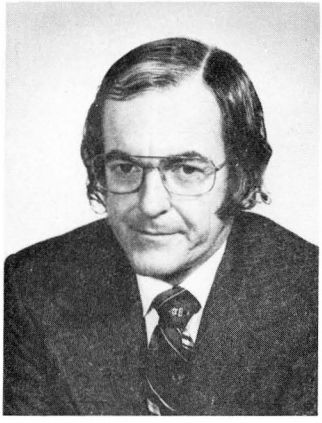
Memorial to Everett Dale Jackson
1925–1978

T. P. THAYER
U.S. Geological Survey, Reston, Virginia 22092

I think I have never had as much fun collaborating with anyone as I had with Dale in 1971–72. Dale loved ideas and he never ceased to generate them. He would discard those that didn't work, but he would nurture a new idea like a gardener with a green thumb.



To appreciate the loss to geological science when Dale Jackson died on July 28, 1978, one should include the above tribute from Eli A. Silver. Dale was born November 29, 1925, in Fresno, California. In 1943, after difficult youthful years, he joined the United States Marine Corps as a volunteer and served three years, partly in the South Pacific. He earned his way through college and graduated magna cum laude from the University of California at Los Angeles (UCLA) in 1950. That same year, Dale joined Josephine Arburua in an exceptionally devoted and successful marriage.

During a short career of only twenty-eight years, Dale pursued three intertwined specialties: (1) petrology of ultramafic and gabbroic rocks, (2) lunar science, and (3) volcanology and tectonics of the Hawaiian Islands and mid-Pacific Ocean. In 1951 Dale left graduate school at UCLA to become chief of the U.S. Geological Survey's Stillwater chromite project. His specific assignment was to determine whether stratigraphy in the layered rocks of the complex could be used to guide exploration for chromite in deep fault blocks. The assignment culminated in 1961 with the publication of U.S. Geological Survey Professional Paper 358, the text of which he had used as a Ph.D. thesis at UCLA in 1960. In effect, with a minimum of supervision as a graduate student, Dale had documented features and formulated nomenclature and fundamental principles (such as the concept of cyclic units) that now are taken for granted in igneous petrology.

The scope of Dale's interests and activities expanded by an order of magnitude after a year of administrative duties in Washington, D.C. In 1963 Dale was assigned to the NASA Manned Space Center in Houston, Texas, to institute and plan geological training for the astronauts in the Apollo program. Although he cultivated the astronauts' interest in geology and convinced them of the importance of geological investigation as one of the main purposes of the lunar missions, difficulties with bureaucracy caused him to leave his position at the Space Center at the end of one year. Dale's interest in the Apollo missions continued after he left Houston, however, and he became a member of the teams that examined lunar samples from Apollos 11, 12, and 14. In 1970, in response to urgent requests, he returned to the Apollo program. He had a major role in planning and conducting the training courses in geology, in studying possible landing sites on the moon, in laying out scientific activities of the missions, and in devising ways and means for prompt dissemination of information from the missions to the public and to the planners of subsequent missions. During the on-site activities of Apollos 15, 16, and 17 at the Moon, Dale's questions and advice to the astronauts from Mission Control Center in Houston helped them resolve many problems and return with better information. Because most of these contributions were made behind the scenes, their importance is not apparent from the printed record. Dale participated in three Group Achievement Awards and was awarded the NASA Exceptional Achievement Medal in 1973.

Despite the energy it demanded and the magnitude of his contributions to it, the Apollo program was only one phase of Dale's activities after he left Washington in 1963. He coupled wide-ranging curiosity with creative imagination to conceive geological problems in a broad framework. He had an exceptional capacity to gather and organize information, together with a genius for stimulating others with new ideas and then enlisting them in projects to test the ideas. Combining these talents with an intense personal drive, Dale covered the vast array of geological problems related to the formation of oceanic crust.

His work in the Stillwater complex greatly increased his understanding of other types of peridotite-gabbro complexes, and further stimulated his interest in them. His critical observations led to identification of a major discontinuity between cumulate dunite and tectonite harzburgite in the Vourinos complex in Greece. He recognized some of the critical differences between harzburgite- and lherzolite-type peridotite-gabbro complexes. He collaborated in consideration of the meaning and nature of the change in peridotite from chromite-bearing harzburgite in the Tethyan belt of the eastern Mediterranean region to lherzolite in the Alpine region. Without this personal knowledge of the rocks in the field and laboratory, including moon rocks, Dale could not have written such a comprehensive and meticulously detailed paper on the origin of ultramafic rocks by cumulus processes.

When Dale left Houston in 1964, he undertook a study of ultramafic inclusions in Hawaiian volcanic rocks. It was the first step on a trail that ended at the Aleutian Trench. In tuffs of Salt Lake Crater he began the first statistical investigation of xenoliths, using a grid system and complete "pebble" count in which thousands of specimens were described individually. His laboratory comparisons of pristine cumulate rocks (and other rocks that had been altered by deformation, re-equilibration, and partial melting) gave him an unexcelled background for studying lunar rocks and the generation of basaltic magma. He correlated the numbers and kinds of xenoliths with their volcanic host rocks, and, by combining this information with regional geophysics and experimental geochemical data with the collaboration of others, he arrived at new interpretations of the oceanic crust and mantle under Hawaii. To determine the origin of rift ridges, Dale and R. S. Fiske resorted to "more and more crazy experiments with Jello," which showed how basalt magma is intruded and erupted along tension zones that are related to nearby older volcanoes by the "edifice effect."

By 1970, Dale had extended his interest beyond the Hawaiian Islands to structural control of volcanism along the Line Island and Hawaiian-Emperor chains. Dale and his colleagues worked out the en echelon pattern of loci along which the volcanoes appear to be distributed, but Dale extended that idea in detail to a curving pattern of loci encompassing all the volcanoes on the chain and used the sense of en echelon offset to infer changing stress patterns within the plate. He and his co-workers were close behind Jason Morgan in their independent development of the concept of hot spots. Dale provided the inspiration and leadership for testing and refining the Morgan-Wilson theory that the volcanoes of the Hawaiian-Emperor chain were formed by northward and westward movement of the Pacific plate over a fixed hot spot near Hawaii. Dale was Co-Chief Scientist on Deep Sea Drilling Project (DSDP) Leg 33 when the Line Island chain was drilled in 1973. After a proposal to drill the Hawaiian-Emperor chain failed in 1971, Dale persevered as usual, and in 1975 he succeeded in getting DSDP Leg 55 approved. He was Co-Chief Scientist also on that leg, which exceeded all expectations in proving the theory valid.

Although Dale's proficiency as a scientist was founded on brilliance, meticulous attention to detail, and great intensity of purpose, his international recognition was won equally by personal warmth, natural ability as a teacher, and generosity with ideas. In his bibliography of more than 110 titles, he is the sole author of 22 major papers and abstracts; the dominance of jointly written papers reflects his qualities and esteem as a team worker and

leader. As a collaborator he was demanding of others, but usually he was a major contributor and the principal writer. In arguments he did not raise his voice but made his points cogently and with good humor. He was very persistent and had an enviable facility for finding funds and otherwise attaining worthwhile objectives. With students he was a friendly listener who did not flaunt his knowledge. Dale was in constant demand as a participant in symposia and as a university lecturer; he was a visiting professor at the University of California at Santa Barbara in 1967 and at Princeton in 1976. He was editor of the *Journal of Petrology* from 1969 through 1973 and a member of the Honorary Advisory Board when he died. He was a Fellow of the American Geophysical Union, the Mineralogical Society of America, and the Geological Society of America, whose Special Commendation Award he received in 1973. He was also a member of several other professional societies.

Dale will be remembered by those who knew him best as a very special person. Although he was impatient with bureaucracy and pomposity, he was highly sensitive to the problems of other people and to injustice. He took a personal interest in many students, serving as an adviser on theses, sponsoring postdoctoral fellows, and otherwise helping several students to get started professionally. Dale and Jo had three children, twin daughters and a son, who are now candidates for Ph.D. degrees. The Jackson family was a closely knit one, yet without any infringement on the individual intellectual freedom that Dale prized so highly and exercised so well.

ACKNOWLEDGMENTS

I greatly appreciate suggestions and information for this memorial from G. B. Dalrymple, R. S. Fiske, A. J. Irving, C. B. Raleigh, E. A. Silver, and H. G. Wilshire.

SELECTED BIBLIOGRAPHY OF E. D. JACKSON

1961 Primary textures and mineral associations in the ultramafic zone of the Stillwater Complex, Montana: U.S. Geological Survey Professional Paper 358, p. 1–106.

1963 Stratigraphic and lateral variation of chromite compositions in the Stillwater Complex: Mineralogical Society of America Special Paper 1, p. 46–54.

—— (with Hotz, P.E.) X-ray determinative curve for olivines of composition Fo_{80-95} from stratiform and alpine-type peridotites: U.S. Geological Survey Professional Paper 450-E, p. E101–E102.

1966 "Eclogite" in Hawaiian basalts: U.S. Geological Survey Professional Paper 550-D, p. D151–D157.

1967 (and Stevens, R. E., and Bowen, R. W.) A computer-based procedure for deriving mineral formulas from mineral analyses: U.S. Geological Survey Professional Paper 575-C, p. C23–C31.

1968 The character of the lower crust and upper mantle beneath the Hawaiian Islands: International Geological Congress, 23rd, Prague, Proceedings, v. 1, p. 135–150.

1969 (with Kistler, R. W., and Obradovich, J. D.) Isotopic ages of rocks and minerals from the Stillwater Complex, Montana: Journal of Geophysical Research, v. 74, p. 3226–3237.

—— Chemical variation in coexisting chromite and olivine in chromitite zones of the Stillwater Complex, *in* Wilson, H.D.B., ed., Magmatic ore deposits: Economic Geology, Monograph 4, p. 41–71.

1970 (with O'Neil, J. R., and Hedge, C. E.) Isotopic investigations of xenoliths and host basalts from the Honolulu Volcanic Series, Hawaii: Earth and Planetary Science Letters, v. 8, p. 253–257.

1970 (and Wright, T. L.) Xenoliths in the Honolulu Volcanic Series, Hawaii: Journal of Petrology, v. 11, p. 405–430.
—— The cyclic unit in layered intrusions A comparison of repetitive stratigraphy in the Stillwater, Muskox, Great Dyke, and Bushveld Complexes: South Africa Geological Society Special Publication 1, p. 391–424.
1971 The origin of ultramafic rocks by cumulus processes: Fortschritte der Mineralogie, v. 48, p. 123–174.
1972 (and Silver, E. A., and Dalrymple, G. B.) The Hawaiian-Emperor chain and its relation to Cenozoic circum-Pacific tectonics: Geological Society of America Bulletin, v. 83, p. 601–618.
—— (with Fiske, R. S.) Orientation and growth of Hawaiian volcanic rifts: The effect of regional structure and gravitational stresses: Royal Society [London] Proceedings, v. 329, p. 299–326.
(and Thayer, T. P.) Some criteria for distinguishing between stratiform, concentric, and alpine peridotite-gabbro complexes, *in* International Geological Congress, 24th, Montreal, Proceedings, Sec. 2, p. 289–296.
(with Wilshire, H. G.) Petrology and stratigraphy of the Fra Mauro Formation at the Apollo 14 landing site: U.S. Geological Survey Professional Paper 785, 26 p.
(with Wilshire, H. G.) Lunar "dunite," "pyroxenite," and "anorthosite": Earth and Planetary Science Letters, v. 16, p. 396–400.
—— (with Nicolas, Adolphe) Repartition en deux provinces des peridotites des chaines alpines longeant la Mediterranee; implications geotectoniques: Schweizerische Mineralogische und Petrographische Mitteilungen, v. 52, no. 3, p. 479–495.
1973 (with Dalrymple, G. B., and Silver, E. A.) The origin of the Hawaiian Islands: American Scientist, v. 61, p. 294–308.
—— (with Wilshire, H. G., and Stuart-Alexander, D. A.) Apollo 16 rocks: Petrology and classification: Journal of Geophysical Research, v. 78, p. 2379–2392.
1974 (with Dalrymple, G. B., and Lanphere, M. A.) Contributions to the petrography and geochronology of volcanic rocks from the leeward Hawaiian Islands: Geological Society of America Bulletin, v. 85, p. 727–738.
1975 (and Shaw, H. R., and Bargar, K. E.) Calculated geochronology and stress field orientations along the Hawaiian chain: Earth and Planetary Science Letters, v. 26, p. 145–155.
(and Sutton, R. L., and Wilshire, H. G.) Structure and petrology of the cumulus norite boulder in Taurus-Littrow Valley, the Moon: Geological Society of America Bulletin, v. 86, p. 433–442.
—— (and Green, H. W., II, and Moores, E. M.) The Vourinos ophiolite, Greece: Cyclic units of lineated cumulates overlying harzburgite tectonites: Geological Society of America Bulletin, v. 86, p. 390–398.
1976 (and Schlanger, S. O.) Regional syntheses, Line Island chain, Tuamotu Island chain, and Manihiki Plateau, Central Pacific Ocean, *in* Schlanger, S. O., Jackson, E. D., and others, Initial reports of the Deep Sea Drilling Project: Washington, D.C., U.S. Government Printing Office, v. 33, p. 915–927.
—— (with Schlanger, S. O. and others) Initial reports of the Deep Sea Drilling Project: Washington, D.C., U.S. Government Printing Office, v. 33, 973 p.
1978 (and others) Drilling confirms hot-spot origins: Geotimes, v. 23, no. 2, p. 23–26.
1979 Further effects of fractional resorption, *in* Yoder, H . S., ed., The evolution of the igneous rocks: 50th anniversary perspectives: Princeton, N.J., Princeton University Press (in press).

Printed in U.S.A. 3/80