MEMORIAL TO HARRY HAMMOND HESS
1906–1969

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Harry Hammond Hess was born in New York City, May 24, 1906, the son of Julian B. and Elizabeth E. Hess. He suffered a fatal heart attack on August 25, 1969, while chairing a committee of the Space Science Board of the National Academy of Sciences at Woods Hole, Massachusetts.

In 1934, he married Annette Burns, daughter of George Plumer Burns, a professor of Botany at the University of Vermont. He is survived by his wife; an older son, George, Assistant Professor of Physics at the University of Virginia; a second son, Frank, at Whitehorse, Yukon Territory; a brother, Frank Hess of Huntington, Long Island, New York; and a grandson, Harry.

Mrs. Hess was a constant strong support for her husband; they frequently entertained visiting scientists, associates, and former and current students, with warm, home-like hospitality.

Harry Hess in effect accomplished the impossible; for thirty-five years he lived five lives contemporaneously: (1) as a family man, (2) a member of the faculty of Princeton University, (3) a mineralogist, geologist, geological geophysicist and oceanographer, (4) an officer in the U.S. Naval Reserve and a statesman-scientist and (5) the organizer, fund-raiser, and administrator of the Princeton Caribbean Geological Research Project.

He spent his first two college years at Yale in the department of electrical engineering but then switched to geology and graduated in 1927. There followed two years as a geologist in northern Rhodesia for Loangwa Concessions. He began graduate studies at Princeton in 1929 and earned the Ph.D. degree in 1932. Later he taught (1932-1933) at Rutgers University and then was a Research Associate at the Geophysical Laboratory, Washington, 1933-1934.

In 1934, he joined the Princeton faculty where he taught until his death. He was Chairman of the department of geology 1950-1966, and a member for a time of practically every major committee of the University. The esteem of his colleagues is indicated by the fact that for eleven consecutive years he was elected to the very important faculty Committee on Appointments and Advancements. In 1964, he was appointed to the Blair Professorship of Geology.

He was visiting Professor, Capetown University, South Africa, in 1949-1950, and at Cambridge University, England, in 1965.

He always spoke in low key, was friendly, unassuming, imperturbable, and sincere with all, and universally known to his friends and associates as "Harry."

He had a creative mind and an intuitive capacity to develop possible solutions to problems. He was always generous with credit to others.

He served on many committees of the American Geophysical Union, National Academy of Sciences, and National Aeronautics and Space Administration. He was consultant to the U.S. Naval Oceanographic Office and Chairman, 1956-1958, of the Earth Science Division, National Research Council. As Chairman of the Space Science Board of the National Academy, he was *the* ranking non-governmental advisor on the scientific objectives for planetary exploration in space; he was also a member of the Space Applications Study Group of the National Academy of Engineering.

Hess had a dry humor. At the International Geological Congress in 1937, we finished a field trip through the Urals at Magnitigorsk. At the farewell banquet, Harry suddenly jumped up on a table and declaimed "Here's to the revolution." As it was during the troublous times of Stalin, a fearful hush occurred. Then he added, "To the Hercynian revolution," and a wave of relief and acclaim followed. During discussion at meetings, he often pictured himself as a rabbit, on the blackboard or on a sheet of paper.

He was no rabbit. A Princeton Dean referred to him as the only department chairman whose bite was worse than his bark. During the war, as Captain of his ship, he was ordered to land a detachment of marines at Iwo Jima and then to await further orders. The Marines ran out of ammunition and pleaded for supplies. He landed them immediately. When in Honolulu for the first time, the harbor-master ordered him to take his ship out before 4:00 a.m.; he replied he would take her out at dawn and not before, and acted accordingly.

That Harry was pre-eminently an exponent and practitioner of "thinking big" is evidenced by his establishment of the Caribbean Geological Research Project to elucidate the origin of island arcs, sponsorship of the Mohole to drill to the mantle, his enthusiastic support and participation in plans for planetary exploration, the authorship of a history of ocean basins, and initiator of an ambitious program for a systematic study of "rock" minerals.

Most of his future interests and career were foreshadowed by his activities in the first few years after the start of his graduate work. In 1930-1931, for his Ph.D. dissertation, he studied a peridotite sheet and its alteration at Schuyler, Virginia; and in 1931, he accompanied F. A. Vening Meinesz on an expedition by submarine to measure gravity and take soundings in the West Indies. From then on he had an interest in geology, geophysics, and oceanography. In 1932, Hess and R. M. Field cooperated in arranging for and studying the core of a 395 foot hole in the Bahamas, and the same year Harry spent a summer on the Stillwater complex (Montana) and became interested in ingneous layered rocks and their mineralogy.

His initial study (1933) on the hydrothermal alteration of the Schuyler ultrabasic was followed successively by (1933) a study of serpentinization and steatitization at 150 different localities, with the conclusion that the first was autometamorphic and the second effected by hydrothermal solutions of external origin; one of the earliest descriptions (1936) of reaction zones and mineral zonation as a result of interdiffusion between peridotite and siliceous country rock; exposition (1938) of the evidence for an ultramafic magma; advancement (1939) of the idea that peridotites occur world-wide at an early stage in development of the most intensely deformed parts of many orogens; discussion of their relationships to island arcs and gravity anomalies; the proposal that serpentine constitutes part of the oceanic crust beneath the basaltic volcanics and that serpentinization could conceivably result in expansion and uplift at sites of rifting, such as mid-ocean ridges; development of the idea that (1964) anisotropy of olivine with preferred orientation may be a factor in interpretation of the seismic data from the uppermost mantle beneath the ocean; and studies of ultrabasics and their origin from Georgia along the Appalachians to Newfoundland, in Montana, and from South Africa, Greece, Spain, Venezuela, Cuba, and oceanic islands. In later years (1965) he accepted the probability of emplacement of alpine type peridotites as intrusions of solid parts of the upper mantle, in some cases very hot. Harry's first and last geologic study was of ultrabasic rock. A.E.J. Engel had reported to him the discovery of peridotite pillow lavas in Barberton land, South Africa. In July, 1969, Harry went to South Africa and after attending the meetings of The Geological Society, was taken by Morris and Richard Viljoen and shown the apparently extrusive ultramafic pillow lavas and evidence that caused him to return to the possibility of ultramafic magma.

He first visited the Stillwater complex in 1932. This was followed by several periods in the field, a detailed study of the mineralogy begun in 1935, and publication of the 230-page Memoir 80 by The Geological Society of America in 1960. Meanwhile he had studied and published on the Bay of Islands and Bushveld complexes, the Great Dyke of Southern Rhodesia and the Palisades sill. In the recent book, *Layered Igneous Rocks*, Hess is referred to in 18 discussions. His detailed description of the Stillwater is illuminated by many interpretations, some new, such as: igneous lamination is a product of crystal settling of tabular crystals in a tranquil setting; interdiffusion across interfaces of cumulates and liquid; an estimate of the rate of crystal accumulation and effects of sorting by vertical currents. He proposed that the "Great Dyke" was a feeder to a vast sheet-like intrusion. For the Palisades sill, he envisioned, except for the olivine-rich layer, fractionation during crystallization from the margins inward, due to convecting magma feeding growing crystals, accompanied by selective diffusion toward them of high temperature components and low temperature components away from them.

Professor G. M. Brown (University of Durham) has written me an evaluation of Harry's work on the pyroxene minerals from which the following excerpts are taken, "Between 1938 and 1953 he wrote, or contributed substantially to, eight fundamental papers that form the basis of modern ideas on the paragenetic relations of the common pyroxenes. The first paper, with Phillips (1938), showed that the fine-scale lamellae in orthopyroxenes were due to subsolidus exsolution of a calcic pyroxene rather than to twinning. Later (1941) Hess proposed that hypersthenes with coarser augite exsolution had inverted from a monoclinic pigeonite phase. Most workers on proxene mineralogy today would agree that he 'revolutionized the quadrilateral' in the interpretation of pyroxene phase relations; in 1952, he opened up the field of study of unit cell dimensions by X-ray diffraction of the orthopyroxenes and in 1953, collaborated with Hiashi Kuno in extending the study to clinopyroxenes."

J.R. Smith, in an introduction to a detailed study of the optical properties of low-temperature plagioclases, expressed deep indebtedness to Hess for supervision and aid. Harry, in wry humor at himself, wrote (1960), "The work of J. R. Smith on plagioclase supersedes a long but unsuccessful investigation by the writer."

In order to most effectively carry on his research work measuring the Earth's gravity field aboard U.S. Navy submarines in the Caribbean area, he joined the U.S. Naval Reserve as a Lieutenant (junior grade). He was called to active duty on December 8, 1941, and served in the Navy throughout the war. At first he was responsible for predicting the probable activities of U-boats, and his success was legendary. Later, at his request, he was assigned to active sea duty. As Captain of the assault transport U.S.S. *Cape Johnson,* he took part in landings in the Marianas, Leyte, Linguayan Gulf, and Iwo Jima. At the end of the war, he held the rank of Commander. In post-war years, he maintained an active status in the Naval Reserve, serving for a short period on active duty each year. He received successive promotions up to Rear Admiral (upper half) in 1966.

As Captain of the *Cape Johnson,* while cruising during the war, he had the cooperation of members of his crew in making systematic echo-sounding surveys in the Pacific Ocean. As a result, he made one of the significant discoveries of this century: the occurrence of 20 flat-topped seamounts between the Hawaiian and Mariana Islands which he described (1946) as "drowned ancient islands of the Pacific basin" and named "guyots" in honor of the first professor of geology at Princeton. He attributed their origin to subsidence of volcanoes that had been eroded to flat tops by wave action. One guyot he named "Cape Johnson," and a later one (17°50′n. lat., 174°15′W., long.) was named "Hess guyot" in his honor.

He was also responsible (1960, 1962) for another great concept of this century, namely, that mantle convection cells may result in progressive migration of the oceanic crust with its volcanic peaks, guyots, and atolls, away from mid-ocean ridges to the flanks; now known as the hypothesis of "ocean-floor spreading," with new sea floor being generated along the axes of the oceanic ridges. This led to an interpretation of magnetic anomaly strips by Vine and Matthews that tended to support the idea. W. H. Lee found that for 1966-1968 the most cited paper in 30 common solid earth geophysics journals was that of Hess (1962) on the *History of Ocean Basins.*

Hess's name became intimately linked with project Mohole, a proposal to drill beneath the ocean into the mantle, because of his drive and sponsorship to secure the requisite financing. Originally suggested to Hess by Walter Munk, an oceanographer, it was discussed by them in 1957 at a breakfast meeting of

AMSOC, (American Miscellaneous Society), a name for an informal group of scientists from miscellaneous fields to consider miscellaneous new ideas that might be worth pursuing further. At the International Congress of Geodesy and Geophysics in September 1957, a resolution was passed recommending the project. Support for the project was not unanimous among geologists, but it was pushed hard by Hess and members of his committee, and funds to start were obtained from the National Science Foundation in 1958. Hess was chairman of the site selection panel. In 1962, the first core of basalt from the bottom of the ocean was obtained. Unfortunately cost estimates for reaching the mantle escalated, debate developed over whether an intermediate phase ship to thoroughly sample deep sea sediments should come first, and partisan political factors entered; appropriations for the project ceased in 1966. The project, however, established the feasibility of dynamically positioning a drilling ship in deep water, obtaining core by rotary drilling, and set a record for drilling in water depth that held until 1968.

Harry participated with Vesing Meinesz in a submarine Gravity Expedition to the West Indies in 1932 and in a U.S. Navy expedition for gravity mapping of the Lesser Antilles in 1934. His papers (1932, 1933, 1938) based on this work are classic, early papers on the relation of gravity to geology, and in them he postulated a great lateral fault along the Cayman trough. In 1947, he initiated a long-term project for geologic research in the Caribbean and obtained the financial cooperation of Princeton University, the governments of Puerto Rico, Venezuela, and Colombia, the U.S. National Science Foundation, the Office of Naval Research, and the aid of several oil companies operating in this area. The project has resulted in 34 published Ph.D. dissertations with 5 more in progress. Students came not only from the United States, but also from Australia, Canada, Colombia, Costa Rica, England, Puerto Rico, South Africa, and Venezuela.

Aside from regional geology and diverse detailed petrologic, stratigraphic and structure studies, the results supplied further bases for discussion of megastructures, emphasized the prevalence of extensive gravity sliding, developed evidence that the metamorphism was due to an increase in geothermal gradient when the rocks were horizontal, led to the hypothesis (1960-1963) that the idea that island arcs are an early stage in alpine-type mountain building is probably invalid and that there are continuous transitions in type of structure from an oceanic island arc, such as the Lesser Antilles, to marginal continental to continental crustal alpine-type of the coastal ranges of South America.

In a recent book (1969), *The Earth's Crust and Upper Mantle*, thirteen different authors refer to discussions by Hess.

He served on the Honorary Advisory Board of the *Journal of Petrology* and took over the editorship of the two-volume treastise on basalts after the death of his friend, Arie Poldervaart, who initiated it.

Professor Hess's brilliant originality in science and carefully reasoned good judgement in public affairs won for him many honors and awards. He was elected to the National Academy of Sciences in 1952, and later to the American

Philosophical Society and the American Academy of Arts and Sciences. He was an honorary Foreign Member of the Geological Society of London, the Geological Society of South Africa, and of the Sociedad Venezolana de Geologos. In 1966, he was elected a foreign member of the Accademia Nazionale dei Lincei and awarded the Feltrinelli prize ($32,000). The same year, he received the Penrose Medal of The Geological Society of America. In 1969, Yale University awarded him an honorary Sc.D. He served as President of two sections of the American Geophysical Union: Geodesy (1951-1953) and Tectonophysics (1956-1958); also as President of the Mineralogical Society of America (1955) and of The Geological Society of America (1963). He was awarded, posthumously (1969), the Distinguished Public Service Award by the National Aeronautics and Space Administration.

As a participant in the lunar sample-analysis program, he had, together with G. Otalora, developed an X-ray system for model mineral analysis of rocks (1969) and was awaiting receipt of a moon-rock sample.

Harry's philosophy embraced more than simple technical studies in science. In a discussion of the justification for planetary exploration, he wrote (1968), "Is *it outrageous for me to suggest that the satisfaction of human curiosity* should or could have its share of support in competition with comfort and happiness as a goal of our society?" He himself had a goal, an intense inner drive for discovery, and he took deep satisfaction in steps toward satisfying man's "need to know."

As Professor R. B. Y. Scott said at the University Chapel, "Harry Hess was not only a thinker and teacher but a doer — servant of his country in war and peace. He lived more in less time than most."

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