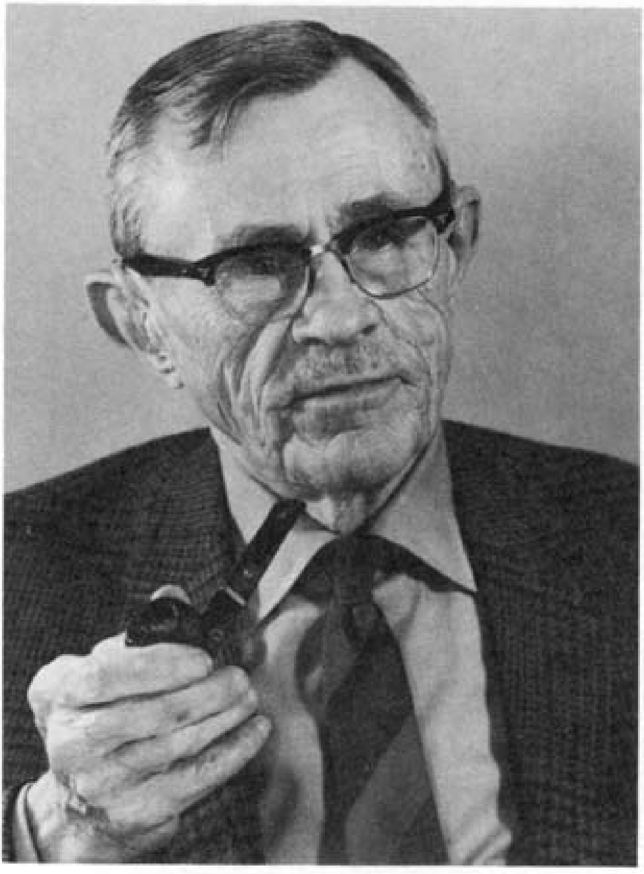
NATIONAL ACADEMY OF SCIENCES

PERRY BYERLY

1897—1978

A Biographical Memoir by
JOHN VERHOOGEN



Perry Byerly

PERRY BYERLY

May 28, 1897–September 26, 1978

BY JOHN VERHOOGEN

PERRY BYERLY was born on May 28, 1897, in Clarinda, Iowa, the only child of Perry Byerly and Pauline Watson Byerly. His health as a child was poor, and on advice of the doctors the family moved to California in 1905. Because of frequent moves, Perry attended a total of sixteen schools before graduating from Redlands High School in 1916. He was an avid reader, particularly of poetry; years later he could still recite Kipling by the yard. High school teachers soon recognized his unusual ability and encouraged him to attend college, which was not in the family tradition, although his mother had wanted him to become a high school teacher. He did his freshman year at the University of Redlands, and his sophomore and junior years at the University of Southern California. He had first thought of majoring in Far Eastern Religion, but later decided he was not sufficiently gifted in foreign languages, and switched to mathematics. For his senior year he moved to the University of California at Berkeley, where the offer of an assistantship in the Physics Department induced him to major in the subject. He successively obtained his A.B. (1921), M.A. (1922), and Ph.D. (1924), all in physics, and all at Berkeley. In 1966 the University of California awarded him an Honorary LL.D degree.

In the early twenties, there was at Berkeley a growing interest in seismology. The University of California had established the first permanent seismographic stations in the Western Hemisphere at Berkeley and Mount Hamilton in 1887. Professor Andrew C. Lawson, of the Geology Department, had chaired the State Earthquake Investigation Commission, whose monumental report on the 1906 San Francisco Earthquake was a landmark in the history of seismology. In 1922, Lawson asked the Reverend J. B. Macelwane, S.J., to join his Department. Father Macelwane, who was then completing a Ph.D thesis on seismograms (in the Physics Department) left Berkeley in 1925 for St. Louis University, but not before asking Perry Byerly, his fellow student, to replace him. Perry, who had spent the year 1924–1925 as an instructor at the University of Nevada at Reno, returned to Berkeley to take charge of the seismographic stations on Monday, June 29, 1925. It so happened that on the previous Saturday evening a great earthquake had shaken western Montana, while another hit Santa Barbara on Monday morning. Byerly arrived at his office to face ringing telephones and frantic reporters whom, with his usual presence of mind, he managed to appease by making a few innocuous, yet profound-sounding statements.

The rest of Byerly's career was spent at Berkeley in the Department of Geology (later Geology and Geophysics), which he chaired from 1949 to 1954. He became emeritus professor in 1965. He was a member of the National Academy of Sciences (elected in 1946) and of the American Academy of Arts and Sciences. He held two Guggenheim Fellowships (1928–1929 and 1952–1953), was a Smith-Mundt Lecturer at the University of Mexico in 1954, and also held a Fulbright scholarship that took him back, in 1960–1961, to Cambridge, England, where he had already spent his first Guggenheim and had met Harold Jeffreys, whose epoch-making *The Earth* (Cambridge University Press, first edition, 1924) was ushering in the age of modern geophysics. Byerly's lifelong friendship with Jeffreys had a profound influence on him.

In 1925 Byerly married his first wife, Ardis Gehring, who unfortunately died of Hodgkin's disease while they were in Cambridge in 1929. A son, Perry Edward, had been born that same year. In 1932, Byerly married Elsie Gillmor and there were two sons, David and Donald. They were divorced in 1940. In 1941, Byerly married Lillian Nuckolls, who survives him.

Considering the enormous expansion in geophysical research that has occurred in the last three decades, it may be difficult to realize how little was known when Byerly started on his career. In the 1920s, the word geophysics itself was rarely used, and then mostly to refer to the fledgling art of detecting underground deposits of minerals and petroleum by physical means. The internal structure of the earth was only vaguely perceived, and the association of earthquakes with geologic faulting was not universally recognized. The field was wide open, and Byerly attacked on several fronts. His first paper (1924) discussed the dispersion of seismic wave trains from distant earthquakes. In 1926, he published an important paper that dealt with the travel times of P waves from the Montana earthquake of June 28, 1925. This paper shows Byerly's straightforward approach to dealing with observations and his preference for straight line segments rather than smoothed, higher-order curves. It was this paper that prompted Jeffreys to begin what became the classical Jeffreys-Bullen travel-time tables, still in use today. It is from these tables that most of our understanding of the earth's internal structure derives. In later years, Byerly returned repeatedly to the study of travel times, particularly in connection with the "20° discontinuity," which arises from physical discontinuities at depths of several hundred kilometers, and with the detection under the southern Sierra Nevada of California of the "root" demanded by isostatic gravitational anomalies. Byerly's method was to compare travel times of seismic waves from foci near the Pacific coast recorded at stations respectively east and west of the Sierra Nevada. Throughout his scientific career he maintained interest in the structure of the crust in northern California, the average properties of which he established rather closely as early as 1939 and 1940. He and his students also paid much attention to some unusual wave packets that appeared consistently on seismograms at certain stations, for instance, the "valley waves" recorded at Fresno and the "false S" (actually a longitudinal wave) recorded in the San Francisco Bay area from earthquakes in northwestern California. The latter were particularly significant, because their interpretation as a normal S arrival could lead to serious error in locating epicenters.

Byerly also devoted much attention to the instrumental side of seismology. Under his guidance, the seismographic stations of the University of California at Berkeley grew from the two original stations he had inherited from Macelwane in 1925 to a total of sixteen at the time of his retirement. These included the first network to be telemetered over telephone lines to a central recording unit, which, although such networks are now rather commonplace, was considered at the time of installation a startling innovation. Byerly also devoted several papers to the theory of the seismograph. The seismographic station on the Berkeley campus now bears his name.

The natural history of earthquakes, that is, the description and analysis of phenomena that occur at or near the source of earthquakes—ground motion, surface breaks, frequency of occurrence, and the like—was of deep interest to

Byerly. Perhaps his greatest contribution to the subject was the study of first motions recorded on seismograms and their relation to the focal mechanism. What Byerly discovered is that a plot on a suitable projection of stations for which the first P wave arrival is respectively compressional or dilatational allows the determination of two orthogonal planes, one of which is the fault plane. Byerly and his students later extended the method to arrivals of S waves, and showed how the sense of displacement on the fault plane could be ascertained from the distribution of first arrivals. The importance of this discovery was fully demonstrated in the 1960s, when the displacement along some of the numerous faults that transect, nearly at right angles, the Atlantic Ridge was found to be in the sense required of the "transform" faults postulated by the theory of plate tectonics, this sense being exactly the opposite of that expected if these faults were of the "transcurrent" types they had always been assumed to be. This compelling seismological evidence, when added to the evidence from the pattern of magnetic anomalies, clinched the argument about seafloor spreading, and it led to the early acceptance of plate tectonics. Curiously, Byerly, who had by then reached retirement, did not seem to grasp the importance of what he had wrought; his turn of mind was too pragmatic, too empirical, and too skeptical, to allow himself ever to be swept off his feet by any world-embracing theory. He loved the particular, and distrusted generalizations; to him points on a plot were individually more interesting than any smooth curve drawn through them.

Byerly's scientific achievements also include a determination of the amount of elastic energy released when a fault breaks. In 1958 he proposed a relation that gives the displacement as a function of distance from a fault; this relation is still in use today.

Interested as he was in the natural phenomenon of earthquakes, he was also much interested in their effect on buildings and engineering structures. He participated actively in earthquake engineering research, and he was frequently consulted by government and private corporations on matters of seismic safety in underground nuclear testing and in siting of nuclear reactors and other structures. His expert advice was sought by companies engaged in seismological exploration for oil.

From 1931 to 1956 he served as secretary of the Seismological Society of America, which he nurtured from relatively modest beginnings to the large and lively organization it is today. He also served on numerous panels of the National Research Council, notably during the International Geophysical Year, 1957–1958. From 1960 to 1963, he was president of the International Association of Seismology and Physics of the Earth's Interior; as such, he was much concerned with the establishment of the International Seismological Center, which opened in Edinburgh in 1965.

When Byerly started teaching and developing a graduate program in seismology, he was one of the first to do so. He is one of not more than a half-dozen men who established the foundations of modern seismology in the United States. He greatly enjoyed teaching. To his mind, his greatest contribution to science was the training and general education of his students, many of whom went on to distinguished careers. He took much interest in the welfare of this students, and frequently provided them with bits of wisdom extending well beyond the realm of seismology. In his teaching he was particulary careful to point out the difference between observation and inference, as in his famous statement that "an epicenter is a cross on the map placed by a seismologist," by which he meant to emphasize that the epicenter of an earthquake is inferred, not directly observed. He liked to illustrate a point by pithy anecdotes, which he hoped would stick better in the student's mind than a more formal discourse. He was a stickler for accuracy in speech, writing, and especially in thought. He loved words so much that he used them only sparingly, and only to maximum effect. He relished irony, paradox, and occasional sarcasm.

Perry Byerly passed away on 26 September 1978.

THE AUTHOR of this memoir is much indebted to Professor Bruce Bolt, whose "Memorial to Perry Byerly" appeared in the *Bulletin of the Seismological Society of America* (69 [1979]: 928–45). That memorial includes a complete bibliography of all of Perry Byerly's writings.

SELECTED BIBLIOGRAPHY

1924

Dispersion of energy without dispersion of frequencies in transverse elastic waves in the Earth. Bull. Seismol. Soc. Am., 14: 91–135.

1925

With J. B. Macelwane, S.J. Report on seismograms of the earthquake of November 10, 1922. Carnegie Inst. Washington Publ., 382:137–39.

Notes on the intensity of the Santa Barbara earthquake between Santa Barbara and San Luis Obispo. Bull. Seismol. Soc. Am., 15:279–81.

1926

The depth of focus of two recent earthquakes and the depth of the surface layer of the earth in California. Bull. Seismol. Soc. Am., 16:1–9.

With George D. Mitchell. Tables of earthquake waves reflected at a discontinuity at a depth of fifty kilometers. Bull. Seismol. Soc. Am., 16:10–14.

The Montana earthquake of June 28, 1925, G.M.C.T. Bull. Seismol. Soc. Am., 16:209–65.

A seismological note. Science, 63:307.

1927

The Evergreen (California) earthquakes of July 19, 1925, and May 28, 1927. Bull. Seismol. Soc. Am., 17:137–46.

1928

The Idria (California) earthquake of July 25, 1926. Bull. Seismol. Soc. Am., 17:203–06.

The Eureka (California) earthquake of August 20, 1927. Bull. Seismol. Soc. Am., 17:213–17.

The nature of the first motion in the Chilean earthquake of November 11, 1922. Am. J. Sci., 16:232–36.

1930

Love waves and the nature of the motion at the origin of the Chilean earthquake of November 11, 1922. Am. J. Sci. 19:274–82.

The California earthquake of November 4, 1927. Bull. Seismol. Soc. Am., 20:53–66.

The dispersion of seismic waves of the Love type and the thickness of the surface layer of the earth under the Pacific. Gerlands Beitr. Geophys., 26:27–33.

1931

With James Hester and Kenneth Marshall. The natural periods of vibration of some tall buildings in San Francisco. Bull. Seismol. Soc. Am., 21:268–76.

The California earthquakes of November 28, 1929 and the surface layers of the earth in California. Proc. Natl. Acad. Sci. USA, 17:91–100.

1932

With Karl Dyk. Richmond quarry blast of September 12, 1931, and the surface layering of the earth in the region of Berkeley. Bull. Seismol. Soc. Am., 22:50–55.

1934

The Texas earthquake of August 31, 1931. Bull. Seismol. Soc. Am., 24: 81–99; 303–25.

1935

The first preliminary waves of the Nevada earthquake of December 20, 1932, Bull. Seismol. Soc. Am., 25:62–80.

With James T. Wilson. The Central California earthquakes of May 16, 1933, and June 7, 1934. Bull. Seismol. Soc. Am., 25:223–46.

With F. B. Blanchard. Well gauges as seismographs. Nature, 135:303–4.

With James T. Wilson. The Richmond quarry blast of August 16, 1934. Bull. Seismol. Soc. Am., 25:259–68.

With F. B. Blanchard. A study of a well gauge as a seismograph. Bull. Seismol. Soc. Am., 25:313–21.

1937

Earthquakes off the coast of northern California. Bull. Seismol. Soc. Am., 27:73–96.

1938

The earthquake of July 6, 1934: Amplitudes and first motion. Bull. Seismol. Soc. Am., 28:1–13.

Comment on "The Sierra Nevada in the light of isostasy" by Andrew C. Lawson. Bull. Seismol. Soc. Am., 48:2025–31.

1939

Near earthquakes in Central California. Bull. Seismol. Soc. Am., 29:427–62.

1940

Seismicity of the Northern Pacific coast of the United States. Bull. Seismol. Soc. Am., 51:255–60.

The seismic determination of deep-seated crustal structure. Trans. Am. Geophys. Union, 21:815–33.

A seismologist's difficulties with some mathematical theory or the lack of it. Trans. Am. Geophys. Union, 21:1113–18.

1942

Microseisms at Berkeley and surf on near-by coasts. Bull. Seismol. Soc. Am., 32:277–82.

1946

The seismic waves from the Port Chicago explosion. Bull. Seismol. Soc. Am., 36:331–48.

1947

The periods of local earthquake waves in Central California. Bull. Seismol. Soc. Am., 37:291–97.

1949

With Alexis I. Mei, S.J., and Carl Romney. Dependence on azimuth of the amplitudes of P and PP. Bull. Seismol. Soc. Am., 39:269–84.

1950

With J. F. Everden. First motion in earthquakes recorded at Berkeley. Bull. Seismol. Soc. Am., 40:291–98.

1952

Theory of the hinged seismometer with support in general motion. Bull. Seismol. Soc. Am., 43:251–61.

1954

With Charles Herrick. T phases from Hawaiian earthquakes. Bull. Seismol. Soc. Am., 44:113–21.

1955

Nature of faulting as deduced from seismograms. Geol. Soc. Am. Spec. Pap., 62:75–86.

1956

Subcontinental structure in the light of seismological evidence. Adv. Geophys., 3:105–52.

1958

With William V. Stauder, S.J. Motion at the source of an earthquake. Publ. Dom. Obs. Ottawa, 20:255–61.

With John DeNoyer. Energy in earthquakes as computed from geodetic observation. In: *Contributions in Geophysics in Honor of Beno Gutenberg*, pp. 17–35. London: Pergamon Press.

1960

Earthquake mechanisms. Science, 131:1493–96.