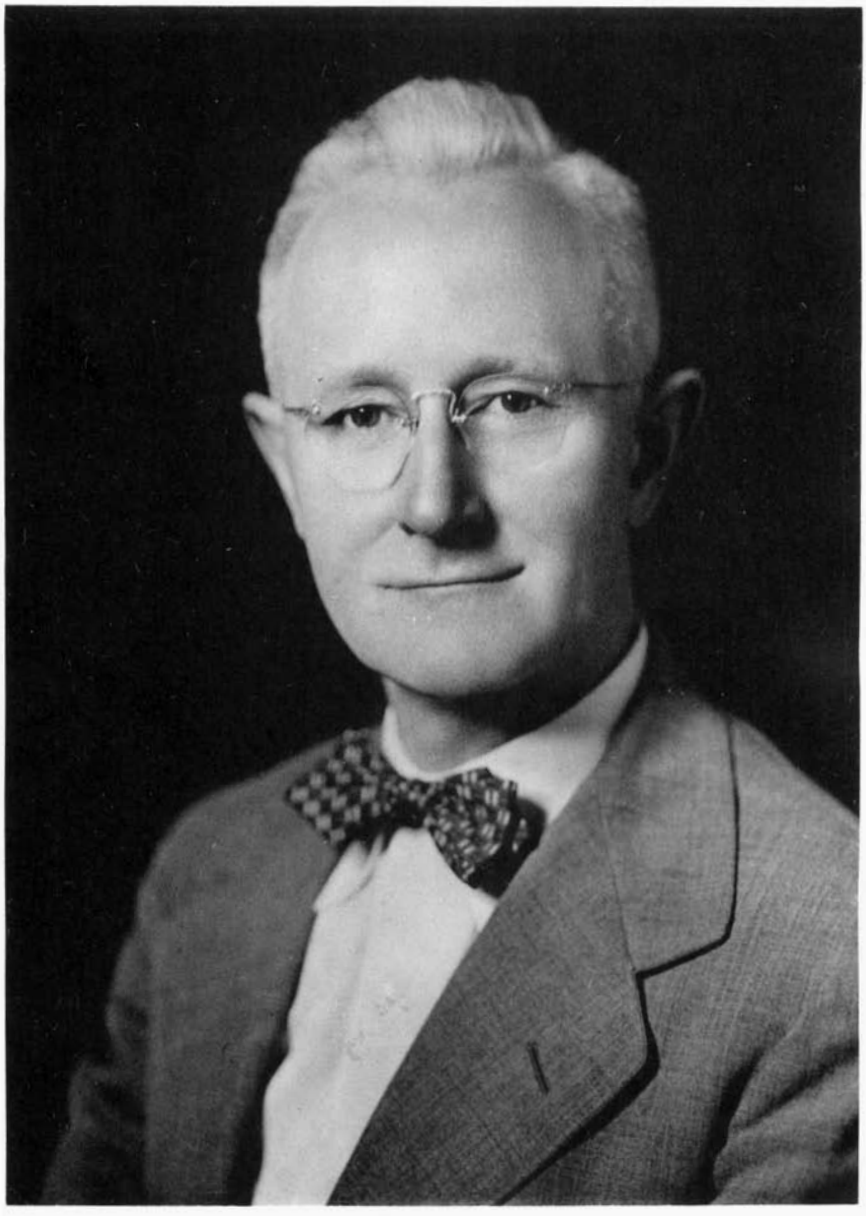

W T Bradley

WILMOT HYDE BRADLEY

Geologist, Geomorphologist, Paleolimnologist, Paleontologist, Administrator

Wilmot Hyde Bradley was born April 4, 1899, in Westville, Connecticut, a village near New Haven. As a perceptive and receptive boy growing up in a rural environment, he soon found a life-long interest: natural history.

When he entered Sheffield Scientific School at Yale University, World War I was on and for two years, 1918-19, he was in the "Yale Navy", that is, in the U. S. Naval Reserve Force detachment based at New Haven. At first he was uncertain what his major collegiate subject would be, but settled on chemistry. Geology did not beckon to him until his senior year in 1920. That summer, after graduating with a Bachelor of Philosophy degree, he had his first U. S. Geological Survey assignment: to serve as Field Assistant to F. C. Calkins on a project in the Cottonwood Canyon district of the Wasatch Mountains.

At the end of the field season Bradley returned to Yale to start graduate work and was in residence there during that academic year and the following one. In 1921 he qualified for an appointment on the U. S. Geological Survey as Geologic Aid. At that time the Fuels Branch (then Section of Geology of Fuels), the Chief of which was K. C. Heald, was the largest unit in the Geologic Division (then Branch). During the field seasons of 1921 and 1922, Bradley was assigned to a Fuels Branch party mapping in northwestern Colorado under the leadership of J. D. Sears. Those two field seasons were a stimulating experience. They offered to Bradley his first acquaintance with the mainly lacustrine Green River formation, of middle Eocene age, in which he immediately became interested. Moreover, the alert young geologists of both seasons were learning field techniques and engaged in lively discussions of every aspect of the geology they were seeing. In 1922 Bradley was promoted to Assistant Geologist at a salary of $1,800. After the field season was over he married Catrina van Benschoten, whom he had known for many years, and they moved to Washington where he took up work on oil shale. In 1923, at the age of 24, he had a field party of his own in southwestern Wyoming. His assistant was a Yale classmate, C. H. Dane, with whom he has been closely associated ever since.

Shortly after Bradley came to Washington, David White (then Chief Geologist), who was interested in the composition and origin of coal and oil shale, urged him to study not only the field relations of the oil shale of the Green River formation but also its composition and origin. White turned over to him a set of thin sections and photomicrographs prepared under the direction of C. A. Davis, who had died before he was able to do anything except some preliminary work. This was the beginning of an intensive field and laboratory study of the Green River and its microscopic fossils. Though it has been interrupted, it is still continuing. In 1927 a thesis entitled "Origin and microfossils of the oil shale of the Green River formation of Colorado and

Utah" was submitted in partial fulfillment of the requirements for the degree of Doctor of Philosphy at Yale. It was published in essentially the same form in 1931.

During several depression years in the 1930's, Bradley worked on the Oriskany sandstone of southern New York and its gas possibilities—an undertaking that started as a Public Works Administration project. Later in the same decade he organized and participated in the work of a group of geologists, paleontologists, and others in a study of the Piggot North Atlantic deep-sea cores. The longest interruption to his work in the west began in 1942, when he was designated Geologist in Charge of the Military Geology Unit (later Branch). This assignment lasted until 1944, when he was appointed Chief Geologist. He was the youngest geologist to hold that position and served the longest term. Before he left for Europe in the spring of 1959 to attend the XIV International Limnological Congress in Vienna, he arranged with the Director to be relieved as Chief Geologist, but that was not generally known until he returned in the fall to take up his new duties as Research Geologist.

His publications on the Green River formation are a good example of his meticulous gathering of field data, his imaginative interpretation of geological history, his mastery of pertinent disciplines and techniques, his rigorous logic, and his lucid writing. The Green River is in many ways a remarkable formation, containing potential oil resources far in excess of the combined production up to the present time and the conventional reserves in the United States. Bradley's work led to new concepts of the history of the ancient lakes in which the oil shale and other deposits were laid down and their relations to contemporaneous strata. Under his treatment this basically economic study branched into unexpected avenues, all of which were integrated. Though hundreds of species of Green River fish, insects, and land plants had been described, the unusual microscopic aquatic flora and fauna were practically unknown before his studies were undertaken. As described in his 1931 publication, these fossils include a great array of bacteria, spores and fragmentary vegetative parts of fungi, algae, spores and pollen of higher plants, rhizopods, insects, and the earliest American mite. Among the rhizopods is the earliest known thecamoebian (*Difflugia calcifera*). The Green River also contains many unusual authigenic minerals, particularly saline ones, five of which are unknown elsewhere and two of which are known elsewhere only in igneous or metamorphic rocks (Milton and Eugster, 1959, p. 124). Bradley himself described the occurrence of some of the minerals. His most notable publication on the Green River formation, however, is "The varves and climate of the Green River epoch" (1929), a classic in a little touched field: the determination of the duration in years of a pre-Pleistocene epoch by means of a penetrating analysis of a purely sedimentary record. By demonstrating that pairs of laminae, one of which is richer in organic matter than the other, are to be interpreted as annual deposits, an estimate of about 6 million years was reached for the duration of Green River time—the longest span of time yet dated by a sedimentary record. That, combined with his estimate of the rate of deposition

of the underlying Wasatch and the overlying Bridger and Uinta formations (all fluviatile), indicates a little less than 23 million years for the Eocene epoch.

Bradley's skill as a draftsman and artist—an avocation from which both he and Mrs. Bradley draw much satisfaction—is shown by illustrations in his "Geomorphology of the north flank of the Uinta Mountains" (1936). This study was a byproduct of the Green River work. Its purpose was to integrate the early Tertiary depositional history of the Green River basin, north of the Uinta Mountains, with the later erosional history.

The latest published byproduct of the Green River investigations was a spectacular venture in paleoscatology, "Coprolites from the Bridger formation of Wyoming; their composition and microorganisms" (1946), which was completed as the United States entered World War II. One of the mammalian coprolites, inferred to be the product of a canivore or omnivore, in particular contains well preserved microscopic fossils: bacteria and algae, chiefly minute desmids. It was concluded that the animal had a last drink from a pool of acid swamp water. The chemical analysis of the coprolite is by Bradley himself, a token of his early training in chemistry.

Bradley was a submarine geologist before that term came into general use. "Geology and biology of North Atlantic deep-sea cores between Newfoundland and Ireland" (1941-42) records a wealth of data, deductions, and speculations on pioneer deep-sea cores from the North Atlantic Ocean. In addition to organizing the investigation, Bradley collaborated with M. N. Bramlette in the preparation of the chapter on lithology and geological interpretations. Four zones characterized by an abundance of sand and subrounded to angular pebbles were interpreted as glacial marine deposits formed by debris from drift ice, probably during minor advances of the last main glaciation. The cores between these zones consist almost entirely of foraminiferal marl. Two zones of silicic volcanic ash aided in correlations. The suggestion that layers sharply set off by regular upward gradation from coarse to fine (graded bedding) are the result of submarine slumping and deposition beyond the slide itself of material thrown into suspension was prophetic. It was the first time that mode of transportation and deposition was invoked for deep-sea sediments.

As Chief of the Military Geology Unit, Bradley recruited and directed a staff of almost 100 geologists, engineering geologists, geomorphologists, groundwater geologists, soils scientists, botanists, cartographers, and translators. The Unit prepared for the Army Corps of Engineers reports and maps on terrain intelligence, trafficability, water supply, sites for airfields and beach landings, and other matters involving terrain and geology. Most of the work was done under demanding urgency. Some of it had the flavor of mystery stories, as when a paleontologist on the staff (K. E. Lohman) was able, through the identification of diatoms recovered from ballast sand, to point to the launching sites of the small Japanese balloons that reached the Pacific coast. The sites were confirmed at the close of the war.

Bradley will long be remembered for his 15-year tour of duty as Chief Geologist. When he came to Washington in 1922, the Geologic Division had some 120 geologists and other professional employees, but when he became Chief Geologist that number had risen to some 400 and it reached a maximum of almost 1,000 in 1955. It was his responsibility to plan and direct, through his Branch Chiefs, the research activities of that large staff. During his tenure of office new vistas in geology were unfolding. He had the foresight to see and anticipate them and the good judgment to explore and expand them. His greatest satisfaction came from seeing new frontiers occupied and bearing fruit, his greatest frustration from the realization that his plans could not be fulfilled on account of the lack of personnel or funds. He inspired loyalty, not only in his Assistant Chief Geologists and Branch Chiefs, with whom he was in closest contact, but throughout the Geologic Division. He enjoyed dealing with people and his relations with them were tempered with his innate modesty and the milk of human kindness, although he could be tough when the rare occasion demanded it.

He could not have borne the exacting demands of his responsibility without respite through contact with the earth. Several summers were spent in the west in the continuation of work on the Green River formation, and others in Maine. The field work in Maine was part of a program of investigations in an attempt to throw light on the declining population of soft-shelled clams (*Mya arenaria*) in some of the Maine bays. Bradley (1957) has published the results of an exhaustive study of the physical and ecologic features of the Sagadahoc Bay tidal flat. His most recent publication (1959), a byproduct of the Sagadahoc Bay study, deals with a charming little clam that has the alliterative name *Gemma gemma*. This little clam and *Mya* tend to be incompatible and evidently compete with each other, either for food or for some other reason.

Bradley's achievements have brought him honors. He is a member of the National Academy of Sciences and the American Academy of Arts and Sciences. In 1946 he was President of the Geological Society of Washington and in 1953 a Vice-President of the Geological Society of America. The Washington Academy of Sciences gave him its Award in the Physical Sciences in 1940. On the occasion of the centennial of the Sheffield Scientific School of Yale University in 1947, his alma mater awarded him the degree of Doctor of Science. In 1958 the Interior Department honored him with its highest award, the Distinguished Service Award and Medal. The Guidebook of the Geology of the Uinta Basin prepared for the Eighth Annual Field Conference of the Intermountain Association of Petroleum Geologists in 1957, was dedicated to him. He has been an Associate Editor of this Journal since 1945.

After an interruption of 17 years, he is at present engaged in the study of the Green River formation of the Bridger, Washakie, and Green River basins —a study all the more exciting on account of recent advances in geochemistry.

W. P. WOODRING

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