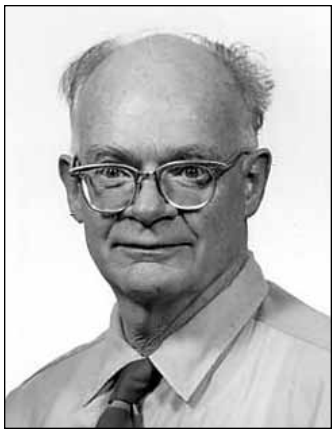
Memorial to David J. Varnes 1919–2002

BY HIS FRIENDS AT THE U.S. GEOLOGICAL SURVEY
Denver, Colorado



David J. Varnes, born April 5, 1919, had a remarkable career in geology that spanned more than 60 years. Following graduation from Cal Tech with honors in 1940 and a year of graduate study at Northwestern, he began, in the summer of 1941, a lifelong association with the U.S. Geological Survey. Dave's first job title in 1941 was "Recorder," and he listed his activities as "cooked, carried instruments, and helped work out the geology of the north half of the Saypo Quadrangle, Montana." This was a time when the USGS was committed to mentoring new hires, and his exposure to geology was shared with a responsibility for the logistic details of fieldwork. Early mapping experience after his work in Montana ranged from a short tour in the Dominican Republic to the San Juan Mountains of southwestern Colorado, principally at Ophir and Rico. By 1945, Dave was supervising junior geologists and leading studies of mineral deposits in the San Juan Mountains.

A most striking characteristic of Dave's career was his ability to extract unexpected and extraordinary scientific insights while completing an assigned task. His early work in the San Juans produced several maps and papers related to mineral deposits. About ten years after leaving the San Juans, he wrote a classic USGS Professional Paper on a structural problem related to mineralization in the San Juans. The study, a theoretical analysis of plastic deformation using von Mises' failure criterion, was then the only mathematical analysis of a major vein system in which the theoretical fault pattern was directly overlaid on the actual mapped structures. This paper showcased his ability to merge thorough analytical analysis with careful geologic observations.

In 1948, Dave became a charter member of the newly organized USGS Engineering Geology branch, under the leadership of Ed Eckel. Here blossomed a lifelong interest in problems related to the application of geology to engineering problems. The investigations he undertook during those early years of the Engineering Geology branch included working on surficial geology in Utah, investigating gravel resources, and serving as advisor to the Bureau of Public Roads on landslide problems in Yellowstone and Grand Teton National Parks, to the U.S. Bureau of Reclamation on the Central Utah Project, and to the U.S. Navy on an explosion site. The bulk of his energies through the mid-1950s were directed to a study of the future site for the Air Force Academy in Colorado Springs, Colorado. He led the acquisition of geologic and hydrogeologic data that were incorporated into the master plan for development of the Academy. The final product, which was completed with Glenn Scott, set the standard for studies of its type. The paper won the Geological Society of America Burwell Award in 1970.

And, in the same way that the work on plastic deformation in the San Juans came indirectly from a principal assignment, Dave produced a definitive work on landslide classification included in the 1958 Highway Research Board book on landslides and engineering practice. Dave's chapter, entitled "Landslide Types and Processes," established the framework for slope

movement investigations in modern geotechnics. The 1958 paper, together with a 1978 revision, has set out what is internationally recognized as the standard for landslide classification.

During this very productive period in his career, another topic caught his attention that would be revisited years later. Dave and others wisely recognized that the Slumgullion earth flow near Lake City, Colorado, is one of the few landslides in the world where movement continues day after day, year after year, and can serve as a field laboratory for studies of ground deformation within and near the active earth flow. Together with Rocky Crandell, he measured rates of movement at several places on the landslide surface and, in a couple of short papers, showed that the velocity was roughly proportional to the width of the landslide. Dave returned to Slumgullion 30 years later to study the deformation in the inactive landslide deposits downhill from the advancing toe of the active landslide.

From 1961 to 1964 Dave took his turn in USGS management, serving as chief of the Engineering Geology branch. Immediately following his hitch in management, Dave returned to Oak City, Utah, to study deposits of the Pleistocene Lake Bonneville. Always an admirer of the work of the giants in geology, he was here following the footsteps of G.K. Gilbert. Imbedded in the pages of one of Gilbert's field notebooks, Dave found a small fishing lure and made sure to catch a trout with it before putting it back. The Great Alaskan Earthquake interrupted work and play in 1964. Dave was handed the job of assessing stability of slopes around the Port of Anchorage, wherein he produced detailed maps and analyses of earthquake-induced ground failures.

By 1970 he was again free to pursue the research interests that had been smoldering for a decade. He started a new project called Rock Mechanics Research and dove into studies of creep to failure and residual stress. He built a physical model out of Popsicle sticks and rubber bands to simulate creep driven by residual stress and made a movie of the model's behavior. This was the beginning of research that would carry him to the end of his career. Almost as a sidebar to his main research interests, he wrote a monumental publication on the logic of geologic maps with reference to interpretation and use for engineering purposes. For this publication, Dave was awarded a second Burwell Award from the Geological Society of America. Thus far, he is the only two-time recipient of that award.

By the late 1970s, Dave was moving full-speed ahead on both creep to failure and engineering geologic mapping. Engineering geologic mapping, especially with respect to landslide-hazard zonation, was pursued through a commission of the International Association of Engineering Geology (IAEG). That activity further exposed Dave's work to earth scientists from around the world and resulted in a United Nations Educational, Scientific and Cultural Organization (UNESCO) publication on landslide-hazard zonation. The French government recognized the work with an award by which Dave was made a Chevalier dans L'ordre des Palmes Academics in 1985. His activities here opened the practice of engineering geology in the United States to a broader international level through participation in the IAEG. Through the National Academy of Sciences, he took the lead to organize an American group for IAEG and served as its first leader. Later, the IAEG honored Dave with their highest award, the Hans Cloos Medal for career achievements in engineering geology.

In collaboration with Dorothy Radbruch-Hall, he began field studies of sackung, which appeared to be a creep-to-failure phenomenon that involved gravitational spreading of ridge tops and potential failures of huge masses of rock. Field observations were begun at several sites in the Rocky Mountains; high-precision measurements were made with electronic distance measuring devices and a theodolite. While the field measurements did not capture a creep-to-failure event, the well-marked stations are in place and have been precisely surveyed several times. Closure for his part in the work was summarized in an IAEG paper with Bill Savage on the mechanics and a USGS Professional Paper that outlined topographic and structural conditions existing in areas of gravitational spreading of ridges in the western United States.

Dave had found some work by Japanese scientists that advanced his ideas of residual stress and creep to failure. The work offered a method to predict time of failure from a series of precursor measurements of a process. To learn whether the work could be adapted to natural events such as volcanic eruptions, large landslides, and earthquakes, Dave began systematically working on published data of measurements of processes leading to failure. The analytical analyses of time to failure appeared to have wide application to several natural earth processes. But the most exciting results for Dave were in terms of earthquake prediction. His analysis of foreshocks provided excellent results in prediction of time-of-earthquake main shock. In a series of papers that described the method, Dave examined seismic energy release for specific events around the world. His 1996 analysis with Chuck Bufe of the fractal and log-periodic timing of a foreshock sequence in the Virgin Islands is a classic. The earthquake prediction work has attracted worldwide attention and debate, and may well be his most enduring contribution.

On January 3, 1995, Dave retired after more than 53 years of work for the USGS. He retained his office and continued to work as a scientist emeritus on the Slumgullion earth flow and time-to-failure theory. A summary of results on Slumgullion won the Holdridge Award from the Association of Engineering Geologists in 1996.

David married Helen Dowling in 1943, and it was through her work on landslides that he developed a career-long interest in slope stability. After Helen's death in 1964, he married Katharine Buck, also a geologist and widow of Larry Buck, an engineering geologist. Their combined family includes five children and three grandchildren.

There was obviously much more to Dave's career than can be described here. On the personal side, he barely escaped with his life when North Korea invaded South Korea in 1951. At the time, he had been detailed to map resources in the Samchok coalfield. He and a colleague were overrun and fell behind enemy lines. David escaped; his colleague did not. On the academic side, one might wonder how a person without graduate degrees could accomplish so much over so broad a range of topics. Of course he was talented, but he took training where he felt he needed it. In his personnel file are transcripts for the non-geology–related training that he felt he needed to understand what he was working on. Included are courses on the theory of elasticity and differential equations as well as Russian and Chinese. Dave was a scholar who studied hard, worked hard, and accomplished much.

Those of us who had the privilege of working with him miss his wonderful humor, scientific insights, and warm friendship.

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