

Memorial to Roald Hilding Fryxell

1934-1974

Friends of Roald Fryxell



Roald Fryxell was not only a brilliant young scientist but also a very warm and real human being. At the time of his tragic death in a car accident in 1974, he was known worldwide for his contributions to Quaternary geology, archaeologic geology, and studies of lunar core samples. A first impression of Roald was that of a quiet, cheerful college professor with a marvelous sense of humor. He had a tremendous zest for life and took a keen interest in a wide variety of topics. His enthusiasm was infectious. He possessed a natural teaching ability and a remarkable talent for clear and persuasive presentation of complex scientific ideas to a wide variety of audiences.

With Roald, speaking, writing, and illustrating were complementary ways of expressing his ideas, and he was adept at all of them. In taking up a topic he instinctively reached for his pen and, on any handy scrap of paper, made his point visually with a sketch, physiographic diagram, or other three-dimensional line drawing. His lectures often became chalk talks in which he illustrated his remarks on the blackboard with one drawing after another. There was no fumbling in any of this; his touch of word and line were both sensitive and sure. He greatly admired those earlier masters of geological illustration, W. H. Holmes, A. K. Lobeck, Irwin Raiz, and Philip King. His own talent, however, was native, not the result of study or copying—evident from earliest childhood when he entertained himself (and any bystander) hour after hour by skillfully dashing off realistic drawings of every conceivable subject from life or his fertile imagination.

Roald held a strong conviction that the often rigid boundaries placed, rather arbitrarily, between academic disciplines could be a hindrance to further advancement of knowledge:

Knowledge is a continuum, like the sphere of the earth but with the uninterrupted vastness of a universe. Our formal academic categories are as arbitrary and artificial as the lines of latitude and longitude we scribe on a globe despite the continuity of the earth's surface. Each worker stands within the expanding field of his own perception, with opportunities which are limited only by his interest and imagination, his ability and the time available to him. To fetter his education or his intellectual growth with the boundaries of traditional disciplines is, to say the least, short-sighted. Much better to free each man to his own sphere of professional and intellectual competence, and to benefit from his unique perspective and contributions to knowledge, whether these lie within our arbitrary academic bounds or straddle them.

He acted on this strong conviction in 1965 by helping create an integrated, interdisciplinary Quaternary Studies Program, one of the first of its kind in the United States, at the Laboratory of Anthropology, Washington State University.

Roald Fryxell was born in Moline, Illinois, on February 18, 1934, the second of

three sons of Fritiof and Regina Fryxell. Roald thus from the beginning showed a remarkable acumen for being in the right place at the right time. He hardly could have chosen finer parents and home to nurture and prepare him for his future career. His father, "Doc Fryxell" to generations of former students, is retired Professor of Geology at Augustana College, Rock Island, Illinois, and an outstanding geologist and teacher. His mother is an accomplished musician, composer, and teacher. Home life, avid reading, and family travels stimulated a remarkable breadth of interests that remained with Roald throughout his life. In high school he was active in sports, drama, art, and writing and yet won the Bausch and Lomb Science Award. Roald was editor of the weekly school paper, *The Crimson Crier*, and later, during college, he contributed award-winning poetry and prose writings to the literary magazine, *Saga*. His interest in good writing matured with the years as shown by the excellence of his own papers and in his service to others as editor and critic. As one graduate student later remarked, "To have Roald Fryxell review a paper was an experience one wouldn't ever forget."

Roald's eagerly anticipated studies at Augustana College met with a serious setback. Migraine headaches, which had set in while he was in high school, became so disabling that he had to drop his studies and be hospitalized. A month of tests left the cause of his illness as much a mystery as ever, but he resumed college the next semester. Though recurrent migraines continued to be a major problem for him, he learned to live with them. Few were aware that what he accomplished through subsequent years was done in spite of this handicap.

During this enforced interruption, Roald quietly made a decision regarding his career: it would not be in commercial art, biology, speech, or other alternatives, but in geology. In this profession, he felt, his many interests would stand him in good stead—as indeed they did—and he could enjoy field studies like those he had often experienced with his father.

Roald chose a divisional major, which provided for a concentration in geology while it encouraged him to elect many courses in the other sciences. He found new outlets for his skill in drawing, including the making of maps, charts, and diagrams for his instructors. Some of these continue to be used at Augustana and elsewhere.

Roald also was active in writing clubs, dramatics, and athletics, and he was a campus leader. Of Roald's many extracurricular activities one was unique. During his college years a succession of pranks convulsed everyone on campus with laughter. They were so refreshingly hilarious as to entertain all without leaving any stings or bad aftertaste. Doubtless no one enjoyed them more than the conspirators themselves, a handful of Roald's buddies. Older faculty members still chuckle as they recall the now legendary "Fryxell phrags" and mention them to students—not to be imitated but as good theme topics.

With mountain climbing expertise learned with his father in the Tetons, Roald conducted many climbing expeditions on the Augustana campus and along the bluffs of the Mississippi River. Many people in this northern Illinois—eastern Iowa community will long remember the "1955 Tea Pot Dome" episode at Augustana, which was the product of Roald's imaginative mind. He organized a midnight climbing expedition up the walls of Old Main, hoisting prefabricated material with which he and his cohorts modified the large dome into a perfect replica of a teapot, with handle and spout large enough to be seen for several miles. Pictures and stories made the news wires all the way to Chicago.

To his fellow conspirators and other friends he was by now frequently known by the nicknames "Rolly" or, most often, as "Fryx." The latter name stuck; he was "Fryx" to friends and colleagues during most of his professional career.

Fryx, recipient of the Augustana Prize Scholarship, graduated with an A.B. degree on June 4, 1956, and the next day was married to Helen Broberg, his college sweetheart. The newly married couple honeymooned in Jackson Hole, Wyoming, where Fryx had a three-month appointment as naturalist in Grand Teton National Park. That fall, Fryx began graduate study in the geology department, Washington State University, in Pullman, Washington. While a teaching assistant at W.S.U., his instructive skills, enthusiasm, and geologic knowledge were evident in the response he received from his students.

In the summers of 1957 and 1958, while a graduate student at Washington State, Fryx worked with the Bureau of Indian Affairs on the soil and grazing resource inventory program at the Colville Indian Reservation in northern Washington. His responsibilities as a member of the evaluation team were to determine the soil-parent material relationships for the entire Colville Reservation. His contributions on the surficial geology of the reservation were highly detailed and uniquely presented. The report on the total resource inventory (including Fryx's contribution and benefiting from his review) received the Department of Interior's "Departmental Citation of Excellence." Fryxell later continued work on glacial deposits of northeastern Washington that he had started while on the Colville Reservation, intending to use this work as a dissertation topic.

During these years at Washington State University, Fryx's breadth of interest led him to delve into plant ecology under Rexford Daubenmire. He also took a highly stimulating introductory course in archaeology from R. D. Daugherty, which was to profoundly affect the course of his future career. Under Henry W. Smith, he gained insight into the origin, characteristics, and classification of soils and the techniques essential for their description and interpretation. This he adapted with great originality for geologic and archaeologic purposes. His interest in soils led him to make a detailed examination of the "Palouse loess," a study he pursued intermittently for several years. He later used this soils background in his pioneering studies of lunar core samples.

Meanwhile, in 1957 and 1958, Jenny and Tom Fryxell were born. The demands of a growing family contributed significantly to the decision by the young graduate student and his wife to leave Pullman and Washington State University in May 1960 and move to Vantage, Washington, where Fryx became Superintendent of Ginkgo Petrified Forest State Park. The park and its fine museum were dedicated to preservation of silicified wood in situ for view by the public. By coincidence, the museum, built during the Depression years, had been planned by Fryx's father, Fritiof Fryxell, as part of a W.P.A. program in the country's national and state parks.

While State Park Superintendent, Fryx strove to establish an in-house research program in the museum. In addition to his regular duties, Fryx continued his research in Quaternary stratigraphy and developed a novel explanation for the near-perfect preservation of wood structure in logs found embedded in lavas of the area (Fryxell, 1973). It was during this time that Fryx became well acquainted with two remarkable individuals, J. Hoover Mackin and C. H. Scammon. Mackin, an exceedingly versatile geologist and gifted teacher, also was interested in Quaternary geology and the geology of the Columbia Plateau, and he encouraged Fryx in his research. Scammon, a self-educated man, was the owner of a remote ranch north of Vantage, and, chiefly

through his own efforts, he had become expert in the stratigraphy of the Columbia River Group lavas in the region and was widely known for his understanding of the local fossil flora. Thus, the year at Vantage for Fryx was not spent in an intellectual vacuum. There was much challenging work to do and stimulus from exceptionally able individuals with similar interests.

Vantage, seemingly an isolated spot on the Columbia Plateau, actually was a half-way point on a frequently traveled cross-state route, so the Fryxells had no lack of visitors. Many stopped to enjoy the warm welcome and generous hospitality that always was a hallmark of Roald and Helen's household. There, as in later years and at other places, the home of the Fryxells reflected the fine taste that Helen and Roald shared; they adorned it with fine paintings and photographs, antique furniture, and, later, with art objects brought back from their travels in Spain, France, Mexico, and Alaska.

In September 1961, the Fryxells returned to Washington State University, living for the first several months in the nearby town of Palouse. The move will long be remembered by friends who greeted their return; the ancient army surplus, World War II 2½-ton truck (borrowed from a farmer), piled high with household goods looked like something out of Steinbeck. Not long after their return, Fryx received an appointment as "Junior Geologist" with the Department of Anthropology.

The return to Pullman and the appointment with the Department of Anthropology reestablished Fryx's collaboration with Richard D. Daugherty, a remarkably rewarding association that ended only with Fryx's death. Daugherty, already well known for his excavation of Early Man artifacts from the Lind Coulee Site, central Washington, was embarking upon an ambitious program of salvage archaeology in the Columbia Basin. Daugherty knew how critical the understanding of archaeologic site stratigraphy and its relation to regional Quaternary stratigraphy could be to working out the archaeologic relations in sites scattered over such a vast region. In Fryxell he found the ideal individual to work out the geologic relationships. Fryx combined a broad understanding of regional bedrock geologic relations, regional Quaternary stratigraphy, ecology, climate, and soils with a virtually unique gift for imaginative and meticulous analysis, description, and documentation of detailed stratigraphy at individual sites. He pioneered the application to archaeologic sites of the technique developed by H. W. Smith and C. D. Moody for collecting undisturbed sample profiles of sediment ("soil monoliths") for preservation as permanent records of site stratigraphy. Fryxell early recognized the importance of volcanic ash layers in Quaternary deposits of the plateau as stratigraphic marker horizons of regional extent.

Fryxell also proved to be a skillful manager and, with Daugherty, he was adept at winning the research grants that were the life blood of the program. Principal supporters of this and related programs were the National Park Service, the National Science Foundation, and the Wenner-Gren Foundation.

The result of this program by Daugherty, Fryxell, and their collaborators was a vastly improved understanding of the archaeology and Quaternary stratigraphy of the Columbia Plateau, a spate of papers describing individual archaeologic sites, a "library" of soil monoliths documenting stratigraphy from many of the sites, and, not the least, the groundwork upon which an integrated Quaternary Studies curriculum later could be based. Demand for expanded facilities because of the program resulted in establishment of the Laboratory of Anthropology. Excavations as part of the program culminated in work at the very important and later famous site, the Marmes Rockshelter.

Fryx's study of stratigraphy in so many sites over this vast region revealed that all had much in common, and that some features were directly linked to past climate.

Rockshelters, in particular, provided especially clear evidence. Blocks wedged from the roof by frost action and incorporated in fill on the rockshelter floor gave proof of a cool, moist environment with vigorous frost activity. Two additional major types of sedimentation at these sites were the deposits of eolian sediment and build-up of organic debris.

Alternate dominance or shift in relative importance of these processes, in the above order, are interpreted as reflecting control by regional climatic conditions. Thus coarse rockfall at the base of this sequence records a cool, moist environment accompanied by vigorous frost activity until about 8000 years ago; next followed a time of relative aridity, lessened frost activity, and increased eolian sedimentation; beginning about 4000 to 2000 years ago conditions gradually shifted toward those of the present, resulting in moderately renewed frost-rockfall activity, moderating eolian deposition, and increasing accumulation of organic debris (Regional patterns of sedimentation recorded by cave and rockshelter stratigraphy on the Columbia Plateau, Washington [abs.]: Geological Society of America Special Paper 76, p. 273).

In 1964, Fryxell and Daugherty, under a grant from the Wenner-Gren Foundation, went to Europe to demonstrate the techniques developed during the archaeological work on the Columbia Plateau, with special emphasis on the collection of soil monoliths as objective records of site stratigraphy. They worked with archaeologists at sites under excavation at Combe-Grenal, Abri Pataud, and Laugerie-Haute in France, Ambrona in Spain, and Fortress of Luisbourg in Canada. At Laugerie-Haute, under excavation by Francois Bordes, Fryx demonstrated the effectiveness of his techniques by stabilizing and removing a Lower Solutrean firehearth in its entirety; the firehearth now is at the museum in Les Eysies. In later years, Fryx was called upon to help document stratigraphy at several sites in the conterminous United States, Alaska, Hawaii, and Mexico, most notably at Blackwater Draw, New Mexico; Onion Portage, Alaska; and Valsequillo, Mexico.

In 1964, Fryx's ideas about Quaternary stratigraphy of eastern Washington became widely known through his leadership, with E. F. Cook, of a Geological Society of America field trip to the Palouse area. During this trip, Fryx demonstrated his view, based on many years' field study that, in his words:

... the "Palouse loess" actually consists of a complex of four or more eolian units of possible formational rank ranging in age from mid-Pleistocene or older to recent, derived from volcanic, glacio-fluvial, and glacio-lacustrine sediments, and other still unsolved sources to the southwest, and in this area of maximum thickness displaying a unique topography produced by the combined forces of prolonged erosion and deposition of silt-sized material, under conditions of remarkably uniform prevailing wind direction (A field guide to the loess deposits and channeled scablands of the Palouse area, eastern Washington; Washington State University Laboratory of Anthropology, Rept. of Invest. no. 27, p. 3).

The trip also examined a scabland tract along the Palouse River that provided convincing evidence for J Harlan Bretz's concept of catastrophic flooding, a concept that Fryx supported with all the persuasiveness at his command.

In the following year both his work in the Colville area and the Columbia Plateau were included in the summary volume (Richmond, Fryxell, Neff, and Weis, 1965) and the Guidebook to Field Conference E of the International Quaternary Association Conference. These field trips and their guidebooks brought wide attention to the exceptional clarity with which Fryx viewed Quaternary stratigraphy and associated land-

scapes as an integrated whole. These field trips were only two of many formal and informal ones that, for many years, he led to various parts of the Columbia Plateau. Scores of students and visitors, from this country and overseas, were introduced to the geology of this region on these trips.

In 1965, Fryx received a regular, full-time faculty appointment to the anthropology department at Washington State University. It is interesting to recall that up to this time, his was a temporary appointment as "Junior Geologist." The new appointment brought with it opportunity to teach on a regular basis, of which he, with characteristic energy and imagination, took full advantage. His basic teaching duties included presenting courses in Quaternary stratigraphy and geologic techniques to archaeology students. Shortly thereafter, however, his determined effort and persuasiveness resulted in creation of a Quaternary Studies Program within the anthropology department. The program was interdisciplinary in the broadest sense; geology, soils, ecology, zoology, palynology, and related fields all were included and several departments on the campus were participants. At the time this was being done, this was a novel approach and not a little revolutionary in the eyes of some. The aim certainly was a laudable one: to provide archaeology students and others interested in the Quaternary with the skills necessary to do good fieldwork, together with a broad understanding of most aspects of the Quaternary. The model for the program was the education that Fryx himself had acquired, the value of which had been demonstrated by his own accomplishments. The program was successful from its inception.

In 1966 and 1967, Daugherty and Fryxell began excavation of the especially rich, stratigraphically complex Ozette site on the Pacific coast of the Olympic Peninsula. The approach to microstratigraphy begun at this site by Fryx proved so fruitful that it remained the standard followed during subsequent seasons when other commitments called him elsewhere.

Fryx's characteristic curiosity, coupled with patient persistence, sometimes yielded unexpected rewards. Nothing better illustrates this than his famous discovery at Marmes Rockshelter in central Washington. Excavations at the rockshelter by Daugherty in 1962 through 1964 revealed a long history of human occupation and an unusually detailed record of Quaternary events. The meaning of these findings was eloquently presented in Fryxell, 1963a (reprinted, 1967). Excavation in the rockshelter itself had been suspended because of the pressing need to work on other sites when Fryx in 1965, curious to see how stratigraphy in the rockshelter was related to that of the floodplain of the adjacent Palouse River, enlisted the aid of a bulldozer. Fryx followed the bulldozer as it cut a trench in the deposits between the rockshelter and floodplain and, when fragments of bone began to appear, had work stopped. Some of these bones proved to be part of a human skull.

Fryx repeatedly returned to the site in ensuing years as time permitted, trying to determine the stratigraphic context of these bones and, if possible, to find others. It was not until 1968, while working at the site with one of his classes, that more bones and some artifacts were found in situ and their stratigraphic position and probable age became clear. They proved to be 10,000 to 12,000 years old, much older than any other well-documented human skeletal material found up to that time in the Western Hemisphere. Characteristically, the first announcements of this important find clearly described the roles of all who had contributed, including the students in the class.

Unfortunately, Marmes Rockshelter was located within the reservoir area of newly constructed Lower Monumental Dam, in an area scheduled to be flooded only a few months following the discovery. A drastic salvage excavation program was begun as

soon as emergency funding became available; it involved scores of voluntary workers. Meanwhile, Fryxell and Daugherty used every means available to forestall flooding of the site before work there could be completed, and they sought somehow to preserve this unique site, already in 1967 designated a National Historic Landmark, so that it could be seen by future generations. Nearly fifty lectures on the project were given to civic and educational organizations. News of the project was featured nationwide in newspapers and newsmagazines. Senator Warren G. Magnuson of Washington took an active interest in the project.

Finally, by executive order of President Lyndon Johnson, the Corps of Engineers constructed an earthfill cofferdam to isolate the site from the area to be flooded. Tragically, this beautiful but useless cofferdam—built at a cost of \$1,500,000 (six times as much as the seven years of archaeological research had required)—failed completely, and Marmes Rockshelter, with the salvage excavation completed only in part, was submerged beneath the waters of the reservoir.

On March 31, 1969, the Senate of the State of Washington conferred the title of "Distinguished Citizen" on Daugherty and Fryxell in recognition of their contributions to the prehistory of their state. The next year Roald was listed among the Outstanding Young Men of America and subsequently in *Who's Who in the West*. In 1971 he completed the Ph.D. at the University of Idaho and in 1972 received an honorary D.Sc. from Augustana College.

Throughout his professional life, Roald was in much demand as a lecturer and traveled about the country to serve as guest speaker or to participate in symposia. Nor was he without honor where he was best known. For instance, he gave the Annual Sigma Xi Lecture at the University of Idaho in 1968 ("Ecological perspectives from outer space"). In February 1972, he participated in a highly successful seminar on space exploration at Augustana College, giving the opening address and serving on the blue-ribbon panel of speakers with Neil Armstrong, Thor Karlstrom, Edward Olsen, and James Van Allen.

Meanwhile, from 1969 through 1971, Fryx spent five summer months in Spain documenting and interpreting the complex stratigraphy in a very important site at La Cariguela, Granada, which contained an unusually rich archaeological record extending from the Paleolithic through the Bronze Age.

In 1972 and 1973, Fryx was geologist for the Lind Coulee archaeological project in the Columbia Basin. His microstratigraphic work aided Ann Irwin's group in distinguishing eight separate occupation levels at this important Early Man site.

In 1973, Fryxell was invited to help document the stratigraphy in new excavations at Hueyatlaco, a site in central Mexico where bifacial tools earlier had been found in association with remains of extinct mammals. Fryx's meticulous drawings of stratigraphy in the new trenches clearly showed that the artifact-bearing horizons pass beneath volcanic ash layers that have a zircon fission-track age of about 250,000 years B.P.; this date is in essential agreement with other geologic data, including a uranium-series date on bone found in direct association with the artifacts. When this result was first announced (Steen-McIntyre, Fryxell, and Malde, 1973), it was greeted by archaeologists with consternation or silence. Typically, Fryx was not daunted by this chilly reception, quietly confident in the correctness of the work of his geologist colleagues, himself, and of the archaeologists who had made and documented the original discovery of the artifacts.

Soon after the flooding of the Marmes Rockshelter, Fryxell was asked to work in the Lunar Receiving Laboratory in Houston on the first lunar samples returned by the

crew of Apollo 11. Fryx first was invited to Houston to conduct a seminar illustrating how unconsolidated ash could be studied. He prepared very carefully for this, making use of loose volcanic ash from the Marmes site and other localities. He "sold" his methods, and himself, to the NASA personnel so completely that after the Seminar he was made a member of the Lunar Sample Preliminary Examination Team and continued as a key member of this group throughout the Apollo Program. During Apollo 11, in the quarantine facility, with constant pressure and excitement permeating the staff, his calm and reasonableness was a steadying influence. He worked long hours under difficult conditions to analyze the first stratigraphic sections (cores) collected on another planet. In order to complete tasks pre-determined by quarantine rules, the cores were to be used for biological testing. Fryxell recognized the value of these cores for geological studies of the lunar regolith and persuaded advisory committees to permit dissection and description of the cores before distributing them for specialized study. Given only a short period of time, he worked continuously with only short breaks for meals. Due to the conditions of working on very delicate material within nitrogen-filled glove boxes, Fryxell was taped into the gloves. He would remain in these uncomfortable positions for up to six hours at a single sitting, patiently taking each core apart grain by grain. Similarly, he dissected and described the lunar core samples returned by the Apollo 12, 14, 15, 16, and 17 missions.

Fryxell was the first to recognize the subtle layering in lunar regolith sampled by coring. During the last eight years, lunar stratigraphy has been the key to nearly all aspects of lunar surface science. Patient application of the techniques mastered for use in archaeological excavations were critical to the initial analysis of lunar cores. He viewed the lunar cores as a resource that should be preserved for future work after the initial allocation of samples. He proposed to do this by impregnating the lower "split-tube" after dissection to retain a "peel" or permanent stratigraphic record of the core. After several years of testing and presentations to NASA advisory groups he was the first person to prepare a stabilized lunar core section. These techniques are now standard practice; undisturbed stratigraphic sections of the lunar regolith now have been preserved for future generations of lunar investigators. He also was one of a small group of investigators to redesign the core samplers to provide a better sample return. The new core tubes retained 80 to 95 percent of the regolith penetrated.

Fryxell's lunar work is best summarized in his 1974 paper, a comprehensive treatment of coring techniques, observations, and analysis of cored regolith and methods of preservation. An avid supporter of planetary exploration, he felt that the people of the Earth needed this exploration to better understand their own situation on a uniquely hospitable planet. He freely gave much of his time to the dissemination of information on the space program throughout the Pacific Northwest and wherever he traveled.

Fryxell was still active in the lunar research program and had begun stratigraphic work associated with restudy of the Lind Coulee site, central Washington, when on May 18, 1974, he was killed in a single-car accident while driving alone across the Columbia Plateau. He was forty years old.

Fryx was keenly anticipating his first sabbatical, beginning in September of that year, which would give him opportunity to complete a number of papers he had presented to professional groups but had published only as abstracts or not at all. A few studies in an advanced state of preparation have been seen through to publication by colleagues; others, however, cannot now be completed. As an associate, Ann Irwin, stated to the Seattle Times, "Fryxell's death will have impact beyond measure . . . some ele-

ments of how our sites tie in with the whole Columbia Basin will be lost to us forever." She also stated, "In terms of professional loss the Spanish site (Granada) may be even greater." Fryx's papers have been gathered together and now are in the archives of the Western History Research Center, University of Wyoming, Laramie.

Appreciation of Roald Fryxell and what he had accomplished found expression in many ways. At Augustana College friends established a memorial scholarship fund to aid needy upperclass students of geology and anthropology. One generous gift, from a college classmate, created a separate endowment, specifically designated to give geology students field experience. At Washington State University, colleagues established the Roald Fryxell Publication Fund for the Department of Anthropology.

The Society for American Anthropology in its December 1977 *Anthropology Newsletter* announced establishment of an award "in memory of Roald Fryxell whose career so well exemplified the crucial role of interdisciplinary cooperation in archaeological research." The Roald Fryxell Award will be presented annually to a scholar who has made "distinguished contributions to archaeology through interdisciplinary research" relating to the Americas (New World). This award, a beautiful bronze medalion designed by the noted sculptor Fred Meyers, and a citation were awarded for the first time in May 1978 to Vance Haynes.

In 1975 the Rotary Club of Rock Island, Illinois, designated an award to be conferred annually on a Rock Islander who has attained distinction through "Professional Excellence." Roald Fryxell was named the first recipient, and the award, given posthumously, was accepted on his behalf by his wife Helen at the Annual Dinner Meeting of the Club, May 27. A few sentences from the citation by Dr. Harry Nelson, Rotary Club President and Director of the John Deere Planetarium, read as follows:

The New York Times, in a two-column review of Roald's career, described him as "a soft-spoken, unpretentious man . . . a scientist who easily reduced technical jargon to layman's terms." The Seattle Post-Intelligencer stated, editorially, "Despite his superior mind and achievement . . . he was unassuming, generous, patient, and tirelessly dedicated to his work." Similar tributes were echoed across the land.

Roald added a new chapter to the fascinating history of early man in America. No less significant were his imaginative contributions to the geology of the Pacific Northwest and the unprecedented challenges of the Apollo Space Program. By every measurement except that of years, his life was truly extraordinary, an inspiration to us all.

ACKNOWLEDGMENTS

Principal contributors to this memorial are Richard D. Daugherty, Fritiof Fryxell, Helen Fryxell, Grant Heiken, David H. McIntyre, Virginia Steen-McIntyre, and Gordon R. Stephenson. We are grateful to numerous others who have helped in various ways; we especially thank Francois Bordes, Maggie Hennigh, Ann Irwin, Ned P. Krier, Harvey S. (Pete) Rice, and Al Ruddy.

SELECTED BIBLIOGRAPHY OF R. H. FRYXELL

- 1956 Geology of the Teton Range, Appendix, *in* Ortenburger, Leigh, A Climber's Guide to the Teton Range: Sierra Club, San Francisco, p. 149-153.
- 1958 Kyrie Eleison: The development of a liturgical chant: *Una Sancta*, v. 16, no. 1.
- 1959 Background study on geology and soil parent materials, *in* Soil and Grazing Resources Inventory, Colville Indian Reservation, Washington: Portland, Oregon, Bur. of Land Operations Survey, U.S.D.I., Bur. Indian Affairs, p. 201-216a.
- 1960 Problems of glacial chronology in Northern Washington [abs.]: Geol. Soc. America Bull., v. 71, p. 2060-2061.
- Stratigraphic descriptions. Appendix 1 to "Archeology in the Sun Lakes Area of central Washington," by Roderick Sprague: Pullman, Wash., Wash. State Univ. Lab. of Anthropology, Rept. of Invest. no. 6, p. 4548.
- The affair at Cunningham's Ranch, *in* Campfire Tales of Jackson Hole: Moose, Wyoming, Grand Teton National Park History Assoc.
- 1961 Geologic field examination of the Park Lake housepit site (45GR90), Lower Grand Coulee, Washington: Washington State Univ. Lab. of Anthropology, Rept. Inv. 9, 7 p.
- Geologic dating of the Entiat, Stayman, Knapp Coulee, and Orondo Rock Shelter archaeological sites: Appendix A, *in* The Rocky Reach Reservoir Region, by Alexander Gunkel: Washington State University Theses in Anthropology, no. 1, p. 271-283.
- Geoaerchaeological dating of low-level stream terraces in the lower Snake River Canyon, Washington [abs.]: Northwest Science, v. 35, p. 159.
- 1962 (and Daugherty, Richard D.) Schematic geoaerchaeological chronology for eastern Washington and related areas: Pullman, Wash. State Univ. Lab. of Anthropology Report of Invest. no. 11 [Chart].
- (and Daugherty, R. D., and Baenen, J.) The discovery of early human skeletal remains near Lyons Ferry, Washington [abs.]: Northwest Science, v. 36, p. 127.
- (and Daugherty, R. D.) Interim Report: Archaeologic salvage in the Lower Monumental reservoir, Washington: Pullman, Washington State Univ. Lab. of Anthropology Rept. Invest. 21, 39 p.
- The archaeology of Ford Island: Section II. Geologic examination of the Ford Island Archaeological Site (45-FR47), Washington: Pullman, Washington State Univ. Lab. of Anthropology, Rept. of Invest. no. 18.
- A radiocarbon limiting date for scabland flooding: Northwest Science, v. 36, p. 113-119.
- Mid-Pleistocene Mammoth remains from the "Palouse Loess" near St. John, Washington [abs.]: Pullman, Wash. State Univ. Lab. of Anthropology, Rept. of Invest. no. 17.
- 1963 Through a mirror darkly: A geologist's interpretation of man's changing environment: Pullman, The Record, Wash. State Univ. Library, p. 118 (selected for reprinting in special issue of *Saga*, Augustana College Library Magazine, Rock Island, Illinois, in recognition of Dr. Henriette C. K. Naeseth, 1967).
- Late glacial and postglacial geological and archaeological chronology of the Columbia Plateau, Washington: An interim report to the National Science

- Foundation: Pullman, Washington State Univ. Lab. of Anthropology Rept. of Invest. no. 23, 22 p.
- Regional patterns of sedimentation recorded by cave and rockshelter stratigraphy on the Columbia Plateau, Washington [abs.]: Geol. Soc. America Spec. Paper 76, p. 273.
- Notes on the occurrence of silicified wood from the Ginkgo Flow of the Yakima Basalt Formation, Washington: Pullman, Xi Trans., v. 1, Xi Chapter, Sigma Gamma Epsilon, Wash. State Univ., p. 32–36.
- (and McIntyre, David H.) A possible Miocene vent breccia in basalt at Lyons Ferry, Washington [abs.]: Northwest Science, v. 37, p. 168.
- 1964 (and Daugherty, Richard D) Demonstration of techniques for preserving archaeological stratigraphy: A report to the WennerGren Foundation: Pullman, Wash. State Univ. Lab. of Anthropology Rept. of Invest. no. 31.
- (and Cook, E. F.) A field guide to the loess deposits and channeled scablands of the Palouse area, eastern Washington: Pullman, Wash. State Univ. Lab. of Anthropology, Rept. of Invest. no. 27, 32 p.
- Notes on the geologic setting of the Fort Spokane-Spokane House Archaeological site, Washington: Appendix A, *in* "Excavations at Spokane House, Fort Spokane Historic Site, 1962–1963" by John Combs: Pullman, Wash. State Univ. Lab. of Anthropology Rept. of Invest. no. 29, p. 81–91.
- 1965 Mazama and Glacier Peak volcanic ash layers: Relative ages: Science, v. 147, p. 1288–1290.
- Neve capped snow pillars resulting from ablation on Teton Glacier, Wyoming: Jour. Glaciology, v. 5, p. 727–734.
- Radiocarbon chronology for post-glacial time in the Columbia Plateau, northwestern United States: Pullman, Internat. Carbon 14 and Tritium Dating Conference.
- (and Richmond, G. M., Neff, G. E., and Weis, P. L.) The Cordilleran ice sheet of the northern Rocky Mountains and related Quaternary history of the Columbia Plateau, *in* Wright, H. E., Jr., and Frey, D. G., eds., *The Quaternary of the United States*: Princeton, New Jersey, Princeton Univ. Press, p. 231–242.
- (and Richmond, G.M., de la Montagne, J., and Trimble, D. E.) Guidebook for Field Conference E, Northern and middle Rocky Mountains: Internat. Assoc. Quat. Res., 7th Congress, Boulder, Colorado, 129 p.
- (and Steen, V. C.) Mazama and Glacier Peak pumice glass: Uniformity of refractive index after weathering: Science, v. 150, p. 878–880.
- 1966 Origin and age of Palouse Hills topography, eastern Columbia Plateau [abs.]: Geol. Soc. America Special Paper 101, p. 74.
- Distribution, origins, and geologic characteristics of loess [abs.]: Moscow Abstracts, Fourth Ann. Symposium on Engineering and Soils Eng., 2 p.
- (and Daugherty, Richard D.) Archaeological, geochronological and ecological investigations of the Ozette Village Site on the Northwest coast of Washington: Pullman, General information circular, Wash. State Univ. Lab. of Anthropology.
- 1967 Iceflow pattern reconstructed for the Okanogan Lobe of the Cordilleran ice sheet, northcentral Washington [abs.]: Northwest Science, v. 41, p. 50.
- (and Daugherty, R. D., and Purdy, B. A.) The descriptive archaeology and geochronology of the Three Springs Bar archaeology site, Washington: Pullman, Wash. State Univ. Lab. of Anthropology, Rept. of Invest. no. 40, 114 p.

- 1967 Reconstruction of Iron Gate House type showing details of construction as inferred from archaeological data and ethnographic comparison (line drawing): Fig. 15 in *The archaeology of a late pre-historic village in northwestern California*, by Frank C. Leonhardy: Eugene, Museum of Nat. Hist. Bull., Oregon Univ.
- 1968 (and Bielicki, T., Daugherty, R. D., Gustafson, C. E., Irwin, H. T., and Keel, B. C.) A human skeleton from sediments of mid-Pinedale age in southeastern Washington: *American Antiquity*, v. 33, p. 511–514.
- (and Bielicki, T., Daugherty, R. D., Gustafson, C. E., Irwin, H. T., Keel, B., and Krantz, G. S.) Human skeletal material and artifacts from sediments of Pinedale (Wisconsin) glacial age in southeastern Washington, United States: 8th Internat. Cong. Anthropological and Ethnological Sciences (Japan, 1968) Proc., v. 3, p. 176–181.
- 1969 (As a member of the Lunar Sample Preliminary Examination Team), Preliminary examination of lunar samples from Apollo 11: *Science*, v. 165, p. 1211–1227.
- Preliminary examination of lunar samples: Apollo 11 Preliminary Science Report, NASA Spec. Pub. SP214, chap. 5, p. 123–142.
- (and Greenwood, W. R.) Condition of drivetube core sampling equipment returned from Apollo 11 mission: Houston, NASA Memo., Lunar Receiving Lab., Aug. 3, 1969.
- (and Keel, Bennie C.) Emergency salvage excavations for the recovery of early human remains and related scientific materials from the Marmes Rockshelter archaeological site, southeastern Washington, May 3–Dec. 15, 1968: A final report to U.S. Army Engineer District, Walla Walla, Corps of Engineers Contract No. DACW68680107: Pullman, Wash. State Univ. Lab. of Anthropology, 79 p.
- Recovery of early human remains from the Marmes Rockshelter archaeological site, southeastern Washington, May 3–Dec. 15, 1968: A progress report to U.S. Army Engineer District, Walla Walla, Corps of Engineers Contract No. DACW6868C0107: Pullman, Wash. State Univ. Lab. of Anthropology, 70 p.
- Emergency salvage excavations for the recovery of early human remains and related scientific materials from the Marmes Rockshelter archaeological site, southeastern Washington: Report submitted to the National Park Service.
- (and Keel, Bennie C.) Recovery of early human remains from the Marmes Rockshelter archaeological site southeastern Washington: Report submitted to the National Park Service.
- 1970 (and Anderson, D., Carrier, D., Greenwood, W., and Heiken, G.) Apollo 11 drive-tube core samples, an initial physical analysis of lunar surface sediment: *Science*, v. 167, p. 734–737.
- Apollo 11 drive-tube core samples, an initial physical analysis of lunar surface sediment, in *Apollo 11 Lunar Sci. Conf. Proc.*: p. 2121–2126.
- (As a member of the lunar sample preliminary examination team) Preliminary examination of lunar samples from Apollo 12: *Science*, v. 167, p. 1325–1338.
- Preliminary examination of lunar samples: Apollo 12 Preliminary Science Report, NASA Spec. Pub. SP235, chap. 12, p. 189–216.
- (and Daugherty, Richard D.) Foreword, in *Kirk, Ruth, The Oldest Man in America*: New York, Harcourt Brace Jovanovich.
- (and Gleeson, Madge) Southern Okanogan Valley and Plateau (physiographic diagram): Pullman, Washington State University Lab. of Anthropology.

- (and Almagro, M., Irwin, H. T., and Serna, M.) Avance a la investigacion arqueologica geocronologica y ecologia de la cueva de la Cariguëla (Pinar, Granada), *Trabajos de Prehistoria*, v. 27, p. 45-60.
- Contribution of interdisciplinary research to geological investigations of pre-history, eastern Washington [Ph.D. dissert.]: Moscow, Geology Dept., Univ. Idaho.
- 1971 (and Lindsay, John F., Heiken, Grant H.) Description of core samples returned by Apollo 12: NASA Tech. Memo. TMX 58066, 22 p.
- (and Heiken, Grant) Description, dissection and sub-sampling of Apollo 14 core sample 14230: NASA Tech. Memo. TMX 58070, 16 p.
- 1972 (and Heiken, G., Duke, M., Nagle, J. S., Scott, R., and Sellers, G. A.) Stratigraphy of the Apollo 15 drill core: NASA Tech. Memo. TMX 58101, 24 p.
- (and Horz, F., Carrier, W. D., III, Young, J. W.) (As part of the lunar sample preliminary examination team) Preliminary examination of lunar samples, *in* Apollo 16 Preliminary Science Report, NASA SP315: p. 724-754.
- Relationship of Late Quaternary volcanic ash layers to geomorphic history of the Columbia Basin, Washington [abs.]: Geol. Soc. America Abs. with Programs, v. 4, p. 159.
- (and Hester, James J., with sections by Ernest L. Lundelins, Jr., and Roald Fryxell) Blackwater locality No. 1: A stratified early man site in Eastern New Mexico: Pub. No. 8, Fort Burgwin Res. Ctr., Southern Methodist Univ.
- Ecological perspectives from outer space: Seminar on space exploration, Augustana College, Feb. 1972, p. 10-13.
- 1973 (As a member of the lunar sample preliminary examination team) Preliminary examination of the lunar samples, *in* Apollo 17 Preliminary Science Report, NASA SP330: p. 71-746.
- (and Heiken, G., Duke, M., McKay, D., Clanton, U., Nagle, J., Scott, R., and Sellers, G.) Preliminary stratigraphy of the Apollo 15 drill core: 4th Lunar Science Conf. Proc., p. 191-213.
- Apollo 17 lunar samples: Chemical and petrographic description: *Science*, v. 182, p. 659-672.
- (and Steen-McIntyre, V., and Malde, H. E.) Unexpectedly old age of deposits at Hueyatlaco archaeological site, Valsequillo, Mexico, implied by new stratigraphic and petrographic findings: Geol. Soc. America Abs. with Programs, v. 5, p. 820-821.
- (and Manseth, Ann, Irwin, Henry T., Gustafson, C. E.) The Lind Coulee archeological site, re-excavation of an early man campsite in central Washington: Report to the Natl. Park Service.
- 1974 (and Heiken, Grant) Preservation of lunar core samples: Preparation and interpretation of three-dimensional stratigraphic sections: 5th Lunar Science Conf. Proc., v. 1, p. 9359.
- (and Goksu, H. Y., Fremlin, J. H., Irwin, H. T.) Age determination of burned flint by a thermoluminescent method: *Science*, v. 183, p. 651-654.
- 1975 (and Steen-McIntyre, V., and Malde, H. E.) Age of deposits at Hueyatlaco archaeological site, Valsequillo, Mexico implied by new stratigraphic and petrographic findings: Southwestern Anthropological Assoc.-Soc. Mexicana de Anthropol; joint meeting, Santa Fe, New Mexico, March 1975.

- 1976 (and Mack, R. M., and Bryant, V. M., Jr.) Pollen sequence from the Columbia Basin, Washington: Reappraisal of postglacial vegetation: *The American Midland Naturalist*, v. 95, p. 390-397.
- 1977 (and Mullineaux, Donal R., Wilcox, Ray E., Ebaugh, Walter F., Rubin, Meyer) Age of the last major scabland flood of eastern Washington, as inferred from associated ash beds of Mount St. Helens Set S: *Geol. Soc. America Abs. with Programs*, v. 9, p. 1105.
- The interdisciplinary dilemma: A case for flexibility in academic thought: Rock Island, Illinois, Augustana College Library, Occasional Paper, no. B, 16 p.
- (and Anderson, Richard C.) The scientific method: Selected writings of master thinkers. An anthology drawn from the American geoscience literature (in prep.).