true intellectual capability.

A sociable person, he thoroughly enjoyed good conversation, good food preceded at dinnertime by a shot of bourbon, and good music. He could sing most of the Gilbert and Sullivan arias, having acted in productions of these operettas in his earlier years, and he delighted in jokes, especially scientific ones. One of his favorites was a poem on entropy, which he sang to the tune of Rock of Ages, ending with the lines, "$\Delta S$ is always plus, No matter how you fume or fuss." As A. L. Pon, Senics, of Incanearch, Philpa, U.A., he created a note, "On the symmetry of the wheaks produced by the Bucessera," which was printed in *Acta Crystallographica* format with the heading "Not reprinted from *Acta Crystallographica*." Its elliptical vocabulary provides an amusing translation exercise for the reader, and Patterson gleefully distributed reprints of the article.

At the memorial service Walter Michels made a moving tribute to his friend, and his closing remarks characterized Patterson in a unique way. Michels said that with all due respect to a beautiful quartet, the music most appropriate to Patterson could only be Beethoven's Ninth Symphony, ending as it does with full symphony and chorus in the triumphant Ode to Joy. In his daily life Patterson somehow succeeded in conveying this feeling to others, and it is this quality above all that we shall miss.

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# MEMORIAL OF ALBERT WILLIAMS POSTEL

**January 5, 1909–May 11, 1966**

Howard W. Jaffe, *University of Massachusetts, Amherst, Massachusetts,* and Elizabeth B. Jaffe.

Albert Williams Postel, better known as Bill, was born in New York City on January 5, 1909. He received his A.B., M.S., and Ph.D. degrees from the University of Pennsylvania, the last in 1939. He also studied at the Royal School of Mines, at Harvard University, and at Bryn Mawr College. He taught geology at the University of Pennsylvania from 1934 to 1941 as an Instructor, from 1942 to 1946 as Assistant Professor, and also taught at Bryn Mawr College from 1942 to 1945 as Instructor and Lecturer. In 1944, while still based in Philadelphia, he joined the U. S. Geological Survey as a geologist. In 1949 he moved to Washington, D. C., as Editor of Geologic Maps and Acting Chief of Geologic Reports, and in 1956 became Chief of the Office of Geologic Reports. In 1958, he was appointed to the position of Geological Adviser to the Division of Publications of the U. S. Geological Survey. He died May 11, 1966, in Bethesda, Maryland.

Bill was, professionally, a well-rounded classical geologist, equally adept in the field and the laboratory. In addition to his major works on the igneous and metamorphic rocks of the Philadelphia area and the Adirondacks, he published several short papers on sampling, modal analysis, sample preparation, and mineralogy. He was a hard-rock geologist to the core, but his first and last papers are concerned with the "soft cover." His work in the Philadelphia area encompassed not only the Springfield (Swarthmore) granodiorite, the subject of his Ph.D. thesis, but also the Wissahickon formation, hornblende gneisses, and the complex Precambrian rocks of the Phoenixville and Honeybrook quadrangles. His work in the Philadelphia area came to an abrupt end during World War II, when the marginal iron reserves of the Adirondack region assumed potential strategic importance. Bill was peculiarly well fitted by his training and experience to take on this geologically complex region. Few details escaped him, in the field or the laboratory, yet he never exaggerated their importance nor lost sight of the big picture. After the war, he continued his field work in the Adirondacks, and with various collaborators completed the geologic mapping of seven and one-third 15′ quadrangles, in the process logging in detail 15,000 feet of diamond-drill core and doing 17,800 feet of dip-needle surveying in Clinton County alone. In his published work he is scrupulous in separating fact from opinion, and in giving alternate hypotheses their due. Where the evidence is inconclusive, he is not afraid to say so; nor does he hesitate to state his own conclusions, tentative though they may be. Bill's administrative work in Washington, and, later, his poor health, brought a gradual end to his active geologic mapping, but not to his interest in Adirondack geology. He was a familiar and welcome sight on field trips in the area: the picture of him that accompanies this memorial was taken on the New York State Geological Association field trip to the Adirondacks in May 1965.

Bill was puritanical only in his devotion to scientific accuracy: he enjoyed life thoroughly, and had a puckish and irreverent sense of humour that could dispel any gloom or puncture any pretense. Even after Bill joined the U. S. Geological Survey, he maintained an office at Bryn Mawr College, because there was little space in wartime Washington. His door was always open to students. He and his wife Dorothy had a warm and friendly relationship with the students and faculty of the Geology Department, and were generous in providing hospitality, or sympathy when it was needed. Their large circle of like-minded friends in Washington will also remember these qualities. No one who knew Bill will forget his ability to put any situation in perspective with a well-placed, sometimes unquotable quip, accompanied by a quizzical grin. Bill was an enthusiastic and adept vegetable gardener, and a gourmet; he took great pride in serving leeks and Swiss chard, produced in spite of the Washington climate and the rabbits of Kensington, Md., where he made his home. He enjoyed the pleasures of the mind as well as of the palate, and could relish equally (and as likely as not simultaneously) a symphony by Sibelius or hot red cherry peppers. Bill's poor health in later years slowed him down a little, both professionally and socially; however he accepted his limitations and worked within them, his zest for life and sense of humour intact.

Bill was a fellow of the Geological Society of America and of the Mineralogical Society of America. He was survived for little more than a year by his wife Dorothy, whom he married in 1939. Bill and Dot will both be long remembered by their many friends: they had no children. With characteristic generosity, Bill left his microscope and his geological library to the Department of Geology at Bryn Mawr College.

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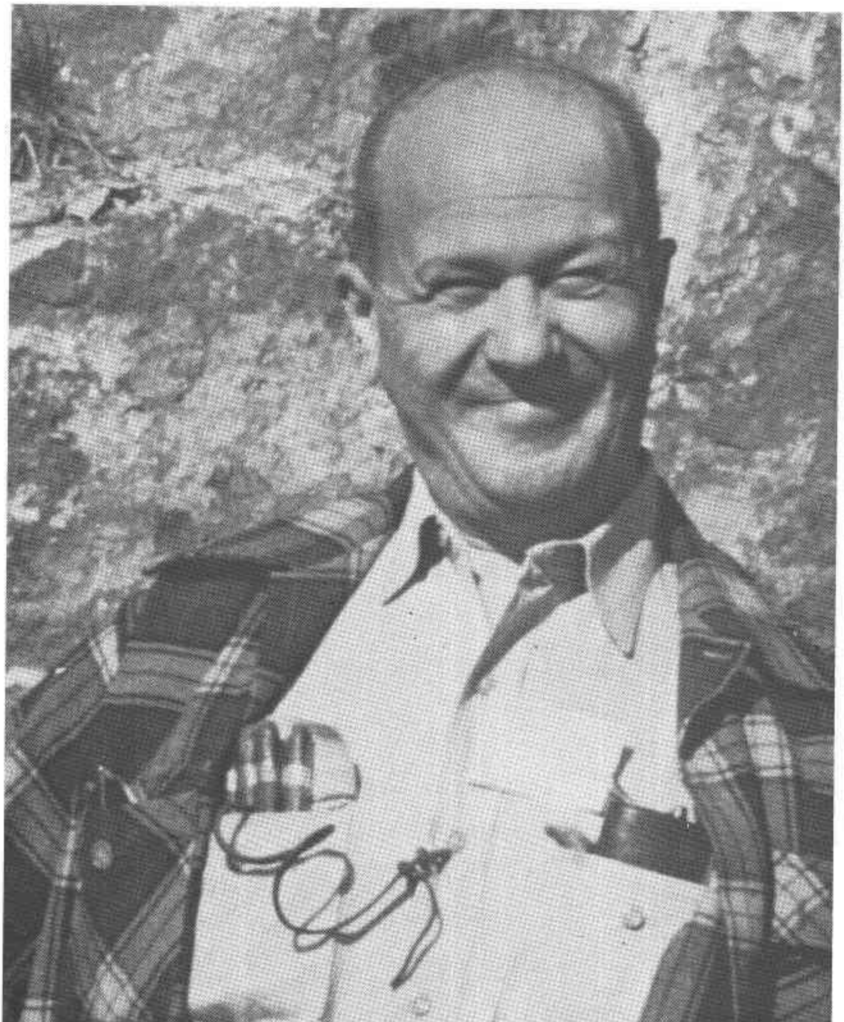

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# MEMORIAL OF PERCY DUDGEON QUENSEL

**September 8, 1881–March 3, 1966**

Brian Mason, *U. S. National Museum, Washington, D. C.*

Percy Dudgeon Quensel was born at Marstrand, on the west coast of Sweden, on September 8, 1881, and died in Stockholm on March 3, 1966. His mother, although born in Sweden, was of Scottish parentage, and retained dual citizenship (British and Swedish) throughout her life, and spoke English by preference in her home; hence Professor Quensel's un-Swedish given names and his perfect command of the English language.

His university studies were at the University of Upsala, but also included periods at Heidelberg and Graz. In the middle of his university career he spent almost two years—from September 1907 to June 1909—on field work in South America, with the Swedish Magellanic Expedition. During this time he visited South Georgia, the Falkland Islands, Tierra del Fuego, and the Juan Fernandez Islands, but the major part of the expedition was a journey from the southernmost Chilean settlements across the Andes and Patagonia to Punta Arenas on the Straits of Magellan. The scientific results of this journey were presented in 1911 in his doctoral thesis "Geologisch-petrographische Studien in der patagonischen Cordillera."

In 1914 Quensel was appointed to the chair of mineralogy and petrology at the University of Stockholm, where he worked for the rest of his life. During his earlier years at Stockholm his research work was concentrated on field mapping and related petrological studies in the mountains of northwest Sweden. The discovery of the Varuträsk pegmatite in 1933 and its subsequent mining by the Boliden company turned his interests towards pegmatite mineralogy, and over more than a decade he published a long series of papers describing the remarkable variety of minerals from this pegmatite, and discussing their paragenetic significance. In 1948 he retired and was appointed Professor Emeritus at the university, but continued to work there practically up to his death. During his retirement he returned to his first love, petrology, and studied the charnockitic rocks near Varberg on the southwest coast of Sweden, publishing a lengthy monograph on this subject in 1951. He revisited Chile and revised his earlier work on the Juan Fernandez Islands. When he was nearly eighty he was active in the preparations for the field excursions for the 1960 International Geological Congress, being a co-author of three of the guidebooks.

My personal friendship with Percy Quensel dates from 1940, when I arrived in Sweden as a refugee from the war in Norway. Thanks to his hospitality and encouragement, I was able to work in his institute during the war years and eventually take a graduate degree. He was an outstanding character, not only for his breadth of knowledge and interests, but also for his kindness, charm, and sociability. A widower since 1933, he lived in a spacious apartment within the central part of Stockholm, and delighted in entertaining his friends. Among my pleasantest memories are the many occasions when meetings of the Geologiska Föreningen adjourned to his apartment for a "Nachspiel" which frequently continued into the early morning hours!

He liked to travel, and his travels took him to most parts of the world. He took part in many International Geological Congresses, including those in Canada (1913), South Africa (1929), and the USSR (1937). He was a keen and discriminating mineral collector, and his travels greatly enriched the collections of his institute, where he set up an attractive series of mineral displays.

I am indebted to Professor W. Uytenbogaardt for the accompanying bibliography.

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# MEMORIAL OF SIR ARTHUR RUSSELL

**November 30, 1878–February 23, 1964**

Arthur W. G. Kingsbury, *University of Oxford, England.*

Sir Arthur Russell was well-known to several generations of British mineralogists, but during the course of his long life he had made friends in many countries and especially the United States. Few men have been so dedicated to mineralogy as he was, and by his death the science of mineralogy has lost one of its outstanding personalities.

Arthur Edward Ian Montagu Russell was born on November 30, 1878, succeeding to the title, as 6th Baronet, on the death of his elder brother in 1944, and died on the 23rd of February 1964, in his 86th year.

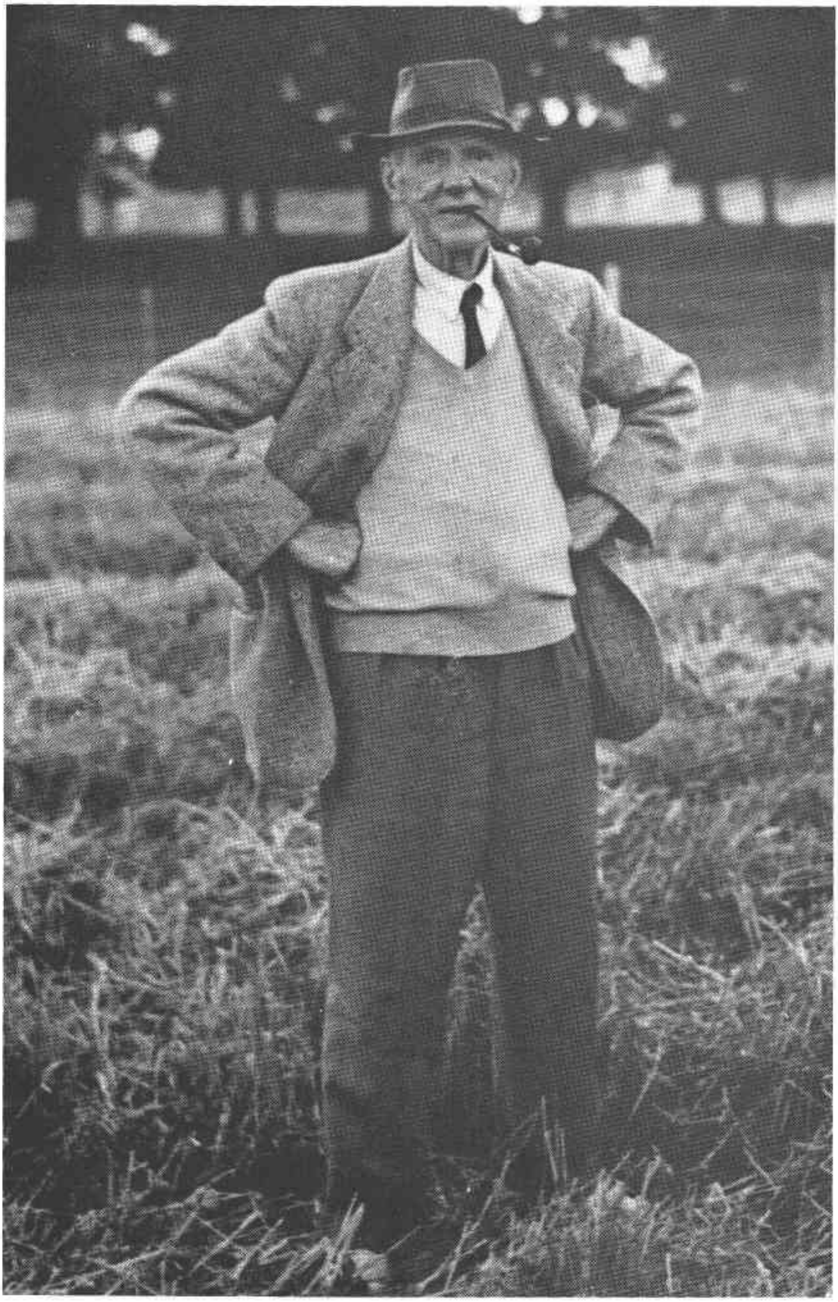
It was from his mother that Russell first acquired his interest in and love of minerals, together with the nucleus of a collection which was, in due course, to become the most comprehensive and outstanding private collection of British minerals that has been made.

Arthur Russell started adding to this collection from about the age of seven, and at the age of eight he made his first visit underground, in a working tin mine in Cornwall, England. From then on he collected from almost every mine, quarry, and other suitable locality in Britain, and in addition to discovering many new occurrences, he actually went underground in every metalliferous mine in the British Isles (with the exception only of the Laxey and Foxdale Mines in the Isle of Man) that had been working during the course of his life.

After leaving school, Russell had gone to King's College, London, to study chemistry, but owing to the early death of his father in 1898, he left after two years and took up an appointment with one of the British Railway companies. After a year's service with the Red Cross in World War I he was invalided home, and was subsequently assigned to special work in the investigation of British mineral resources. During all this time, however, he had continued his mineral collecting whenever opportunity arose.

Arthur Russell was a very good "mixer" and made friends easily in all walks of life, particularly among those concerned with mining and quarrying. He was, as a result, almost always notified of interesting discoveries, and was consequently able to procure many fine specimens which otherwise might have been destroyed or damaged. He had, moreover, three other valuable attributes—a great sense of humor, an infectious and almost boundless enthusiasm, and unlimited patience. In the field he was an outstanding collector, having an almost uncanny flair for finding minerals; he paid great attention to local conditions and environment, and had a remarkable eye for good specimens. His knowledge of British minerals and localities was encyclopaedic.

Russell's collection at his home at Swallowfield Park, Reading, Berkshire, England, became known throughout the world, and was visited by many mineralogists both British and from overseas, all who went there being accorded an enthusiastic welcome. At the time of his death, the collection comprised some 14,000 specimens and included not only a large amount of material collected by himself, but many well-known British collections of the past. Among those may be mentioned part of the collection of Philip Rashleigh (1728–1811) of Menabilly, Cornwall, England, and the bulk of John Ruskin's collection. Many of these collections



*Sir Arthur Russell*

dated back prior to 1800, and the collection as a whole contains many superb and outstanding examples of British minerals from almost every known British locality. By Arthur Russell's generous bequest, this wonderful collection passed to the British Museum (Natural History) in London on his death.

Arthur Russell was a member of the Mineralogical Society (of London) from 1902 till his death, having been President from 1939–1942. During the postponed 18th Session of the International Geological Congress in Great Britain in 1948, Russell led a special mineralogical excursion to Cornwall and Devon, and in the same year he was awarded the William Bolitho Gold Medal by the Royal Geological Society of Cornwall (founded in 1814). In 1953 the Royal Institution of Cornwall awarded him their Henwood Medal for his work on the mineralogy of Cornwall. In 1956 he was awarded the Honorary degree of Doctor of Science by the University of Oxford.

Russell published some thirty papers, of a descriptive or historical nature, mainly in the Mineralogical Magazine, the majority dealing with British occurrences. He made outstanding contributions to the knowledge of British minerals and, either alone or as coauthor, described the first British occurrences of, inter alia, bementite, carminite, celsian, ceruléite, corubite, cotunnite, laurionite, nadorite, paralaurionite, phenakite, realgar, serpierite, and turquoise. The mineral rashleighite was named and first described by him, and two new minerals, found by him (in one case jointly), were named after him, russellite, and (jointly with Arthur Kingsbury) arthurite.

Arthur Russell will be greatly missed by his wide circle of friends, especially those who had known him more intimately and had worked with him, but he leaves a fitting and lasting memorial in his wonderful collection on which he had spent so much time and bestowed so much care.

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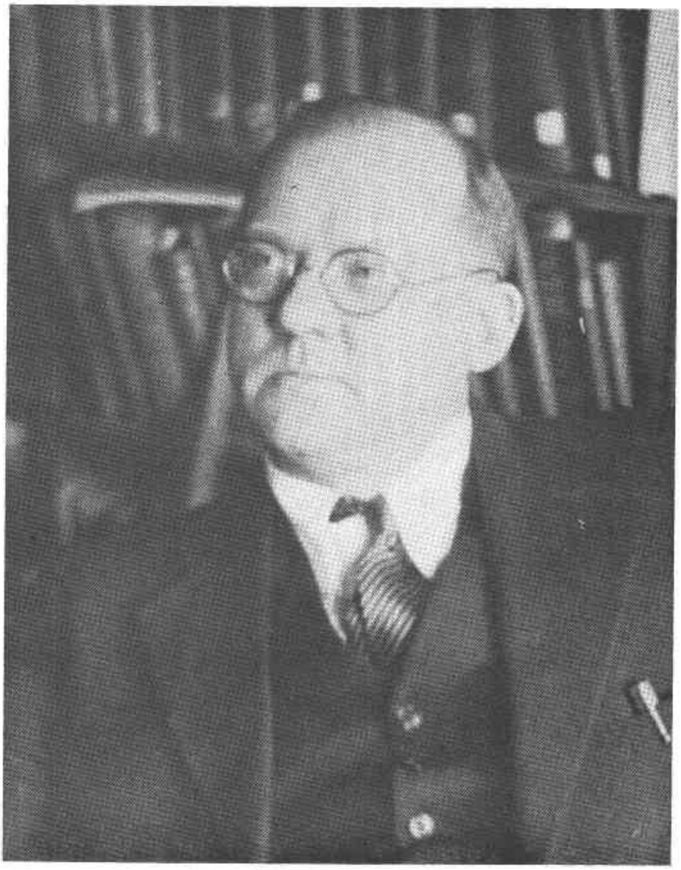
## MEMORIAL OF OTTO CHARLES VON SCHLICHTEN

**July 19, 1886–October 4, 1950**

RICHARDS A. ROWLAND, *Shell Canadian Exploration Company, Houston, Texas 77025.*

Otto Charles von Schlichten died unexpectedly on October 4, 1950. Born in Cincinnati, July 19, 1886, he had been closely associated with the University of Cincinnati, as a student and teacher, for more than forty



*Otto Charles von Schlichten*

years. Professor von Schlichten completed his undergraduate work at Cincinnati in 1911 and was elected to Phi Beta Kappa. He became a member of Sigma Xi while a graduate student at the University of Wisconsin in 1913 and later he was the first president of Sigma Xi at the University of Cincinnati. Throughout his subsequent life, he showed great interest in the goals of Sigma Xi, and through his counseling and teaching, he did much to help both his colleagues and students to attain these goals.

Professor von Schlichten's contributions to the advancement of science were made as a teacher and a consultant. As a teacher, he organized the Five-year Cooperative Geological Engineering Program in which many of us were trained. Von Schlichten served the city and local industry as consultant in connection with problems of foundation stability, landslides and other phases of engineering geology. Many of his colleagues on the faculty found that their perplexing problems were made easier by "Von's" generous sharing of his broad scientific understanding. To students and colleagues he was known as an exceptionally able teacher, possessing a broad and accurate knowledge of many branches of science which he was able to convey simply and clearly.

In addition to his association with the University of Cincinnati, von Schlichten instructed at Lehigh and was a member of the Missouri Bureau of Mines. His interest in mineralogy and gems took him to Ann Arbor almost every summer to work with the renowned mineralogical faculty of the University of Michigan.

Besides Phi Beta Kappa and Sigma Xi, he was also a member of the Ohio Academy of Science, the American Association for the Advancement of Science and a Fellow of the Mineralogical Society.

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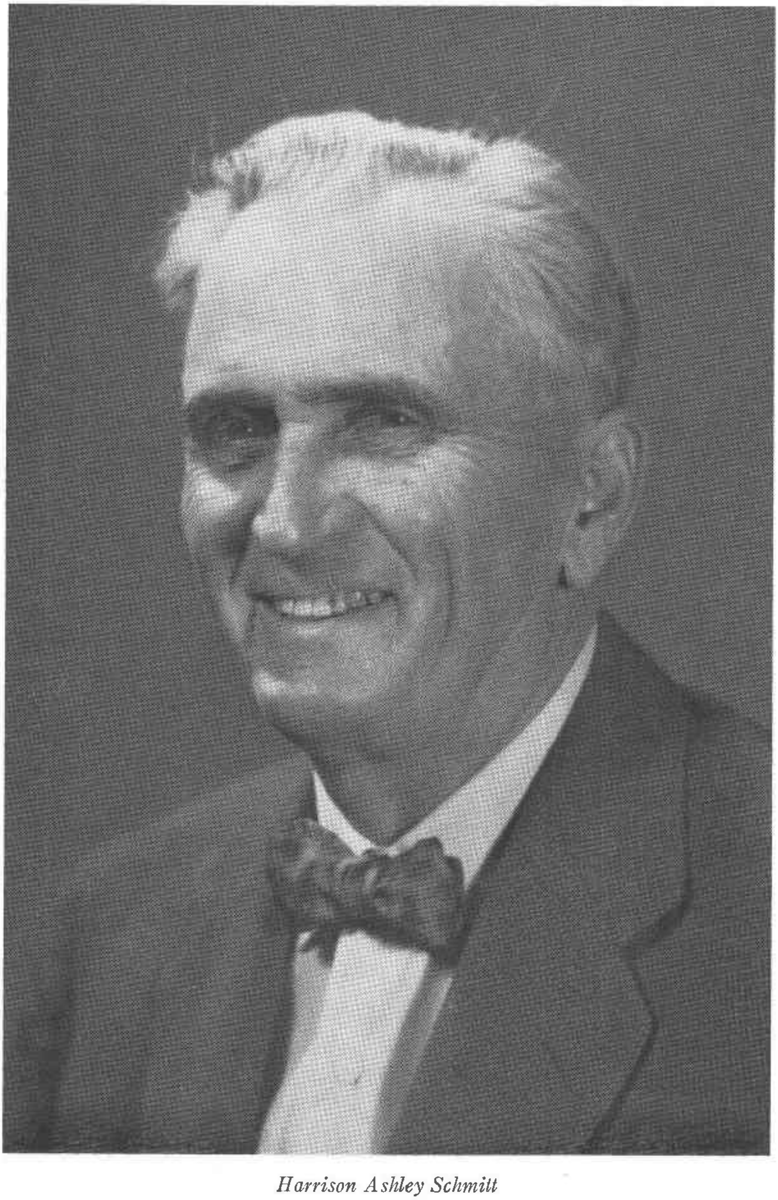
# MEMORIAL OF HARRISON ASHLEY SCHMITT

**June 11, 1896–October 26, 1966**

H. H. Schmitt, *National Aeronautics and Space Administration, Houston, Texas.*

Harrison Ashley Schmitt was one of a generation of geolotists who developed the art and science of mining geology into a leading factor in the unprecedented growth of mineral exploitation in the last thirty years. Loosely allied with such men as Augustus Locke, Hugh McKinstry and many others, he joined in branching from the footsteps of Waldemar Lindgren toward the application of detailed ore deposit studies to the exploration for new mines. Our generation, in the spell of great advances



*Harrison Ashley Schmitt*

in exploration geophysics and geochemistry, has in part turned away from the path of applied ore deposition blazed by these men. However, the continued linking of Harrison Schmitt's name with recent porphyry copper developments—Christmas, Esperanza, Mineral Park and Battle Mountain—suggests that we have strayed too far. In the same manner that Harrison Schmitt and his generation combined the logic of chemistry and physics as they knew it with the descriptive philosophy of Lindgren, it is up to us to combine their applied ore deposition with the new techniques of geochemistry and geophysics.

"The Doctor" was born June 11, 1896, in Mankato, Minnesota, into the family of Harrison Lincoln and Esther Grannis Schmitt; a lawyer's family only one generation removed from the frontier. Although the necessity to be a carpenter, a smithy, or a hunter was rapidly disappearing, he nevertheless acquired these and related skills in his youth to his and his family's lasting pleasure and benefit. After graduating from Mankato High School he entered the University of Minnesota at Minneapolis apparently intent on studies foreshadowed by his boyhood "excursions" into chemistry. Upon the completion of his second year of university study he volunteered for duty with the Marine Corps where he and his fellows took part in another of our continuing attempts to preserve liberty on this planet. This period of national service appears to have fertilized a deep concern for the long term health of our society, a concern about which he continued to speak and write throughout his life.

It was also during his tour with the "Horse Marines" that his reading in geology and his affection for nature led him eventually to return to the University of Minnesota where he obtained a doctorate in geology in 1926. His thesis work in the Parral District of Chihuahua, Mexico (Schmitt, 1931) and other investigations in that country for the American Smelting and Refining Company began the first of two major phases in his studies of ore deposits. He continued this phase of detailed field studies with work on the vein, manto and pipe types of ore deposits in Mexico from 1922 to 1926, in the Central Mining District of New Mexico from 1927 to 1931, and subsequently as a consultant throughout Mexico and southwestern United States. This work gave him extensive if not unique knowledge of the structure, mineralogical associations and ore finding techniques related to pyromatasomatic and hypogene ore deposits and supergene alteration (Schmitt, 1933, 1938, 1948). His 1939 paper on the Pewabic Mine of the Central Mining District (Schmitt, 1939) is considered by many to be one of the foremost illustrations of the application of systematic field and laboratory investigations to a problem in ore deposition and mining. During this period he also wrote extensively on the use of systematic geological techniques in ore search and mining (Schmitt, 1932, 1933, 1936). He recognized and deplored the early stages of the current trend to deemphasize training in geologic mapping at the college level, writing in 1936:

> "Most recent discoveries of ore by geologic methods resulted from detailed studies of structural conditions and these had detailed large-scale mapping as their base. Few recent college graduates seem to have had training in mapping methods known to be effective. . . . The student is expected to acquire the needed skill somehow after graduation; yet it may mean his bread and butter for several years. Indeed he may never learn to map well and therefore be ineffective in exploration."

Soon after the end of World War II, Dr. Schmitt's interests followed those of the mining industry into the exploration for disseminated, or "porphyry" copper deposits. This second phase of his study of ore deposits culminated in one of the most impressive string of successful mining property developments of which I am aware. Of particular note is his involvement in the discovery and development of ore bodies at the Christmas, Esperanza, Mineral Park and Peach mines in Arizona, and at Battle Mountain in Nevada. As part of his work with the Defense Minerals Production Agency of the Federal Government he was also involved in evaluation of the Bor Mines in Yugoslavia in 1951 and the Toquepala, Peru, copper deposit in 1952. Several other properties which he recommended in recent years show promise of becoming major producers in the near future.

The broadening of Dr. Schmitt's experience with the ore deposits of the Southwest led him to think and write about his cumulative knowledge of these deposits. He was among the first to document the importance of the hot spring environment in epithermal mineral deposition (Schmitt, 1950). He also reemphasized the importance of wall-rock alteration as a source of vein silica (Schmitt, 1954). In recent years the implications of subcontinental structure in the localization of and search for ore deposits (Schmitt, 1959, 1966) attracted his attention. Also in the few years just prior to his death he had begun to compile his data and impressions on ore deposition and leached cappings related to disseminated copper and molybdenum deposits. Although presented orally on numerous occasions most of these papers have not yet been formally published (see, however, Schmitt, 1953, 1959, 1960, 1961, 1962).

In spite of his positive successes in ore search and development, he wrote in a personal note "I feel that an important contribution to the mining industry especially in the Southwest has been my rejection of hundreds of prospects that would otherwise have absorbed and wasted a good deal of exploration money." To this contribution we can add the on-the-job training of numerous young mining geologists and engineers who worked with him during nearly forty years of supervisory activity. His legacy to these men was the example of success resulting from the combination of professional knowledge and professional ethics.

As we look back on the development of Schmitt's studies of ore deposits there is a trend from the detailed to the general, but always with a clear rationale for these studies, namely our need for the long-term exploitation of the Earth's mineral resources. As we look forward into the future that includes many new technological advances in field and laboratory methods, including exploration by remote sensing form space, we must not forget the need to understand as fully as possible what we are looking for. This is the lesson we should learn from Harrison Schmitt and his generation.

Dr. Schmitt was a fellow of the Mineralogical Society of America and the Geological Society of America, and a member of the Society of Economic Geologists, the American Association for the Advancement of Science, the American Geophysical Union, the Geochemical Society of America and the American Institute of Mining and Metallurgical Engineers. He served on the councils of both the GSA and the SEG. He was a member of Sigma Xi, Sigma Gamma Epsilon and Gamma Alpha. His social fraternity at the University of Minnesota was Beta Theta Pi.

Harrison Schmitt was prominent throughout his professional career in the Arizona and New Mexico Geological Societies and local chapters of the AIME. He was an honorary life member of the New Mexico Geological Society and served as its president from 1951 to 1952. He was president of the Silver City AIME at the time of his death. In 1962 he was elected Man of American Mining for that year by Mining World.

His chief clients after becoming a consultant included American Smelting and Refining Company; American Zinc Company; Banner Mining Company; Black Hawk Consolidated Mines Company; Duval Sulphur and Potash Company; Kennecott Copper Corporation; Kerr-McGee Corporation; Lewisohn Copper Corporation; New Jersey Zinc Company; Peru Mining Company; Quintana Petroleum Company; and U. S. Smelting, Refining and Mining Company. During the Depression years he organized the Shingle Canyon Mining Company and developed a small lead-zinc mine near Fierro, New Mexico. This mine was later sold to the U. S. Smelting, Refining and Mining Company.

Although El Paso, Texas, was the center of his early consulting activities he moved to Hanover, New Mexico, in 1933 where he had lived previously while working for New Jersey Zinc Company. The family then moved to nearby Silver City in 1937. Next to his beloved Minnesota lakes, Silver City remained "home" through the following years of travel.

Dr. Schmitt's interest in civic activities, education in particular, was reflected in his tenure from March 1961 to April 1964 as president of the Board of Regents of Western New Mexico University at Silver City. He was also in demand as a speaker not only in his profession but with civic groups who wished to hear about other of his varied interests, including archaeology, meteorology and economics. He was an honorary life member of Rotary International, an honor he valued as highly as any.

Harrison is survived by his wife, Ethel Hagan, a Tennessee-born teacher whom he married in 1929; by three children, two granddaughters, and by three sisters.

"The Doctor" died of a first heart attack on October 26, 1966, at the age of 70. The week before his death he took his last trip with a client through Nevada and California examining several properties in some of the most beautiful mountain country in the world. He received ". . . as much pleasure from that trip as from any in recent years." This was the retirement he talked of for many years.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# MEMORIAL OF LAWRENCE RICKARD WAGER

**February 5, 1904–November 20, 1965**

E. A. VINCENT, *Department of Geology and Mineralogy, University of Oxford, England.*

The sudden death on 20 November, 1965, of L. R. Wager, Professor of Geology in the University of Oxford, deprived the world of one of its most outstanding geologists and this Society of one of its most distinguished Fellows.

Lawrence Wager (Bill to many of his closer friends and colleagues) was born on 5 February, 1904, at Batley in Yorkshire, and received his early education at the school of which his father was headmaster, and later at Leeds Grammar school. He gained an open scholarship in Natural Science to Pembroke College, Cambridge, where he graduated with a First Class in Geology in 1926. His interest in nature having been aroused at an early age, and stimulated by contact with his uncle H. W. T. Wager, a distinguished botanist, Lawrence Wager quickly responded to the teaching of such eminent Cambridge men as Professor J. E. Marr, Alfred Harker, and C. E. Tilley, and it was to Harker that he always felt he owed his real awakening to the science of petrology. After graduation, Wager remained at Cambridge for three more years to carry out his first researches, concerned with metasomatic phenomena in the dolerite of the Great Whin Sill and with the tectonics and jointing patterns in the Great Scar Limestone (Carboniferous) of Western Yorkshire. During his Cambridge years he had, in addition, steadily been building a considerable reputation as one of the finest young mountaineers and rock climbers in Britain, interests and skills which were soon to attract him to more remote parts of the world and to their geological problems.

On leaving Cambridge in 1929, Wager was appointed as the second member of the staff of the vigorous young geology department of Reading University, a post he held until 1943. During the first ten years of this time, up to the outbreak of war in 1939, Wager seemed to manage to fit in on the average very nearly one major scientific expedition a year. He was first invited to join Gino Watkins' British Arctic Air Route Expedition to

Eastern Greenland in 1930–31. This experience largely determined the course of much of Wager's subsequent scientific work, and it is for his exhaustive and far reaching researches in East Greenland, and especially into the classic Skaergaard layered basic intrusion, first visited during Watkins' expedition, that his name will be chiefly remembered by petrologists of future generations. In 1932, Wager returned to East Greenland as a member of the Scoresby Sound Committee's expedition under the leadership of Ejnar Mikkelsen and in 1933 he went to the Himalayas as a member of Hugh Ruttledge's Everest team when, with P. Wyn Harris, Wager reached a height of some 28,000 ft. in a final attempt to reach the summit without the use of oxygen: it was not until 20 years later that Hunt's expedition, using oxygen and following a different route, was to do better. In 1934, Wager again visited East Greenland with the *Pourquoi Pas?* expedition led by Dr. J.-B. Charcot, although the main intention of the expedition, to climb the Watkins Mountains, was defeated by weather conditions. Wager' sexpedition activities in the '30's culminated in the organization of his own British East Greenland Expedition of 1935–36 which overwintered at Kangerdlugssuaq and saw the completion of the field work that was to lead to the publication of the classic Skaergaard intrusion memoir by Wager and Deer in 1939. This small expedition, of which his wife and his brother were also members, also carried out a vast amount of other geological work as well as managing the ascent of the Watkins Mountains (the highest mountains in the Arctic) left over from the 1934 expedition.

The years from 1936–39 were spent mostly at Reading, working up the Skaergaard results for publication with W. A. Deer. It was during this period that the writer had the inestimable privilege of first becoming one of Wager's pupils, and a remarkably stimulating experience it was.

Not long after the outbreak of war in 1939, Wager was commissioned in the Royal Air Force. He served with distinction in the photographic reconnaissance section, work for which his Greenland expedition work had peculiarly fitted him, and saw service in Arctic Russia.

Wager's geological career was resumed in 1944 when he was released from the R.A.F. in order to take the Chair of Geology at Durham, recently vacated by Arthur Holmes. Beginning with three rooms and a three man staff, he steadily built up his department during the post-war years, adding facilities for modern petrological and mineralogical research. He resumed his own work, further developing his interests in geochemistry with the classic study of trace element distributions in the Skaergaard intrusion in collaboration with R. L. Mitchell. He also at this time wrote fine papers on the stratigraphy and tectonics of parts of Eastern Greenland, and began taking an active interest in the geology of

*Lawrence Rickard Wager*

the Tertiary igneous centres of Scotland, particularly the Islands of Skye and Rhum. He was elected a Fellow of the Royal Society in 1946.

In 1950, Wager was elected to the Chair of Geology at Oxford. Here, the department had recently moved into new quarters, but again lacked the facilities necessary for modern research on the petrological and mineralogical sides. Wager, with characteristic energy and persistence, set about rectifying this state of affairs and within a very short time had established a flourishing research school backed up by most of the necessary staff and equipment. Geochemistry was added to the active interests of the department and Oxford quickly became recognised as one of the leading research centres in petrology and geochemistry in Europe. For some years Wager had been among the rather few geologists and geochemists to appreciate the implications for their subject of the rapid advances being made in the study of isotopes and of radioactivity in general. By about 1955 he had decided that a laboratory for radiometric age determination ought to be set up in Oxford, and devoted much of his time and energy to this end over the succeeding years. Massive support was obtained from the then Department of Scientific and Industrial Research and the first British laboratory for research of this kind was established.

Wager was a man who always made the fullest possible use of his time, and although at Oxford he gradually found that committee work, both inside the University and beyond called for an ever increasing share, he nevertheless continued to find the energy to keep his own personal research going along vigorously. Among the many activities of a man so thoroughly devoted to the advancement of his science must be mentioned his interest in scientific publication: we shall all be long grateful for his initiative, with one or two other people, in launching *Geochimica et Cosmochimica Acta* in 1950 and the *Journal of Petrology* in 1960. He continued to work at his Greenland problems, and fresh impetus was given to further detailed work on the Skaergaard intrusion by another expedition to Kangerdlugssuaq which he organized, together with W. A. Deer, in 1953. This was to be his last expedition; preparations were far advanced for a further venture planned for the summer of 1966, but, sadly, he was not to participate.

Both as geologist and explorer, Wager's merits were recognized by numerous distinctions. From the Geological Society of London he received the Lyell Fund in 1939, the Bigsby Medal in 1945 and the Lyell Medal in 1962; he served as Vice-President of the Society from 1951–1953. In 1948, Wager received the Spendiarov Prize at the 18th International Geological Congress in London. He was President of Section C (Geology) of the British Association for the Advancement of Science in

1958, and served as President of the Mineralogical Society from 1960 to 1963. As an explorer, his work was recognised by the award of the Polar Medal in 1933 and the Mungo Park Medal by the Royal Geographical Society in 1936.

Although to most readers of this journal, Wager will no doubt be chiefly remembered for his far-sighted and detailed work on the Skaergaard intrusion with W. A. Deer and others, and for his work in trace element geochemistry, his stature as a complete geologist must not be overlooked. He was deeply interested in and concerned with everything that had to bear upon the science of the Earth. Some of his earliest research concerned structure and tectonics in the Carboniferous Limestone Series of Northern England, and in later years he liked to spend some time during every University vacation at his farm in Yorkshire, where he would often go out for the day with map, hammer and rucksack continuing to map and study in detail these rocks of his home countryside for which he always retained a deep affection. Acquaintances who knew him less than well were sometimes prone to think that his interests were rather narrow, and the intensity with which he would prosecute a particular line of research might sometimes have given rise to this impression. The breadth of Wager's competence and interest as a geologist can be gauged from the list of his publications; all his papers contain fresh ideas and he never published unless he had something worthwhile to say.

Although essentially a mountaineering venture, the 1933 Everest expedition, for example, provided Wager with the opportunity to use his acute powers of observation and his broad geological interests for the purpose of making several fundamental contributions to Himalayan geology. And, quite apart from his fundamental researches into the Skaergaard intrusion, we should remember that practically all that is known of the geology of the eastern part of Greenland south of Scoresby Sound is due to him. When one considers his personal achievements during the East Greenland expeditions one begins to gain some idea of the stature of the man not only as a scientist but also as one of the toughest, most single-minded explorers that Britain has produced for a very long time.

At the other end of the scale, Wager applied to his laboratory investigations the same tenacity and attention to detail that characterised his expedition work, and always insisted that no piece of petrology was worth very much unless the individual rock-forming minerals had been studied as completely as possible. To Wager and Deer we owe the discovery and characterisation of ferroaugite and ferrohortonolite, thus completing the common clinopyroxene and olivine series, and the recognition of the relationship between iron-wollastonite and ferro-hedenbergite; while with

R. L. Mitchell, Wager made the first really systematic attempt to determine and understand the partition of trace elements among the coexisting minerals of a suite of igneous rocks. He was a very keen mineralogist, and used to say that the discovery of a really handsome specimen of some well-crystallised mineral, however common, was to him one of the greatest thrills geology had to offer.

Lawrence Wager was always exceedingly modest about his own attainments and was basically somewhat shy and retiring in disposition. He had, however, great strength of personality, undeviating honesty and sense of purpose. These personal qualities endeared him to his closer colleagues and friends. He took their problems seriously and would devote endless, valuable time unselfishly attempting to help them arrive at the correct solution, no matter whether the problems were personal, academic or scientific. He never arrived at any decision hurriedly but viewed every problem from all angles, so that his answer, in the end, should be the best possible. An absolute perfectionist, Wager was never over-lavish with praise; he was the real, critical, exacting scientist and he expected others to share his high standards and his capacity for sustained effort. He was invariably stimulating, and ten minutes' discussion with him could send a research student or a colleague away with sufficient ideas for several months of work. He had great vision and was always quick to perceive which new directions in geological science were worth pursuing with vigor, and he was adept at encouraging his associates to think along these new lines and to venture into new fields of interest. As a professor, he was no showman and his students grew to respect and to love him especially after they had spent some time in the field in his company and the barriers of shyness on both sides had been broken down.

The picture his friends and associates will always retain in their memory is of Wager, relaxed of an evening at his home and with his charming family, when he would begin to talk geology—which, after all, was his life's passion—with evident enjoyment, away from the distractions and interruptions of the day spent in his University department. Or perhaps the memory of a walk home across the hills after a long day's geology in the field, when his companionship and gentle talk would often take on a golden quality.

His death came all too soon. He was in the midst of planning further expeditions with Deer to Greenland, and, great though his achievements for geology in Oxford were, his work for his department was by no means finished.

His wife, Phyllis Margaret Worthington, whom he married in 1934, was his constant and unfailing partner in all he did, and organized his home in such a manner that the Wagers' hospitality was an experience to be remembered, as any of the numerous visitors who have stayed with them can testify. It was a real privilege to know Bill Wager; his untimely passing leaves a gap in the ranks of the great geologists of our time which will not easily be filled.


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# MEMORIAL OF ERIOL JOSEPH WEISS

**March 18, 1918–June 14, 1967**

W. F. Bradley, *University of Texas, Austin, Texas.*

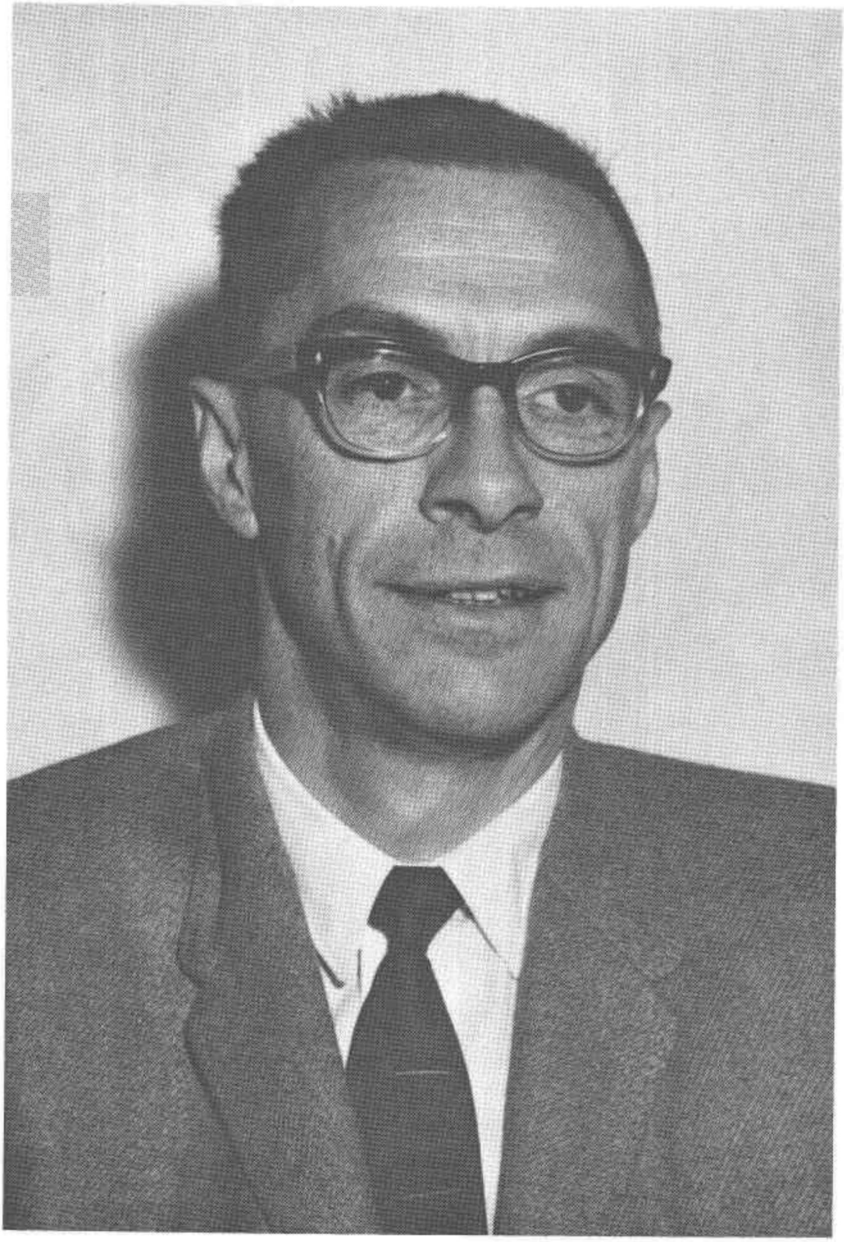
Eriol Joseph Weiss was born on March 18, 1918, at Lancaster, Ohio. His death, after an extended period of difficult health, occurred at Homestead, Florida, on June 14, 1967.

Dr. Weiss first attended school at Ohio University, Athens, Ohio. His abiding faith in alphabetical seating was based on his marriage in 1943 to Helen Weirauk. She and three sons survive.

He continued his education at The Ohio State University, receiving B.Cer.E. and M.S. degrees in Ceramic Engineering in 1944 and 1945, and the Ph.D. degree in Mineralogy in 1949. From 1950 he participated in a comprehensive reorientation of the Ceramic Engineering Department in the University of Texas, phasing out traditional technological aspects in favor of instrumentation for analysis and control, materials beneficiations, and new outlet developments. In 1960 his program became incorporated into the Department of Chemical Engineering as a Materials Science curriculum.

Dr. Weiss substituted for physical vigor a strong will and keen perception. His greatest contributions were in the form of counsel to students and academic and industrial associates. In 1963 he joined the Georgia Kaolin Company in Elizabeth, New Jersey where he remained until continued declining health forced his retirement.

Dr. Weiss was a Fellow in the Mineralogical Society of America and in



*Eriol Joseph Weiss*

the American Ceramic Society. He was a member of the Mineralogical Society (London), the Geological Society of America and the Geochemical Society. For several years he served on the Committee on Clay Minerals of the National Academy of Sciences-National Research Council, and he was active in the formation of its successor, The Clay Minerals Society. He was a member of Tau Beta Pi, Sigma Xi, Phi Lambda Upsilon, and Omega Chi Epsilon.

His many friends deeply regret the foreshortening of his so productive career.

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# MEMORIAL OF PETER ZODAC

**September 14, 1894–January 27, 1967**

NEAL YEDLIN, *New Haven, Conn.*

Peter Zodac, 72, editor and publisher of *Rocks and Minerals*, died suddenly on January 27, 1967, at his home, 157 Wells St., Peekskill, N. Y.

*Peter Zodac*

He was born in Peekskill on September 14, 1894, the son of Alexander and Minnie Bybel Zodac. A product of the local educational system, he participated in football and hockey in and around Peekskill, and became an engineering inspector for the Westchester (N. Y.) Parks Commission, where his interest in collecting minerals developed. In 1926 he conceived the idea of publishing a magazine devoted to mineral collecting and collectors, and in September of that year *Rocks and Minerals* was born. No publication of this type had been in existence since the demise of Chamberlain's *Mineral Collector* in 1909, and it was Zodac's dream to develop and spread the hobby throughout the country.

That he succeeded is manifest by casual statistics. When *Rocks and Minerals* was founded there were but three mineral clubs in the United States—The New York Mineralogical Club, founded in 1886, the Philadelphia Mineral Society, established shortly thereafter, and the Newark (N. J.) Mineral Society, begun just prior to the first publication of Zodac's magazine.

Today there are hundreds of societies (The Eastern Federation alone numbers over 100 member clubs) and hundreds of thousands of collectors, beginners, advanced, professional, all with a matching level of enthusiams for the hobby. Zodac, by his tireless efforts and financial sacrifices (he left his engineering post to devote his full time to his publication) was certainly instrumental in developing this widespread interest.

In 1951, the 25th anniversary of the first publication of *Rocks and Minerals*, Harvard University issued the September-October number as a tribute to Peter Zodac and his work. In a beginning article in this memorial Arthur Montgomery, who, with Clifford Frondel, edited the issue, stated: "This issue is an attempt by . . . those who recognize Mr. Zodac's contributions to mineralogy to show him that his efforts have not been in vain. A number of the leading professional and amateur mineralogists contributed articles to an issue honoring Peter Zodac. These articles largely combine popular interest and scientific substance; . . . they stand as the fulfillment of the dual purpose to which *Rocks and Minerals* was dedicated . . . to promote popular and also educational mineralogy." The list of contributors to this issue reads like a "Who's Who" in the field. It includes Hugh Ford, Arthur Montgomery, Henry S. Canby, Charles Palache, Charles G. Toothaker, Richard V. Gaines, Clifford Frondel, Lloyd W. Fisher, A. Pabst, C. D. Woodhouse, M. Vonsen, George Switzer, Samuel G. Gordon, Mark C. Bandy, David Seaman, Arthur J. Boucot, Elmer S. Rowley, Gunnar Bjareby, E. William Heinrich, F. H. Pough, and Pauline and Louis Moyd. So profuse were the contributions that the limitations of space resulted in many being omitted from the publication.

In 1953 the Mineralogical Society of America elected Peter Zodac a Fellow, an honor not given to many outside the ranks of the professional.

It is customary to tabulate the works of those whose memorial is being written. In the case of Peter Zodac the list is imposing. Aside from a beginner's pamphlet, "*How To Collect Minerals*," *Rocks and Minerals*, from the date of the first issue, Vol. 1, No. 1, to the time of his death, Vol. 42, No. 1, had been published 328 times. So great has been Zodac's influence that it goes on as a continuing memorial.