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Harold T. James

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BY PAUL BARTON

HAROLD LLOYD JAMES IS widely recognized for his trailblazing interpretations of the field relationships and petrology of the metamorphosed and structurally complex iron-rich sedimentary rocks known as "iron-formation." Although James focused his research primarily in northern Michigan, the fundamental interpretations he made there have proven applicable worldwide, and northern Michigan has served as the archetype of sedimentary iron deposits that constitute the bulk of the world's iron ore resources. He is broadly acknowledged to have been a world leader in this scientifically and economically important subject.

Prior to James's work, the unusual chemical and mineralogical character of iron-formation was attributed to metamorphism and hydrothermal alteration of iron-rich carbonate sedimentary rocks. James peered through the veil of metamorphism and subsequent local oxidation, unraveling the spatial relations among rock types, deciphering their primary igneous and sedimentary patterns, understanding their structural and petrogenic affiliations, and showing that the iron-rich assemblages of rocks exhibit a systematic and oft repeated sequence of intergradational facies that reflect the integrated sedimentary environments in ancient ma-

rine basins. These deposits include (1) a carbon-rich and sulfide-rich series of lithologies indicative of a highly reduced, deep water, euxinic part of a basin; (2) a carbonate-rich facies reflecting non-euxinic but still poorly oxygenated water; (3) a silicate facies deposited in waters having an intermediate oxidation state; and (4) a shallow-water, variably well-oxygenated facies having two subfacies distinguished by the oxidation state of the iron, the less oxidized represented by magnetite + chert and more strongly oxidized by hematite + chert. The magnetite or hematite + chert type constitutes the banded iron-formation of major resource interest. James showed that all these rock types may have been locally, and with varying intensities, metamorphosed and/or hydrothermally altered to yield different textures and mineral assemblages, yet for the most part, retaining distinctive features that enable their protoliths to be identified, thereby making possible the conceptual reconstruction of the parent sedimentary basins. The effective use of that reconstruction is a powerful tool to locate the economically important oxide facies rocks that represent the principal economic targets. James's model for the genesis of iron-formation became widely acclaimed, and the Michigan deposits became a Mecca for geologists worldwide who wished to learn about iron resources.

The Michigan work spawned another significant contribution having global application. Descriptions of diverse terranes of ancient, almost entirely unfossiliferous Precambrian rocks (that represent more than 85 percent of the total age of Earth) had resulted in an array of names for rock units that were only locally applicable. This disjointed situation impeded correlations and interpretations between different areas. James (1978, 1981) was the leader in an international community of geologists that organized the evidence based on geochronologic correlation and under

his guidance introduced the now widely accepted "W-X-Y-Z" terminology for Precambrian rocks that facilitates communication.

James's constructive influence extended far beyond his own scientific work: as friend, advisor, mentor, role model, and colleague to many associates, as an active member of the geologic community, and culminating in service (1965-71) as chief geologist of the U.S. Geological Survey. He taught advanced courses at Northwestern University and the University of Minnesota. He was active in the professional community as a leader in several societies and an active participant in various study groups.

Harold Lloyd James (known to his many friends and colleagues as Hal) was born on June 11, 1912, in Nanaimo, British Columbia, the eldest of five children (two sons and three daughters) of Evan and Blodwen James, who had emigrated from Wales in 1911. Hal's father was a coal miner in Wales, in British Columbia, and finally in Washington state, and he loved music, playing the organ and the piano, and choral singing. His mother (nee Davies) had been the head mistress of an elementary school in Wales and taught briefly in Canada. The family moved to Bellingham, Washington, in 1923 and Hal became eligible to declare himself a U.S. citizen when his father became naturalized in 1929; but through no fault of his own, the paperwork for his naturalization was not completed until 1940.

Hal attended public schools in Nanaimo and Bellingham and graduated from the latter's Whatcom High School in 1933 at the age of 20, having spent six years of full-time work to supplement his family's finances, beginning at age 14 as a lumber mill worker and shifting at 18 to a contract coal miner (often teamed with his father, he was evidently quite proficient at it). He began college at Bellingham Normal School (now Western Washington University) in the

summer of 1934 and transferred to Washington State College (now University) for the fall term, intending to major in mining geology. In a 1995 letter to his sons he relates that although he initially lacked specific academic goals and certainly did not visualize a career as a scientist, he did feel that he needed to become a professional of some sort, and in view of his experience, mining geology came closest. Hal repeatedly interrupted his formal education to recoup his finances by working as a coal miner, but he returned to earn a bachelor of science degree in geology as a member of Phi Beta Kappa and with highest honors in 1938; he was the first of his family to graduate from college. He had spent only five semesters on campus, but met graduation requirements by transfer credits from Bellingham Normal School and correspondence courses, plus some helpful boosts from Washington State faculty who recognized Hal's exceptional potential and went out of their way to help him.

His is an excellent example of an immensely productive career whose direction and accomplishments hinged several times on good fortune, generous responses from supervisors and educators, and support from family and associates, combined with his own persistent quest for long-range betterment rather than immediate gratification. Perhaps his best good fortune came on February 13, 1936, when he married the former Ruth Graybeal, daughter of close family friends in Bellingham and younger sister of his youthful best friend, Herb. Ruth provided steady support and encouragement for more than 53 years; they raised four sons: David E., Robert C., Hugh L., and Herbert T.

Just prior to James's graduation in 1938 the departmental chair, Harold Culver, recommended him to be a summer field assistant to Charles Park, then with the U.S. Geological Survey (USGS) and later dean of earth sciences at Stanford, who was mapping the supposedly extensive man-

ganese deposits of the Olympic Peninsula, Washington. This association began James's career-long affiliation with the USGS. As it turned out, Park and coworkers (James among them) demonstrated that the manganese deposits were indeed widespread but of marginal quality and trivial quantity. (We will return to the consequences of this study later.) James had intended to return to Washington State for graduate work, but two of his coworkers, Ralph Roberts and Bob Yates, were graduate students at the University of Washington, and they persuaded him to undertake graduate work there where a compact but vigorous department was headed by petrologist George Goodspeed and included geomorphologist J. Hoover Mackin. James spent 1938-40 as a graduate student in geology at the University of Washington and assisted in Goodspeed's petrology laboratory. A long field season in 1939 was split between the ongoing Olympic manganese study and a study of chromite deposits in Oregon and California as an assistant to Francis Wells. James spent the early summer of 1940 with Preston Hotz on chromite studies in southwestern Oregon and then a final month completing work with Park on the Olympic manganese showings. In 1940, before James completed a degree, several of the Washington faculty advised him to transfer to the University of Minnesota, which had a very strong hardrock-dominated Department of Geology. However, Minnesota lacked an appropriate opening that year, and Princeton provided an attractive fallback choice with a graduate assistantship with Harry Hess. This proved to be a very fortuitous turn of events, and Princeton provided an ideal intellectual and social environment. In 1942 Hess, who held a reserve commission in the Navy, was called to active service, and James took over as instructor in mineralogy.

Let us digress for a moment to provide some context for external events influencing James's early career. In the

late 1930s and early 1940s competition for mineral resources among nations contributed substantially to international instability that precipitated actions such as Japan's expansion into Manchuria and other parts of China, Korea, and eventually most of southeast Asia; Italy's struggle in Ethiopia; and Germany's aggression in central Europe, Scandinavia, and Russia. The United States, although relatively well endowed with mineral raw materials and fuels, did not possess extensive proven deposits of most ferrous metals (manganese, chromium, vanadium, tungsten, nickel, cobalt), aluminum, and a few other minerals essential for defense purposes. Evaluation of domestic resources became a major national concern and resulted in many high-priority, quick response studies by the USGS and the U. S. Bureau of Mines. Resource geologists were more valuable than soldiers and were deferred from the draft; and James, with his almost accidental experience with manganese and chromium, was among them.

One example of resource evaluation was the previously mentioned study of Park and others of the Olympic manganese deposits that, based on a 1918 reconnaissance report, had been widely touted to contain valuable resources; moreover, metallurgists at Washington State had already developed a process to extract manganese from refractory manganese silicate minerals typical of the Olympic deposits. Pressure for development mounted. In October of 1941 a "manganese convention" was held at Aberdeen, Washington, to review progress, and USGS Director Walter Mendenhall was invited to present the agency's findings. Mendenhall deferred the presentation of what he knew were unfavorable prospects to Charles Park. Park, not wishing to journey all the way from Washington, D.C., to Aberdeen just to present highly negative findings, sent some slides and notes to James, who was then in Oregon evaluating a

chromite prospect in the Twin Sisters Mountains. With no little trepidation, Harold James, a newly minted junior geologist (grade P-1) presented the USGS results to an audience many members of which were both disappointed and hostile. The well-documented facts that James presented, however, burst the Olympic manganese bubble and saved the nation fiscal resources for more productive pursuits. He was subsequently commended by several persons (representing railroads, utilities, and other infrastructure parties) who had been under pressure to make major expenditures, without credible assurances, based on the proposition that the amount of ore theretofore advertised actually existed.

James had intended to study some interesting hornblende gabbros of southwestern Oregon for his doctoral dissertation, but because of wartime concerns, he abandoned that project. He completed his Ph.D. qualifying exam in May of 1942 and began full-time USGS employment in June as part of the Strategic Minerals program. Until mid-1943 he worked mostly on chromite deposits near Red Lodge, Montana, and used the results of that study as his Princeton Ph.D. dissertation. He completed the dissertation in 1945 under Arthur F. Buddington as his principal mentor, and it was published in 1946 as USGS Bulletin 945-F, “Chromite Deposits near Red Lodge, Montana.” Although these deposits ultimately proved to be marginal in both size and metallurgical grade, they were within a few miles of the Stillwater mafic complex, which contained the principal known chromium resources within the United States, and thus their evaluation was of major interest for the war effort.

During those early war years James also made rapid-response evaluations of occurrences of materials of interest to the war effort: talc, optical calcite, graphite, sapphire (a critical mineral for bearings in instruments), abrasive co-

rundum, asbestos, and copper in southwest Montana, chromite in Oregon, and nickel in Washington. It was an intense existence, with steep learning curves. In August 1943 he joined John Albers, Paul Sims, and several others in a more sustained study of the lead-zinc ores of the Metaline district, Washington; they were supervised by Edward Sampson, then on wartime leave from Princeton. In contrast to the targets of his many brief prior studies of strategic and critical minerals, supplies of neither lead nor zinc were deficient for national defense; and James felt that his efforts were inappropriately applied. Therefore, in early 1944, after receiving no response to a request to the USGS for a more meaningful assignment, he sought a commission in the Navy. This action did awaken his supervisors, and they successfully urged James to reconsider and to join the USGS Military Geology Unit based in Washington, D.C. The Military Geology Unit had been established by Wilmot Bradley and Charles Hunt earlier in the war to perform terrain analysis to aid military operations, such as selecting beaches for landings, sites for forward airfields, and availability of water supplies, and identifying problems and opportunities that various terrains offered for operations. The unit had large, highly qualified scientific and library staffs that provided timely strategic technical information presented in a non-technical mode. It was a busy and satisfying task, and it even had some humor. For example, although his security clearance was at the secret level, some reports he prepared were immediately stamped “Top Secret,” so that he was forbidden to view some of his own work.

In early 1945 James was invited to join a special Engineering Terrain Intelligence Team attached to the 30th Engineer Battalion in Hawaii under Philip S. Shenon. Their status was peculiar, being uniformed civilians in a military organization. James’s simulated rank was that of major. They

puzzled about saluting rules and whether they should be addressed “sir” or “mister” before finally settling on “doctor” regardless of whether it was academically correct. The team worked intensively with aerial photographs in a secluded underground facility near Schofield Barracks, providing tactical support by producing detailed maps on very short notice for operations in the Pacific theater. In the spring of 1945 the team began examining southern Kyushu preparatory for the invasion of the Japanese home islands, noting with considerable concern the many sheltered potential gun positions offered by caves along the proposed beachheads. James’s part of the team was scheduled to follow on the third day of the initial landings to provide close advisory support for the combat engineers of the 6th Army. Fortunately the atomic bombing of Hiroshima and Nagasaki terminated that plan, and James returned to his family in Bellingham in September 1945.

In November 1945 his old supervisor, Charles Park, assigned James to a joint USGS-state of Michigan study of the iron deposits in the 300-square-mile Iron River-Crystal Falls district, a task that he accepted unenthusiastically because the intellectual challenges were ill defined at the time. The family moved to Iron River, Michigan, and remained there until 1954; it was an excellent environment in which to raise children and offered an opportunity for Hal to hone his skills in hunting, with the bow as well as rifle. James worked with a group initially under Carl E. Dutton and including full-timers Larry Smith and Dwight Lemmon, supplemented by summer mapping by Francis J. Pettijohn and Carl Lamey. Dutton soon was transferred to Madison, leaving James in charge. His slot had been previously occupied by geophysicist James Balsley, who was reassigned to follow up his innovative geologic use of airborne magnetometry initially developed as an antisubmarine tool by the

Navy. Thus James found himself the project magnetics expert, an important role because magnetics was an essential tool to extend direct geologic observations into the subsurface, especially pertinent for magnetic iron-formation. This task passed on to Ken Wier in late 1946.

In 1945 what at first seemed a mundane assignment soon evolved into an opportunity to unravel geologic intricacies about iron-resource occurrences that had theretofore been undecipherable and to clarify the geologic history of the oldest part of northern Michigan. A large group of geologists was associated with the project, each member contributing significant pieces; but it was James who led the assembly of the regional picture, inserted the iron deposits into their genetic context, and prepared three classic papers. The first, in 1954, definitively described the stratigraphic relations among the facies of iron-formation and was preceded by abstracts of two papers presented in 1949 and 1951 at the Geological Society of America annual meetings. The second, in 1955, defined the nodal pattern of metamorphism in northern Michigan and established the relation between the metamorphic grade and the character of the iron ore. The third, in 1958, assembled and clarified the stratigraphic relations among the diverse older Precambrian rocks throughout northern Michigan. These three seminal studies defined the core of James's personal scientific work and formed the principal basis for his election to the National Academy of Sciences in 1962.

In 1953 and again in 1954 James interrupted his studies in Michigan to become visiting lecturer for the spring terms at Northwestern University. There he taught graduate courses in mineral deposits and shared a graduate course in petrology with Arthur Howland. In 1954 the project headquarters was transferred to the newly opened USGS center in Menlo Park, California. This center included many exceptional earth

scientists such as Richard Doell, Arthur Lachenbruch, Allan Cox, Vincent McKelvey (who subsequently became director of the USGS), and Donald White, and it provided a mutually stimulating scientific environment that continues to this day. He joined with McKelvey and White to review the design for an expansion of the Menlo Park center and, to the temporary chagrin of USGS Director Tom Nolan, to redesign Building 2 so that, to paraphrase James's own words, the design fitted the needs of its earth-scientist occupants rather than the artistic concepts of the architects. The essential elements of that design proved exceptionally workable and were incorporated 15 years later into the design of the John Wesley Powell headquarters building for the USGS in Reston, Virginia.

James served a two-year tour as assistant chief of the large Mineral Deposits Branch in Washington under Charles Anderson. He returned to Menlo Park in 1958 and began a field study of the bedded iron deposits in the Early Proterozoic rocks of southwestern Montana. In 1961 he interrupted these studies to accept an appointment as professor of mineral deposits at the University of Minnesota, where he taught graduate courses concerning the origins and methods of study of mineral deposits. His work on the Michigan iron deposits continued and included a path-blazing study with Robert Clayton in 1962 on the fractionation of oxygen isotopes between magnetite, hematite, and quartz. At Minnesota, James established a laboratory for oxygen isotope analysis in collaboration with Eugene Perry. He remained affiliated with the USGS on a when-actually-employed basis, a common practice at the time that was used to ensure optimal interaction with academia.

In 1965 James was called on to serve a four-year term as chief geologist for the USGS in Washington, where he managed more than 2,000 scientists and support personnel work-

ing on topics such as oil and gas, uranium, astrogeology, paleontology, regional geology, geophysics, and of course, mineral deposits. He initiated a program of environmental geology in the USGS. This service was extended until 1971, when following the USGS's traditional practice of recycling scientists into and out of administrative assignments, he returned to Menlo Park to pick up the trail of those ancient rocks in southwestern Montana. In 1974 he retired but retained an official affiliation as research geologist until 1996, continuing work in Montana and remaining involved in national and international professional affairs. He and Ruth moved to Port Townsend, Washington. After Ruth died in 1989 he moved to Bellingham and continued to contribute to the earth-science literature until the mid-1990s.

Harold James was active in scientific and professional organizations, serving as national program chair (1961-62), councilor (1962-65), and president (1970-71) of the Society of Economic Geologists, which honored him with its Penrose Medal in 1976; councilor of the Mineralogical Society of America (1964-66); councilor of the Geological Society of America (1959-62) and associate editor of its *Bulletin* (1964-66); member (1967-84) and chair (1976-84) of the Subcommission on Precambrian Stratigraphy of the International Union of Geological Sciences; and associate editor of *Precambrian Research* (1973-92). He chaired the Governor's Advisory Committee on the Minnesota Geological Survey (1961-63). He served as chair of the Section of Geology in the National Academy of Sciences (1969-72) and on the Report Review Committee (1984-91), National Committee on Geology (1969-71), Commission on Natural Resources (1973-78), Board on Mineral and Energy Resources (1977-79), and Board on Radioactive Waste Management (1978-82). The Department of the Interior awarded him its Distinguished Service Award in 1966. He was a member of Phi

Beta Kappa, Sigma Xi, Phi Kappa Phi, and Sigma Gamma Epsilon.

We remember Hal for his penetrating questions, contagious smile, and ready humorous quips; and although most of us were accustomed to seeing his uneven gait, a consequence of combining youthful exuberance with a toboggan and a precipitous hill, it scarcely slowed him in getting around in the field or elsewhere.

Hal died by his own hand on April 2, 2000, at Ruth's gravesite in Bellingham.

I HAVE BEEN aided by thoughtful reviews and commentaries from David James, Cliff Nelson, Philip Bethke, Paul Sims, and Wallace Pratt. The most prolific contributor to this memorial, however, has been Hal James himself, with a pair of long letters addressed to his four sons written in 1991 and 1995 and kindly made available by his son David.

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