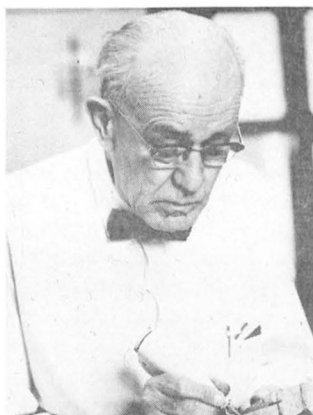


Memorial to Ernst Cloos

1898-1974

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On May 28, 1974, Ernst Cloos, Professor Emeritus of Johns Hopkins University, died in his 77th year. He was a remarkable man whose penetrating investigations of the structure of the Earth's crust were as unique as his extraordinary personality.

Ernst Cloos was born on May 17, 1898, in Saarbrücken, Germany. The family moved to Cologne where his father, an official of the German railroad, died when Ernst was about six years old. Because his older brother Hans was then a student at the University of Freiburg (in Breisgau), the family moved to a place in the Black Forest near Freiburg. Ernst was sent to several boarding schools for boys, but he proved to be an indifferent scholar. At age 17 he was caught up in World War I and became a pilot of an

observation plane in the German army. He was shot down while on patrol and his observer was killed, but he managed to maneuver his crippled aircraft to a safe landing over the border in neutral Switzerland where he was promptly interned, given a square meal, and permitted to continue his schooling.

At the end of the war and after his release from internment, he entered the University of Freiburg where he began preparation for a career in biology. There ensued a tussle for his soul between Professor Spemann, the well-known professor of biology at Freiburg, and Ernst's brother Hans, then professor of geology at Breslau (now Wrocław). In the end Ernst exchanged his dissecting needles for a knapsack and hammer and sallied forth to study the crystalline rocks of the Black Forest. He left Freiburg and went to Breslau to study geology. Not only did Professor Spemann lose a pupil, but he also lost a daughter, because Ernst married his daughter in 1923 and eventually carried her off to America.

Among his fellow students at Breslau were Robert Balk and H. B. Stenzel, both of whom were also destined to come to America. Robert and Ernst became close lifelong friends. Both left Breslau for a time to study under Hans Stille at Göttingen, but in the end they returned to receive their doctoral degrees from Breslau in 1923. Both wrote dissertations on the fabric of the crystalline rocks of the Bohemian massif. S. von Bubnoff and Hans Cloos, geologists, and von Frisch, of bee fame, were Ernst's examiners.

Upon receipt of his doctorate, he was offered a job as Stille's assistant at Göttingen. A telegram on the eve of his wedding informed him that the offer was cancelled. Although Ernst salvaged a job cataloging fossils, he left shortly to work for Seismos G.m.b.H. of Hannover — a geophysical company then being founded by Lutger Mintrop and destined to make exploration history in both Texas and the Middle East. When geophysical work was introduced to the Gulf Coast of Texas, the oil industry in that area was in the doldrums. Salt domes, which were so productive, were difficult to find. Of some 675

wildcat wells drilled in search of salt domes, only one was a success (Rosaire, *Geophysics*, 1938, v. 3, p. 31). The seismic method, then viewed with skepticism by "practical" oil men, proved to be the key to finding these structures. Ernst Cloos was a member of the first Seismos field party to Texas (under contract to the Gulf Oil Company), which revolutionized oil exploration. The work was done under less than ideal conditions. Mintrop was a hard taskmaster; the crew worked late hours, had one Sunday per month off, and there were no coffee breaks. In the beginning the company ran low on funds and paychecks were held up. The dynamite explosions set off here and there were a disconcerting novelty to both the Texans and their cattle. Travel was often difficult, because the pavement ended at the city limits of Houston, and the roads of the countryside were a mire in wet weather and a dust bin in dry. This was the era of the Model-T Ford; they had just removed the hitching posts at the Rice Hotel. It was a time when the "Old West" had not quite disappeared, when spittoons still graced hotel lobbies, when the ten-gallon hat was commonplace, and Prohibition was the law of the land. Such was the life to which Ernst Cloos and his family came in the early twenties.

After a sojourn in Texas, Ernst was sent to the roadless, mosquito- and snake-infested swamps of Louisiana. Two years later the geophysical crew went to the Middle East and Ernst's family returned to Germany. For one fall and winter his camp moved among the ruins of Mesopotamia until the heat of summer drove all white workers out of the desert.

In 1930 Ernst returned to the United States — this time as a free agent supported by a research grant from the *Notgemeinschaft der Deutschen Wissenschaft* — to study the granite of the Sierra Nevada in California. For two summers he traveled back and forth between the gnat swarms of the high Sierras and the tourist swarms of Yosemite Valley. He ranged from the foothills bordering the lemon groves of the San Joaquin Valley to the summit of Mount Lyell. This study, akin to his own doctoral studies in the Bohemian massif, was an application of the techniques of Hans Cloos who had founded the German school of granite tectonics. It was the first study of its kind in America. Although the principal results appeared in the German literature, a significant report with map was contained in Guidebook 16 of the XVI International Geological Congress, published in 1933.

The California episode was a turning point in Ernst's career and a most fortunate one for us, because it was on his return to Germany in 1931, after completion of his Sierra project, that he drove into Baltimore and stopped long enough to be offered and to accept a lectureship at Johns Hopkins University. Ernst was given a desk in the office of E. B. Mathews, then head of the department. He had to endure Eddie Mathews' cigars, had no real space of his own, and was given but a small salary and little or no other financial support from the university. Cloos came to Hopkins "to teach a course in structural geology"; he stayed a lifetime. In 1937 he was made associate professor and was promoted to full professor in 1941, a rank he held until his "retirement" in 1968 when he became professor emeritus.

Ernst fell to work immediately on the crystalline rocks of the Piedmont and Blue Ridge. The famous "Volume Thirteen" of the Maryland Geological Survey appeared in 1937, the first part of which was a statement of the principles of microtectonics and the newer methods of looking at the metamorphic and crystalline rocks — an approach new to the American scene. Included in this volume were substantial papers by four of Cloos's students: Garland Hershey, Carl Broedal, John Marshall, and Charles Cohen. Thus began a long and fruitful career of teaching and research at Hopkins — a career that was to revitalize the study of the crystalline rocks of the central Appalachians. Out of this study came a flood of papers by Cloos and his students. One of the most famous perhaps was the study on the "Martic overthrust" and the Glenarm series of Maryland

and Pennsylvania published (with Anna Hietanen) as Geological Society of America Special Paper 35 in 1941. This monograph went far toward building a solid foundation for understanding the fundamental problems of the Appalachian geosyncline. It was a "quantum jump" ahead of earlier work and set a standard not yet surpassed.

Ernst reveled in field work and his enthusiasm for it was contagious. The many doctoral candidates under his direction were likewise imbued with a love for field studies. His published papers show, however, that he was also a good microscopist and skilled at making sketches. Few contemporary geologists can match his ability to sketch either thin sections or mountinside.

Ernst's penchant for detail was enormous. His maps and those of his students are peppered with symbols recording measurements of bedding, cleavage, and various lineations. He deplored the lack of structure symbols on contemporary geologic maps. In fact, he led a not wholly successful one-man crusade to convince the profession that a map with few or no structural symbols was an incomplete and unsatisfactory map.

Ernst's teaching was unique. He very much disliked lecturing; he felt the best place to teach geology was in the field, and he was ready to lead a field trip on the drop of a hat. His course on structural geology was scheduled for the field — all day Saturday every Saturday. This course made an indelible imprint on all who took it. During inclement weather his students wrote field reports, drew cross sections, or plotted fabric diagrams on the Schmidt net, a device they all came to know well.

With the advent of World War II, field work was curtailed and teaching altered to conform to the war situation. Ernst taught meteorology to the army personnel then in training on the Hopkins campus — a subject that he mastered one day ahead of his students. To fill in his free time and retain his geological interests, he compiled his memoir on lineation (Geological Society of America Memoir 18, 1946). He brought together the literature on the subject and directed attention to this hitherto largely neglected character of rocks, especially of the crystalline rocks. With the return to normalcy after the war, his paper on South Mountain appeared. This, perhaps his best-known work, was published in the *Bulletin* of the Geological Society of America in 1947. The oolites ("ooids" of Cloos) in the limestone involved in the South Mountain anticline provided an unsurpassed means for measurement of strain and analysis of rock deformation. Demand for this paper was so great that Ernst had it reprinted at his own expense. He conducted numerous geologists, who came to Baltimore from many places here and abroad, over the outcrops of the South Mountain structure, which by now had become a classic locality. It was this study, perhaps as much as anything, that led to his election to the National Academy of Science in 1950.

It was to the South Mountain structure that Ernst turned again following his retirement. His study of deformed oolites was extended into Virginia. The results were published by the Johns Hopkins Press as a beautifully illustrated book entitled *Microtectonics*, dedicated to Robert Balk, his classmate at Breslau and lifelong friend.

Cloos's earlier work in the central Appalachians was accomplished in large part because of the close working relations between the Maryland Geological Survey and the Department of Geology at Hopkins. The head of the department was also director of the survey, and the departmental faculty was employed by the survey during the summer recess of the university. Other publications that grew out of this symbiosis were the survey reports and maps of Washington County (1951) and of Howard and Montgomery Counties (with C. E. Hopson in 1964).

Ernst Cloos's association with the survey continued until his death. In 1952, when he became chairman of the department, he declined to assume the post of director of the survey as both jobs had become too demanding. In 1962, however, he accepted an

appointment by Governor Tawes as chairman of the State Commission for the Maryland Geological Survey. He became acting director of the survey itself in 1962 and 1963 upon the death of J. T. Singewald, Jr. Ernst presided over the commission in a period of rapid transition. He was involved in the selection of a new director and setting the course for the survey for the next decade.

In 1952 Detlev Bronk, then president of Johns Hopkins University, asked Ernst to become chairman of the Department of Geology following the retirement of J. T. Singewald, Jr. Ernst accepted the job and began at once to rebuild the department. Although the small department had a long and distinguished record, it was in need of revitalization, and Ernst Cloos was just the man for the job. He persuaded Aaron Waters of Stanford University and F. J. Pettijohn of the University of Chicago to join the faculty. Within a short time Hans Eugster of the Geophysical Laboratory also came to Hopkins. The department once more became one of the dozen top centers of graduate study in geology in the United States. Four of its faculty of eight were, or became, members of the National Academy of Sciences. This accomplishment is indeed a most fitting tribute to Ernst's vision, energy, and persuasive powers. Although Ernst retired as chairman in 1963, he continued his participation in teaching for another five years.

Even following his full retirement at age 70, Cloos still came regularly to his office (often before anyone else), taught an elementary course on a voluntary basis without pay for a couple of years, participated in departmental deliberations, and conducted field trips right up to the day of his final illness.

Ernst Cloos was much involved in university affairs. He was repeatedly elected to the Academic Council of the university — the highest academic body primarily responsible for appointments and promotions. His influence here was critical, as his insistence on the highest standards, which often encountered the displeasure of his less critical colleagues, was of the greatest service to the university, because for only by such standards can the faculty and the university be upgraded. In the end he commanded the respect of all. Hopkins recognized his contributions to science and his service to the university by awarding him an honorary Doctor of Laws degree at its convocation in the spring of 1973.

Ernst also became active in off-campus affairs, especially in the geological profession at large. He was recognized as a scientist of the highest caliber and was called on for various tasks in the service of his profession. He was elected Fellow of the Geological Society of America in 1932, served as councillor from 1947 to 1949, was elected vice president in 1953 and president in 1954. He was asked by Detlev Bronk, then president of the National Academy of Science, to be the chairman of the Division of Geology and Geography of the National Research Council. He held this post from 1950 to 1953.

Ernst Cloos lived in no ivory tower. He not only preferred the field to the classroom, but he often applied his geology to practical matters. Beginning with his years as geophysicist with Seismos, he continued, during his tenure at Johns Hopkins, to serve as consultant to private firms. He was retained by the Thomasville Stone and Lime Company, and about once a week he went to Thomasville (Pennsylvania) for the company to plan and monitor their exploration and operations. He mapped their property and was largely responsible for their decision to mine as well as quarry limestone. The large underground mining of limestone attracted a good deal of attention from the industry. Cloos conducted several field trips to this operation for geologists. So large and extensive was the mining that the field excursion was carried underground in a Greyhound bus!

Cloos was also a consultant for Esso Production Research in Houston, Texas. He went

once or twice a year for a week at a time to participate in their training seminar on structural geology. His contribution was to set up a series of model experiments using soft clay to illustrate fracture patterns, grabens, and the like.

Ernst Cloos became well known for his scale-model experiments. He followed the procedure inaugurated by his brother. As noted by M. King Hubbert, most early work with models was faulty because they were incorrectly scaled; only those of Hans Cloos utilizing soft wet clay approached correct scaling. Not only were Ernst Cloos's students introduced to the subject but so also were many visiting geologists as well as those in the Esso Laboratories in Houston. It was his ingenious use of such experiments that led to Ernst's concept of deformation in the Gulf Coast province — a line of investigation that culminated in a paper in the *Bulletin* of the American Association of Petroleum Geologists that won for him the President's Award, which was given to him at the Calgary meeting of the association in 1970. The whole subject was reviewed in Cloos's presidential address to the Geological Society of America, which was published in the *Bulletin* in 1955.

The influence of Ernst Cloos on American geology was considerable. He believed that a very careful and detailed study of a small region furnishes results more useful to others than the most brilliant generalizations based on insecure facts. Ernst Cloos never wavered from this principle; his own work bears this out. His keen observations in the field — the distinction between bedding and cleavage so commonly missed — upset previous concepts of structure and stratigraphy at such places as Harpers Ferry and Sugarloaf Mountain. Cloos and his students contributed much to our understanding of the geology of the central Appalachians, especially the Blue Ridge and adjacent Piedmont. It was particularly fitting, therefore, that an Appalachian volume, a Festschrift, was dedicated to Ernst Cloos. This book with its 33 contributors, published in 1970, is a measure of the renewed interest in Appalachian studies, a renewal sparked by Ernst Cloos himself.

How may we sum up the life of this remarkable man? His career spanned an extraordinary period in history: three-quarters of a century of change, from the Model-T to jet airplane, from the polarizing microscope to the microprobe and mass spectrometer, from the concept of a rigid earth with fixed continents to the theory of plate tectonics. He was a part of this change and also apart from it. He was a part in that he partook of the first application of seismic methods to oil exploration; he was apart in that his own research was basically "watching and wondering," to use the expression of 1973 Nobelist Nikolaas Tinbergen (*Science*, July 1974). He demonstrated unequivocally that meaningful and significant observations can be made in the field — a truth that seems to have been forgotten by some avant garde researchers. Ernst Cloos never lost his perspective. Although he appreciated the new tools and techniques and was responsible for modernizing the laboratories at Hopkins, he never forgot that these were only tools to observe more closely. The x-ray diffractometer is, after all, an expensive hand lens. Moreover, the significance of an object does not necessarily increase with its diminution in size. The important thing is the question; how the data are collected is secondary.

Ernst Cloos's decision to come to America was in part accident and in part a desire to stand on his own feet — to establish himself and to be no longer introduced as the brother of the famous Hans Cloos. Although his interest in clay-model experiments and in microtectonics is traceable to his brother's influence, there is no question about the place Ernst Cloos carved for himself in the New World to which he came.

Many honors came to him in his later years. In addition to his election to the National Academy in 1950, he was elected a member of the American Philosophical Society in 1954, was made a foreign member of the Finnish Academy of Science and Letters, a

corresponding member of the Geological Society of Finland, was awarded the Gustav Steinmann Medal of the Geologischen Vereinigung in 1968, and as noted, granted an honorary degree by the Johns Hopkins University in 1973. He represented the university at the 500th anniversary of the University of Basel in 1960 and at the 100th anniversary of the National Academy of Sciences in 1963.

He was a distinguished lecturer of the American Association of Petroleum Geologists in 1942, served on various ad hoc committees of both the Geological Society of America and the National Academy of Sciences. He was awarded a Guggenheim Fellowship in 1956-1957.

He was a member of the American Geophysical Union, the Geological Society of Washington, the American Association for the Advancement of Science, the National Association of Geology Teachers, the Geologists Association, the Geological Society of London, the Geological Association of Canada, the German Geological Society (Geologische Vereinigung), Society of Sigma Xi, Phi Beta Kappa, and the German Society of Maryland.

There is no more appropriate tribute to conclude this memorial than that of Professor O. M. Phillips, chairman of the Department of Earth and Planetary Sciences at Johns Hopkins: "It will not be the same without him. His perception, his vast experience, his wisdom, his warmth, kindness and unfailing courtesy brought the respect and affection of generations of students and colleagues. To be with him in the field was an experience not forgotten. To have him in a Journal Club audience was perhaps slightly intimidating for the speaker, but always rewarding. To ask his advice on a tough problem was to have the problem illuminated and sharpened, so that the way ahead became clear. In my life I have known but few great men, a very few, and he was certainly one of them. We will miss him more than we know. No, it will not be the same place without him, but it will long be a vastly better place for his having been here, and for this we are grateful."

He is survived by his wife, Margret Cloos, and two daughters, Gisela (Mrs. W. R. Evitt) of Palo Alto, California, and Veronica (Mrs. F. C. Evinger) of Burlington, Vermont.

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