

stature to organizations designed to elevate standards of mineralogical knowledge and training among jewelers. He became president of the Gemological Institute of America in 1945 and in 1954 was designated an "Honorary Certified Gemologist" by the American Gemological Society.

To the published record Kraus contributed nearly 100 papers and co-authored five books, three of which went into extra editions. One of them, *Gems and Gem Materials*, persists as a standard reference work.

Most of Kraus' scientific contributions were in descriptive mineralogy, but his catholic interests also resulted in papers in the fields of crystallography, geology, chemical mineralogy, gemology, mineralogical apparatus, and the history of mineralogy. His diverse deanships also resulted in publications in education, dentistry, ceramics, pharmacy, and Michigan history. Between 1910 and 1957 he generated some 80 book reviews and for 14 years (1943–1957) prepared the annual review of mineralogy for the Britannica Book of the Year.

Dean Kraus held membership in nearly three dozen professional and honorary societies, half of which he served either as president, chairman, petitioner, charter member, or honorary fellow.

Among those in earth sciences were the A.I.M.E. and the Geological Society of America, of which he became a Fellow in 1902.

To this immense, seemingly endless investment of professional energy there accrued a high return of polygenetic interest. Seven honorary degrees and titles graced him. In 1945 he was Russel Lecturer for The University of Michigan, the same year that he was awarded the Roebing Medal. In 1954 he delivered the Orton Lecture to the American Ceramic Society. His renown was inscribed in eight major biographical compendia, continuously in *American Men of Science* from its first edition in 1906.

With his passing, it is entirely fitting that the Fellowship and Membership of the Mineralogical Society of America pause momentarily in silent tribute. Much of what we are and will be descends directly from his efforts on our behalf.

Bibliography

For a selected bibliography of Edward H. Kraus, which includes all of his significant contributions in mineralogy and allied fields, consult *The American Mineralogist*, **46**, 948–951 (1955).

American Mineralogist, Volume 59, pages 404–408, 1974

Memorial of William Frank Bradley January 29, 1908—January 16, 1973

HUGO STEINFINK

University of Texas at Austin

RICHARDS A. ROWLAND

Houston, Texas

William Frank Bradley was born at Quincy, Illinois, January 29, 1908, the son of William C. and Nonae Frank Bradley. After attending public schools in Quincy, where he was a scholar and an athlete, he entered the University of Illinois in 1925. In 1930 he earned the B.A. degree in geology, and in 1935

the Ph.D. in chemistry, both from the University of Illinois. His doctoral thesis, done under the direction of Professor G. L. Clark, was entitled: *X-Ray Diffraction Studies of Some Clay Colloids*.

He joined the Illinois State Geological Survey as Assistant Chemist (1934–39), rose to Associate



Chemist (1939–43), to Chemist (1943–46), and finally to Chemist and Head of the X-ray Division (1946–61). These years were tremendously productive. His papers on the identification techniques for clay minerals are classics and made clay mineralogy into a quantitative science. His mind had the rare ability to think in three dimensions. The crystal structure of the complex silicate mineral palygorskite, deduced from powder X-ray diffraction data, is an unparalleled example of the derivation of such a difficult structure from this type of data. He was among the first to make a systematic investigation of the thermal behavior of clays and advanced the concept that the crystallographic orientation of the high temperature phases retained a structural relationship to the clay mineral precursor. His publications on clay-organic complexes laid the foundation for a new technology of high temperature grease, oil based drilling muds, and thixotropic paint formulations. Had he followed up on the commercialization of these scientific discoveries, as others eventually did, he would have become a very wealthy man. He was a consultant for the Shell Oil Company for many years, where his expertise in clay mineralogy contributed greatly to the research effort in progress

at the Exploration and Production Research Laboratory in Houston, Texas.

When the University of Texas at Austin considered the initiation of a Materials Science program, Professor E. J. Weiss of the Department of Chemical Engineering asked him to be a Visiting Professor during the Spring of 1959. In September 1961 he resigned from the Illinois Survey to take a position as Professor of Chemical Engineering at the University of Texas at Austin, where he remained until his death. His move to the University was sufficiently newsworthy that *Time* magazine commented on it in its Education section. He continued to serve the Illinois State Geological Survey as a Research Consultant and held summer appointments at the Survey during these years.

He bore his mantle of scientific eminence with modesty and was elected to the highest offices of his societies in recognition of his achievements. No clay mineralogist visiting this country considered his visit complete until he spent a day with Bill.

But not only the well known approached him. Young scientists on the threshold of their careers sent him papers and dissertations of their work for his evaluation. There are dozens of Ph.D.'s, from universities in this country and abroad, who benefited from his advice. His office frequently was filled with students who, in effect, received private instruction from him. He gave of his time unstintingly to further their academic development, and was as generous with his personal resources when, as it did happen occasionally, a student needed help of a personal nature.

Dr. Bradley's death occurred in Gainesville, Florida, on January 16, 1973, as the result of an automobile accident. He was buried January 21 at the Mt. Hope Mausoleum on the Urbana campus, across the street from the building where his scientific career had spanned nearly three decades.

His scientific endeavors at the University of Texas at Austin spanned 12 years, enhanced by his teaching of and interaction with undergraduates, graduates, and colleagues. Those of us who knew him either as a colleague or teacher will be deprived of lucid and penetrating discussions of scientific problems. Those who became his friends will in addition miss the incomparable Bill or Brad or Frank, as he was variously addressed by us, for his uncompromising honesty and down to earth philosophy of life that subtly exerted influence on those who had close contact with him.

Professor Bradley married Ruth Campbell in 1935 at Nashville, Illinois. He is survived by his wife; by a son, William C. Bradley, an electrical engineer residing in Massachusetts; by a daughter, Mary Bradley Nabors of Irving, Texas; by four grandchildren; and by a brother, Robert, and his mother, both of Temple City, California.

During his career Dr. Bradley was author or co-author of approximately seventy technical papers, most of which pertained to the structure of clay minerals and related problems. In recognition of his eminence, the accolade "Distinguished Member" was to have been conferred on him at the meeting of The Clay Minerals Society, in Banff, Canada, October 1973. The honor will be bestowed posthumously. The Society will also publish a Bradley Memorial issue, No. 1 of Volume 22 of *Clays and Clay Minerals*. He served as referee for innumerable papers and was an abstractor for *Chemical Abstracts* for more than thirty years. He was a member of many technical societies and served on many scientific committees including:

Association Internationale pour l'Etude des Argiles; Secretary, 1952–1956; President, 1972–
American Chemical Society.

Fellow, Mineralogical Society of America; Councilor, 1963–1965; Vice-President, 1969; President, 1970.

American Crystallographic Society.

Fellow, Geological Society of America.

Clay Minerals Society; Editor, 1962–1965; Vice-President, 1972; President, 1973.

American Society of Agronomy.

American Geophysical Union.

Society of Economic Paleontologists and Mineralogists.

Geochemical Society.

Mineralogical Society of Great Britain and Ireland.

ASTM Joint Committee for Chemical Analyses by X-Ray and Electron Diffraction.

Board of Editors of *The American Mineralogist*.

Associate Editor, *Proceedings of the Clay Minerals Conference*, 1956–

Co-editor, *Transactions of the American Crystallographic Association*, Vol. 2, 1966.

Publications of William Frank Bradley¹

1936 (with R. E. Grim, and R. H. Bray) The constitution

¹ Publications identified with a * have been republished in the *Illinois State Geological Survey Report of Investigations Series*.

of bond clays and its influence on bonding properties. *Am. Foundrymen's Ass. Trans.* **7**, 211–228.

1937 (with G. L. Clark, and R. E. Grim) Notes on the identification of minerals in clays by x-ray diffraction. *Z. Kristallogr. Mineral.* **96**, 322–324.

(with R. E. Grim, and G. L. Clark) The study of the behavior of montmorillonite upon wetting. *Z. Kristallogr. Mineral.* **97**, 216–222.

*(with R. E. Grim, and R. H. Bray) The mica in argillaceous sediments. *Am. Mineral.* **22**, 813–829.

(with R. E. Grim, and J. E. Lamar) The clay minerals in Illinois limestone and dolomite. *J. Geol.* **45**, 829–843.

The place of X-ray diffraction in clay mineralogy. *Ill. Acad. Sci. Trans.* **30**, 165–166.

*1939 Some concepts of the relationship between the chemical compositions and structures of clay minerals. *Ill. Acad. Sci. Trans.* **1938**, **31**, 130–131.

*(with R. E. Grim) A unique clay from the Goose Lake, Illinois area. *Am. Ceram. Soc. J.* **22**, 157–164.

1940 (with G. L. Clark, and V. J. Azbe) Problems in lime burning—a new x-ray approach. *Ind. Eng. Chem.* **32**, 976.

*(with R. E. Grim) Investigation of the effect of heat on the clay minerals illite and montmorillonite. *Am. Ceram. Soc. J.* **23**, 242–248.

The structural scheme of attapulgite. *Am. Mineral.* **25**, 405–410.

*1945 Molecular associations between montmorillonite and some polyfunctional organic liquids. *J. Am. Chem. Soc.* **67**, 975–981.

*Diagnostic criteria for clay minerals. *Am. Mineral.* **30**, 704–713.

(with R. E. Grim, and J. S. Machin) Amenability of various types of clay minerals to alumina extraction by the lime sinter and lime-soda processes. *Ill. State Geol. Surv. Bull.* **69**, 77 pp.

1946 (with R. E. Grim) High temperature thermal effects of clays and related minerals. *Am. Mineral.* **31**, 195.

1948 (with R. E. Grim) The illite clay minerals (abstr.). *18th Int. Geol. Congr.* London, Volume of titles and abstracts, pp. 127–128.

*(with R. E. Grim) Rehydration and dehydration of the clay minerals. *Am. Mineral.* **33**, 50–59.

(with J. E. Comeforo, and R. B. Fischer) Mullitization of kaolinite. *Am. Ceram. Soc. J.* **31**, 254–259.

*(with R. E. Grim) Colloid properties of layer silicates. *Phys. Colloid Chem. J.* **52**, 1404–1413.

1949 (with R. E. Grim, and R. S. Dietz) Clay mineral composition of some sediments from the Pacific Ocean off the California coast and the Gulf of California. *Geol. Soc. Am. Bull.* **60**, 1785–1808.

1950 The alternating layer sequence of rectorite. *Am. Mineral.* **35**, 590–595.

Interstratified growths in clays and clay-like minerals. *Int. Congr. Soil Sci. Trans.* **1**, 101–105, 425–427.

1951 (with R. E. Grim, and G. Brown) The mica clay minerals. Chap. 5 of G. W. Brindley, Ed., *X-ray Identification and Crystal Structures of Clay Minerals*, pp. 138–172. Illus.

*(with R. E. Grim) High temperature thermal effects of clay and related materials. *Am. Mineral.* **36**, 182–201.

- 1952 (with R. E. Grim) The illite clay minerals (abstr.) *Int. Geol. Congr., 18th, Great Britain, Rep.*, pt. 13, 302, London.
- Analysis of mixed-layer clay mineral structure. *Anal. Chem.* **25**, 727-730.
- *1953 (with J. F. Burst, and D. L. Graf) Crystal chemistry and differential thermal effects of dolomite. *Am. Mineral.* **38**, 207-217.
- *1954 X-ray diffraction criteria for the characterization of chloritic material in sediments. *2nd Nat. Conf. Clays Clay Minerals Proc., NAS-NRC Publ.* **327**, 324-334.
- *(with W. D. Johns, Jr., and R. E. Grim) Quantitative estimations of clay minerals by diffraction methods. *J. Sediment. Petrol.* **24**, 242-251.
- (with B. Nagy) The structural scheme of sepiolite. *Acta Crystallogr.* **7**, 683.
- *1955 Structural irregularities in hydrous magnesium silicates. *3rd Nat. Conf. Clays Clay Minerals Proc., NAS-NRC Publ.* **395**, 95-102.
- *(with R. E. Grim) Structural implications in diagenesis. *Geol. Rundschau*, **43**, 469-474.
- *(with B. Nagy) The structural scheme of sepiolite. *Am. Mineral.* **40**, 885-892.
- *1956 (with C. E. Weaver) A regularly interstratified chlorite-vermiculite clay mineral. *Am. Mineral.* **41**, 497-504.
- *(with R. A. Rowland, and E. J. Weiss) Dehydration of monoionic montmorillonites. *4th Nat. Conf. Clays Clay Minerals Proc., NAS-NRC Publ.* **456**, 85-95.
- *The green compression strength of natural bentonites. *4th Nat. Conf. Clays Clay Minerals Proc., NAS-NRC Publ.* **456**, 41-44.
- 1957 (with R. E. Grim, and W. A. White) Petrology of the Paleozoic shales of Illinois. *Ill. State Geol. Surv. Rep. Invest.* **203**, 35.
- *1958 (with J. M. Serratosa) Infrared absorption of OH bonds in micas. *Nature*, **181**, 111.
- *(with J. M. Serratosa) Determination of the orientation of OH bond axes in layer silicates by infrared absorption. *J. Phys. Chem.* **62**, 1164-1167.
- *(with R. A. Rowland, E. J. Weiss, and C. E. Weaver) Temperature stabilities of montmorillonite- and vermiculite-glycol complexes. *5th Nat. Conf. Clays Clay Minerals Proc., NAS-NRC Publ.* **566**, 348-355.
- *1959 Current progress in silicate structures. *6th Nat. Conf. Clays Clay Minerals Proc., Int. Ser. Mon. Earth Sci.* **2**, 18-25.
- *Density of water sorbed on montmorillonite. *Nature*, **183**, 1614-1615.
- *1960 (with J. M. Serratosa) A discussion of the water content of vermiculite. *7th Nat. Conf. Clays Clay Minerals Proc., Int. Ser. Mon. Earth Sci.* 260-270.
- *(with R. E. Grim, and J. B. Droste) A mixed-layer clay mineral associated with an evaporite. *8th Nat. Conf. Clays Clay Minerals Proc.* 228-236.
- *(with P. W. Hughes, and H. D. Glass) Mineralogical analysis of carbonate rocks by X-ray diffraction. *J. Sediment. Petrol.* **30**, 619-622.
- 1961 Diagenesis in sediments. *Anal. Edafol. Agrobiol. (Madrid)*, **20**, 99-105.
- (with R. E. Grim) Mica clay minerals. Chap. 5 in *The X-ray Identification and Crystal Structures of Clay Minerals*, 2nd ed. London, Mineralogical Society, pp. 208-241, illus., tables.
- *1962 (with D. L. Graf) The crystal structure of huntite, $Mg_3Ca(CO_3)_4$. *Acta Crystallogr.* **15**, 238-242.
- *(with D. L. Deadmore) The crystal structure of K_3SiF_7 . *Acta Crystallogr.* **15**, 186-189.
- X-ray diffraction analysis of soil clays and structures of clay minerals. *Soil Clay Mineral., Symp.*, Virginia Polytechnic Inst., C. I. Rich and W. G. Kunze, Eds. Univ. N. S. Press, pp. 113-124.
- 1963 Heterogeneous equilibria in sediment under transport. *U.S.A. Energy Comm.* TID-7664, 61-67; discussion, 68-70.
- (with E. J. Weiss, and R. A. Rowland) A glycol-sodium vermiculite complex. *Clays, Clay Minerals*, **10**, 117-122.
- 1964 (with G. W. Kunze) Occurrence of a tabular halloysite in a Texas soil. *Clays, Clay Minerals, Proc. 12th Nat. Conf. Clays Clay Minerals*, pp. 523-527.
- (with R. E. Grim) Clay mineral composition and properties of deep residual soils from Sao Paulo, Brazil. *Proc. II Congr. Panamer. Mech. Solos e Eugenharia de Fundades, Sao Paulo, Brazil*, pp. 63-72.
- 1965 (with Rong Wang, and H. Steinfink) The crystal structure of alunite. *Acta Crystallogr.* **18**, 249-252.
- 1966 (with R. Wang, and H. Steinfink) The crystal structure of lanthanum telluride and tellurium-deficient neodymium telluride. *Inorg. Chem.* **5**, 142-145.
- (with C. T. Deeds, and H. van Olphen) Intersalation and interlayer hydration of minerals of the kaolinite group. In *Int. Clay Conf., Jerusalem Proc. 1*; Jerusalem, Israel Program Sci. Trans., pp. 295-296.
- (with D. L. Graf, and R. S. Roth) The vaterite-type ABO_3 rare earth borates. *Acta Crystallogr.* **20**, 283-287.
- (with W. L. Cox, and H. Steinfink) The structure refinement of La_2Te_3 , a Th_3P_4 -type structure. *Inorg. Chem.* **5**, 318-319.
- (with S. W. Bailey, editors) *Clay and Clay Minerals*. Pergamon, 453 pp. (reviewed in *Nature*, **212**, 1019).
- 1967 (with C. T. Deeds, and H. van Olphen) Intersalation and interlayer hydration of minerals of the kaolinite group. In *Int. Clay Conf., Jerusalem, Israel, June, 1966, Proc. 2*; Jerusalem, Israel Program Sci. Transl., pp. 183-199.
- (with K. M. Towe) Mineralogical constitution of "hydrous ferric oxides." *J. Colloid Interface Sci.* **24**, 384-392.
- (with K. Susa, and H. Steinfink) Crystal structure of a pyridine-vermiculite complex. *Clay Mineral.* **7**, 145-154.
- 1968 Memorial of Eriol Joseph Weiss (March 18, 1918-June 14, 1967): *Am. Mineral.* **53**, 617-619, portrait.
- Trends in mineralogical analyses. *SSSA (Soil Sci. Soc. Am.) Spec. Publ.* **3**, 91-106.
- 1969 Structures and chemical properties of clay minerals. *Trav. Com. Int. Etude Bauxites, Oxydes, Hydroxydes Alum No. 6*, 75-86.
- 1970 (with G. V. Henderson) Rectorite and the rectorite-like layer structures. *Clays Clay Mineral.* **1870**, **18**, 115-119.
- Layered silicate crystallochemistry. *Probl. Petrol. Genet. Mineral.* **2**, 152-156.

Diskussionnye aspekty kristalokhimii sloistyxh silikatov (Discussional aspects of the crystallochemistry of layered silicates) (with English abstr.). In, *Problemy petrologii i geneticheskoy mineralogii*, 2: Moscow, Akad. Nauk SSSR Sibir. Otdeleniye (Izdatel'stvo "Nauka"), pp. 152-155.

1971 Low-key crystallography. *Am. Mineral.* **56**, 375-386.

1972 (with L. S. Land, and E. Mutis) Crystallochemical and geochemical comparisons of recent and older dolomites. *7th Forum on Geology of Industrial Minerals, Florida Bur. Geol., Spec. Publ.* **17**.

American Mineralogist, Volume 59, pages 408-411, 1974

Memorial of Sir (William) Lawrence Bragg March 31, 1890—July 1, 1971

PETER GAY

*Department of Mineralogy and Petrology,
University of Cambridge, England*



Of very few men can it be said that they played the major part in founding a new branch of science, but since Sir Lawrence Bragg achieved this distinc-

tion at the outset of his career he had the unique satisfaction of witnessing the impact of X-ray analysis upon the studies of matter from the simplest ionic compounds and metals through the increasing complexities of minerals to the immense molecules of the living cell. Not that he was a bystander only, for his scientific curiosity led him to make major contributions in most of these fields. He recognized the importance of a personal involvement in the development of ideas and wrote that ". . . science is unlike the arts, where the value of original thought is often enhanced by time. Science is like a coral reef, alive only on the growing surface." This philosophy stimulated him throughout his life.

Bragg was born in Adelaide, South Australia, five years before Röntgen discovered X-rays, and was reading physics at Cambridge when the diffraction of X-rays by zincblende was first demonstrated in Germany early in 1912. He heard about these experiments from his father Sir William Bragg, then Professor of Physics at Leeds, during the summer of that year, and immediately began to re-interpret the patterns so as to eliminate some of the apparent discrepancies in von Laue's original approach through three-dimensional scattering. Within a very short time he told the Cambridge Philosophical Society how the diffraction effects could be completely and simply explained in terms of "reflexions" from successive atomic planes in the structure and he re-