

Memorial to Gary L. Dixon 1943–2017

PETER D. ROWLEY

Geologic Mapping Inc., New Harmony, Utah 84757, USA

TERRY C. KATZER

Cordilleran Hydrology, Inc., Carson City, Nevada 89703, USA

MEL A. KUNTZ

U.S. Geological Survey Emeritus, Denver, Colorado 80225, USA

GARRETT S. VICE

ExxonMobil Upstream Research Company, Houston, Texas 77060, USA

DOUGLAS M. MORTON

U.S. Geological Survey Emeritus, Riverside, California 92521, USA

JAMES E. FAULDS

Nevada Bureau of Mines and Geology/University of Nevada, Reno, Nevada 89557, USA

Gary L. (Leo) Dixon died on 14 January 2017, at his home in Blackfoot, Idaho, from colorectal cancer. He is survived by his wife Wendy Dixon; his son Chris Dixon and his daughter Natalie Dixon Pique to his first wife Suzanne Scherer; grandchildren Aaron Dixon and Jake and Scott Pique; great-grandchild Cooper Pique; and sisters Dee Hall, Lynda Pittman, and Ginger Larson (tragically, Ginger died later in January). Gary was a loving husband and father, a loyal friend, and a great field geologist. His most obvious passions were geology, golf, supporting his wife's demanding career, and encouraging her devotion to her horses. He and Wendy built their own private paradise in Blackfoot. There he melded with the community by serving with the Riverside Canal Company and the zoning commission. He loved to cook and barbeque, planted timothy grass for the horses, and grew an orchard for canning fruit. He and his brother-in-law, Chuck Hall, played in many golf trips around the country and even at St. Andrews, Scotland, where they competed not to lose to the other and get "da shoe," an old beat-up golf shoe that the loser had to put on prominent display until their next match. He became an expert on the health and care of horses, including as "midwife." Clearly, Gary's contributions and interests were broad and varied.



Gary was born in Salt Lake City on 14 October 1943, to Alice and Harry Dixon. He graduated from East High School in Denver in 1961, and attended Western State College in Gunnison, Colorado, from March 1962 to June 1965, majoring in geology and history. He joined the Geologic Division of the U.S. Geological Survey (USGS) in June 1965 as a physical science technician with the Special Projects Branch in Denver. During this time, the United States was in the Cold War, and the Branch was engaged in research to site underground nuclear bomb tests and to identify storage sites for radioactive wastes. His research specialties became geologic mapping, hydrogeology, and volcanic geology. He applied these specialties as manager in projects involving nuclear weapons, waste storage, and groundwater dispersal of contaminants,

supported by the U.S. Department of Energy (DOE) and its predecessor agencies, on the Nevada Test Site (NTS) and other parts of southern and central Nevada. His research involved some of the best geologists in the country, and Gary learned fast from them. Gary's supervisor, E. Bart Ekren, was one of these people, and he and others soon recognized Gary's budding geologic and leadership talents and persuaded him to return to Western State from June 1967 to March 1969, receiving his B.A. in 1969.

Gary was promoted to geologist in 1970 and began mapping geologic quadrangles in central Nevada with Bart Ekren, Ken Sargent, Bob Bucknam, Ernie Anderson, and others. The region was underlain mostly by Tertiary outflow ash-flow tuffs and their calderas, and was considered for possible testing sites and waste-storage areas. A 1:250,000-scale geologic map of the Tertiary rocks of Lincoln County, Nevada (the size of Vermont), headed by Bart and Gary, was part of a high-deadline USGS project to map all counties of Nevada. More practical needs called for him to evaluate containment of nuclear wastes from hundreds of nuclear tests (above-ground tests ceased by 1962, and underground tests ceased by 1992) on the NTS. Gary not only helped site tests but also post-test drill holes, then evaluate the results. By 1973, he was supervising this work, and by 1977, he was the coordinator for many waste-management programs on the NTS. He was particularly good at combining geology, geophysics, and hydrology, then writing proposals and completing report deliverables at strict deadlines set by DOE.

By 1981, Gary was the acting branch chief of the Special Projects Branch, which consisted of about 45 geologists. By then, world politics had changed and the USGS decided to disband the Branch. Gary was responsible for enacting that change, including placing his staff in other assignments. He was also, until 1989, the program manager for the Radioactive Waste Disposal Program, supervising 75 people and all activities by the Geologic Division on the Nevada Test Site. He moved to Las Vegas in 1983 to handle these responsibilities, along with the role of deputy chief for program development, Weapons Program. His duties in these jobs were to represent the USGS in collaboration with DOE and other agencies through endless advisory panels and committees, field trips to the NTS, and interviews with print, radio, and TV news media. During all this, he found the time to marry Wendy Arevelo on 7 July 1983. He and Terry Katzer, then head of the Nevada State Office of the USGS Water Resources Division (WRD), established the USGS Las Vegas office in 1985, where unusually close cooperation between the two divisions continued in parallel projects at NTS and Yucca Mountain. Other joint projects included determining water resources and siting production wells for Southern Nevada Water Authority (SNWA)/Las Vegas Valley Water District and other outside-funded clients.

From 1989 to 1995, he returned to geologic mapping, this time in the Mojave Desert of California, working with Doug Morton. The Landers earthquake (1992) created miles of ground rupture that they mapped. Late one day, Gary took a shortcut across an area that should not have had any surface breaks, only to come to an abrupt halt at a rupture with sizeable offset! Societal issues, including identifying pollution problems, finding groundwater resources, and identifying geologic hazards, were a major part of the work. He and Doug secured outside funding from Air Force bases to do much of their mapping. In 1995, Gary founded the Las Vegas Urban Corridor project and brought in Pete Rowley to take over management of the NTS program for the Geologic Division; in fact, the two of them co-managed both projects. Project work included the Las Vegas 1:100,000-scale geologic quadrangle with Ric Page, the final 1:100,000-scale NTS map, and other maps and reports where societal issues dominated. The NTS work, with continued DOE funding and close cooperation with WRD, identified groundwater flow-paths contaminated by deep underground nuclear tests.

In 1999, Gary retired from the USGS and started his own consulting company, Southwest Geology Inc. With colleagues Pete Rowley, who retired a year later, and Bart Ekren, they

identified groundwater resources in upstate Nevada for SNWA to supplement Las Vegas' water supply in Lake Mead. They focused on compiling 1:250,000-scale geologic maps and cross sections for SNWA, on contracting geophysics from the USGS, and as expert witnesses at state engineer hearings. The SNWA work embraced a map area of more than 25,000 square miles that included two great regional groundwater flow systems that spanned the Nevada-Utah border. Other consulting work, most of it cooperative, included geologic and hydrogeologic reports and siting well fields and wells for water districts and private citizens in Idaho, Nevada, and Utah. The results of these efforts were generally published, regardless of whether the employer paid for it. The last of these publications, now in press, included the SNWA research, almost 20 years in the making.

Gary has a significant research legacy, with more than 70 peer-reviewed published reports that he authored and coauthored, not including abstracts. No person knew the geology and hydrogeology of Nevada better than he. The concepts of groundwater fracture flow, the meaning of spring mounds, siting production water wells on the downthrown side of basin-range faults, and applying geologic mapping and structural geology to trace groundwater flow paths are largely based on his ideas. He helped understand east-west Cenozoic transverse zones. He was an insightful technical reviewer. Yet probably his greatest contributions were in scientific leadership through management, especially in practical and "societally relevant" aspects of geology. Gary had a natural supportive talent, honesty, high morals, leadership, sense of humor, common sense, and fairness that made him both respected and loved by those who worked with and for him. Many of his discoveries and ideas were given to others to publish and contributed to their promotions. He mentored many students and other young people who came his way, whether in geology or elsewhere. He had extraordinary people skills and these, along with his oral skills and high standards, made him especially valuable in managing and publishing cooperative work with many scientists across numerous agencies. Once in private practice, his colleagues received the lion's share of money in projects for which he secured the funds. Gary was genuinely humble; he never understood how much of an effect he had on those who benefited from his presence. He seemed to believe in others more than himself. Because he cared about others, one of his greatest scientific influences was on the careers and lives of others. His emphasis on societally relevant geology also inspired many and changed the trajectory of careers. His knowledge and integrity cannot be replaced but continue on in the many lives that he touched. Through it all, even when he knew his stage 4 cancer would do him in, his remarkable courage and sense of humor continued to encourage others. All who knew Gary will miss him terribly.

SELECTED BIBLIOGRAPHY OF GARY L. DIXON

- 1972 (with Snyder, R.P., and Ekren, E.B.) Geologic map of the Lunar Crater quadrangle, Nye County, Nevada: U.S. Geological Survey Miscellaneous Investigations Map I-700, scale 1:48,000 (15-minute quadrangle).
- 1972 (with Hedlund, D.C., and Ekren, E.B.) Geologic map of the Pritchards Station quadrangle, Nye County, Nevada: U.S. Geological Survey Miscellaneous Investigations Map I-728, scale 1:48,000 (15-minute quadrangle).
- 1972 (with Ekren, E.B., and Hedlund, D.C.) Geologic map of the Wall quadrangle, Nye County, Nevada: U.S. Geological Survey Miscellaneous Investigations Map I-719, scale 1:48,000 (15-minute quadrangle).
- 1973 (with Ekren, E.B., and Rogers, C.L.) Geologic map of the Reveille Range quadrangle, Nye County, Nevada: U.S. Geological Survey Miscellaneous Investigations Map I-806, scale 1:48,000 (15-minute quadrangle).

- 1975 (with Sargent, K.A., and Carr, W.J.) Abandonment of the Indian Trail Formation and distribution of certain equivalent ash-flow tuffs, eastern Nevada Test Site: U.S. Geological Survey Bulletin 1422-A, p. 29–54.
- 1976 (with Ekren, E.B., Bucknam, R.C., Carr, W.J., and Quinlivan, W.D.) East-trending structural lineaments in central Nevada: U.S. Geological Survey Professional Paper 98, 16 p.
- 1977 (with Ekren, E.B., Orkild, P.P., and Sargent, K.A.) Geologic map of Tertiary rocks, Lincoln County, Nevada: U.S. Geological Survey Miscellaneous Investigations Series Map I-1041, with text, scale 1:250,000.
- 1993 (with Ward, A.W.) Preliminary geologic map of the Rogers Lake South quadrangle, Los Angeles and Kern Counties, California: U.S. Geological Survey Open-File Report 93-697, scale 1:24,000.
- 1993 (with Ward, A.W.) Preliminary geologic map of the Edwards quadrangle, Kern County, California: U.S. Geological Survey Open-File Report 93-698, scale 1:24,000.
- 1993 (with Ward, A.W.) Preliminary geologic map of the Rogers Lake North quadrangle, Kern County, California: U.S. Geological Survey Open-File Report 93-696, scale 1:24,000.
- 1993 (with Ward, A.W.) Preliminary geologic map of the Redman quadrangle, Los Angeles and Kern Counties, California: U.S. Geological Survey Open-File Report 93-695, scale 1:24,000.
- 1995 (with Schmidt, D.L.) Geology and aquifer system of Coyote Spring Valley area, southeastern Nevada: U.S. Geological Survey Open-File Report 95-579, 47 p.
- 1998 (with Page, W.R., and Workman, J.B.) The Blue Diamond landslide—A Tertiary landslide breccia deposit in the Las Vegas area, Clark County, Nevada: Geological Society of America Map and Chart Series MCH083, 11 p., scale 1:24,000.
- 1999 (with Slate, J.L., and 13 others) Digital geologic map of the Nevada Test Site and vicinity, Nye, Lincoln, and Clark Counties, Nevada, and Inyo County, California: U.S. Geological Survey Open-File Report 99-554-A, 53 p., CD-ROM, scale 1:100,000.
- 2001 (with Rowley, P.D.) The Cenozoic evolution of the Great Basin area, U.S.A.—New interpretations based on regional geologic mapping, *in* Erskine, M.C., Faulds, J.E., Bartley, J.M., and Rowley, P.D., eds., *The geologic transition, High Plateaus to Great Basin—A symposium and field guide (The Mackin Volume)*: Utah Geological Association Publication no. 30 and Pacific Section of the American Association of Petroleum Geologists Guidebook GB 78, p. 169–188.
- 2002 (with Workman, J.B., and others) Tectonic map of the Death Valley ground-water model area, Nevada and California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2381-B, scale 1:250,000.
- 2002 (with Katzer, T.) Geology and hydrology of the lower Virgin River Valley in Nevada, Arizona, and Utah: Mesquite, Nevada, Virgin Valley Water District Report VVWD-01, 126 p., scale 1:100,000.
- 2003 (with Workman, J.B., and others) Geologic map of the Death Valley ground-water model area, Nevada and California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2381-A, scale 1:250,000.
- 2004 (with Rowley, P.D., D'Agnesse, F.A., O'Brien, G.M., and Brickey, D.W.) Geology and hydrology of the Sand Hollow Reservoir and well field area, Washington County, Utah: St. George, Utah, Washington County Water Conservancy District Report WCWCD-01, 14 p. + CD-ROM, scale 1:12,000.
- 2004 (with Rowley, P.D.) The role of geology in increasing Utah's ground-water resources from faulted terranes—Lessons from the Navajo Sandstone, Utah, and the Death Valley flow system, Nevada-California, *in* Spangler, L., ed., *Ground Water in Utah—Resource, protection, and remediation*: Utah Geological Association Publication 31, p. 27–41.

- 2005 (with Page, W.R., Rowley, P.D., and Brickey, D.W.) Geologic map of parts of the Colorado, White River, and Death Valley groundwater flow systems, Nevada, Utah, and Arizona: Nevada Bureau of Mines and Geology Map 150, 21 p., scale 1:250,000.
- 2005 (with Rowley, P.D., and Brickey, D.W.) Geology along the route of the Lake Powell water pipeline, Utah and Arizona: St. George, Utah, Washington County Water Conservancy District Report WCWCD-02, 17 p. + CD-ROM, scale 1:75,000.
- 2005 (with Page, W.R., and others) Geologic and geophysical maps of the Las Vegas 30' x 60' quadrangle, Clark and Nye Counties, Nevada, and Inyo County, California: U.S. Geological Survey Scientific Investigation Map SIM-2814, 53 p., scale 1:100,000.
- 2007 (with Rowley, P.D., Burns, A.G., Watrus, J.M., and Ekren, E.B.) Geology of White Pine and Lincoln Counties and adjacent areas, Nevada and Utah—The geologic framework of regional groundwater flow systems: Las Vegas, Southern Nevada Water Authority, Doc. No. HAM-ED-0001, variously paginated + CD-ROM, plus 9 plates of 1:250,000-scale digital geologic maps, hydrogeologic maps, geologic cross sections, hydrogeologic cross sections, and explanation of map units; map area 25,000 mi².
- 2009 (with Rowley, P.D., Burns, A.G., and Collins, C.A.) Geology and hydrogeology of the Snake Valley area, western Utah and eastern Nevada, *in* Tripp, B.T., Krahulec, Ken, and Jordan, J.L., eds., *Geology and geologic resources and issues of western Utah*: Utah Geological Association Publication 38, CD, p. 251–269 + Plate 1, Geologic map, cross sections, and explanation of geologic units of the Snake Valley area (scale 1:250,000); map area 6,000 mi².
- 2012 (with Rowley, P.D., and others) Fault-derived conduit and barrier groundwater flow at Sawyer Spring, eastern margin of the Pine Valley Mountains, Washington County, Utah, *in* Hylland, M.D., and Harty, K.M., eds., *Selected topics in engineering and environmental geology in Utah*: Utah Geological Association Publication 41, CD, p. 99–114.
- 2012 (with Ekren, E.B., and others) Geology of the Quinn Canyon Range and vicinity, Nye and Lincoln Counties, Nevada: Las Vegas, Southern Nevada Water Authority Doc. No. HAM-ED-0004, 61 p., scale 1:100,000.
- 2016 (with Rowley, P.D., and others) Geology, selected geophysics, and hydrogeology of the White River and parts of the Great Salt Lake Desert regional groundwater flow systems, Utah and Nevada, *in* Comer, J.B., Inkenbrandt, P.C., Krahulec, K.A., and Pinnell, M.L., eds., *Resources and geology of Utah's West Desert*: Utah Geological Association Publication 45, p. 167–200.
- In press, 2017 (with Rowley, P.D., and others) Geology and geophysics of White Pine and Lincoln Counties, Nevada, and adjacent parts of Nevada and Utah—The geologic framework of regional groundwater flow systems: Nevada Bureau of Mines and Geology, CD-ROM, plus 5 plates of 1:250,000-scale digital geologic maps, geologic cross sections, and explanation of map units; map area 25,000 mi².