NEVADA BUREAU OF MINES AND GEOLOGY

OPEN-FILE REPORT 12-10

Biennial Report of the Nevada Bureau of Mines and Geology

2012

Nevada Bureau of Mines and Geology

Mackay School of Earth Sciences and Engineering
College of Science
University of Nevada, Reno

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Cover photo:
Quartzite rocks are seen in the cirque and at Baker Peak (elevation 12,298 feet) in the Snake Range looking south from the summit of Wheeler Peak (elevation 13,063 feet), White Pine County (above). *Photographer: Jim Faulds*

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Nevada Bureau of Mines and Geology

The Nevada Bureau of Mines and Geology (NBMG) is a research and public service unit of the University of Nevada and is the State geological survey. NBMG is part of the Mackay School of Earth Sciences and Engineering within the College of Science at the University of Nevada, Reno.

NBMG scientists conduct research and publish reports on mineral resources, engineering geology, environmental geology, hydrogeology, and geologic mapping. Individuals interested in Nevada geology are encouraged to visit, call, write NBMG, or visit our home page.

http://www.nbmg.unr.edu

Most NBMG scientists (Director and research faculty) and cartographic and administrative staff are located on the **University of Nevada campus**, 775-794-6691.

U.S. Mail:
Nevada Bureau of Mines and Geology
Mail Stop 178
University of Nevada
Reno, NV 89557-0178

UPS or Federal Express:
Nevada Bureau of Mines and Geology
University of Nevada / Mail Stop 178
1664 N. Virginia Street
Reno, NV 89503

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Reno, NV 89512

Please contact the Publication Sales Office to purchase NBMG geologic maps and reports and U.S. Geological Survey geologic maps, publications, and topographic maps. Walk-in customers, please note: **The cash register closes at 3:00 p.m.** (Tuesday–Friday).

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E-mail: nbmg@unr.edu
Web: www.nbmg.unr.edu

Please contact the Information Office for information on aerial photographs; cuttings, core, and well records for oil, gas, and geothermal; and general geological information.

Phone: (775) 682-8767 (Tuesday–Friday, 8:00 a.m.–3:00 p.m., PST)
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Mission Statement

The Nevada Bureau of Mines and Geology (NBMG) is a research and public service unit of the University of Nevada and is the state geological survey. NBMG is part of the Mackay School of Earth Sciences and Engineering within the College of Science at the University of Nevada, Reno. NBMG scientists conduct research and publish reports on mineral resources, engineering geology, environmental geology, hydrogeology, and geologic mapping.

Current activities in geologic mapping and mineral resources include detailed geologic mapping and stratigraphic studies in Nevada, comparative studies of bulk-mineable precious-metal deposits, geochemical investigations of mining districts, metallic and industrial mineral resource assessments, igneous petrologic studies, hydrothermal experiments, analysis of geothermal fields, and research on the origin of mineral deposits.

Engineering geology, environmental geology, and hydrogeology projects include investigations of earthquake hazards and related aspects of neotectonics, examination of geological issues involved in disposing nuclear and hazardous wastes, mapping of geomorphic features, radon hazard studies, studies of landslide hazards, geochemical characterization of natural environmental hazards, investigations of the fate of mercury from processing Comstock ores by amalgamation in late 1800s, and investigation of land subsidence, primarily in Las Vegas Valley.

Earth science education projects include writing guidebooks for laymen, teachers, and students; presenting lectures, short courses, and workshops; and assisting with science fairs, curriculum development, and conferences. Geologic and geographic information activities include creating and updating databases on mining districts, active mines and prospects, and geothermal and petroleum exploration and production; implementation and development of statewide geographic information systems and the digital maps needed for these systems; and maintenance of core and cuttings facilities, rock and mineral collections for research, aerial photographic imagery and maps, and extensive files on Nevada geology and resources.

NBMG cooperates with numerous state and federal agencies in conducting research and in providing geologic and resource information. Research results are published as NBMG bulletins, reports, maps, and special publications as well as in federal publications and scientific journals. In addition to addressing the needs for geologic information by conducting research, publishing reports and maps, and creating computer databases, staff members assist the public, industry, and government agencies by answering specific questions regarding Nevada geology and resources and by providing some chemical and mineralogical analyses.

History of the Nevada Bureau of Mines and Geology

The following paragraphs are excerpted from the chapter "The Nevada Bureau of Mines and Geology" by Joseph V. Tingley (in *The State Geological Surveys: A History*, edited by Arthur A. Socolow, published by Association of American State Geologists, 1988, pages 282–295)

To read the entire chapter on the history of the Nevada Bureau of Mines and Geology, see the following link on the Nevada Bureau of Mines and Geology website:

http://www.nbmg.unr.edu/_docs/HistoryOfNBMG.pdf

On March 20, 1865, during its first session, the Nevada Legislature created the position of state geologist; an act was passed that provided for appointment by the Board of Regents of a State Geologist of Nevada who,

> ...shall proceed to make a preliminary and superficial geological survey of the mineral regions of the state, ...and to prepare a map, marked and colored in such a manner as to indicate the general geological divisions, as developed in the country examined.

The following year [1866], during the second session of the legislature, an act was passed which created the office of State Mineralogist. The State Mineralogist was to serve under the Board of Regents and was, among other things, to be superintendent of a state mining school; to visit and examine mineral properties within the state; to collect, mark, and catalog mineral specimens; to devise the course of studies at the mining school; to teach at the school; and to collect information concerning the different modes of working mines and reducing ores.

In 1869, the position of State Mineralogist was removed from the control of the Board of Regents and was made an elective office; White was appointed to continue in the position until the general elections of 1870. H.R. Whitehill was elected to the position and took office in January 1871. Whitehill held the job until 1878 when the office was abolished by the Legislature. The reports of the State Mineralogist, issued biennially during the 12-year life of the office, are in some cases the only surviving records of many mining operations in remote parts of the state.

In 1888, a School of Mining was formally organized at the new Reno campus of the University of Nevada with Robert D. Jackson as its first Director. In 1895 the Nevada legislature charged the University with the responsibility of providing an assay service for citizens of the state and the Mining Analytical Laboratory was established. As the first public service division of the University, the laboratory was the organizational predecessor of the Nevada Bureau of Mines and Geology.

In 1929, under Fulton's directorship, the Nevada Bureau of Mines was formed as the second public service division of the University of Nevada. Fulton took personal credit for initiating legislation which led to the formation of the Bureau. In a letter to the President of the University in 1939, Fulton stated:

> The mining states of the West all have a Bureau of Mines...The services performed by these Bureaus are of great value to the mining industry and inasmuch as mining is the paramount industry in Nevada, it seemed to me important to have such an agency here. ..I therefore, after discussing the matter with the President [of the university], had a bill introduced in the 34th legislature in 1929 establishing a Bureau of Mines...

History of the Nevada Bureau of Mines and Geology

Assembly Bill No. 83, approved March 29, 1929, brought the Nevada Bureau of Mines into existence. It was to be under the direction of the Board of Regents of the University and "a competent mining engineer" was to be appointed director. Clearly spelled out in the bill were objectives that Director Fulton must have had in mind. The first listed was:

> To, by questionnaire or otherwise, conduct a thorough mineral survey of the state and to catalog each and every mineral deposit and occurrence, both metallic and nonmetallic of whatsoever nature.. ., and to serve as a bureau of information and exchange on Nevada mining.

This still remains as one of the prime functions of the organization.

The Nevada Bureau of Mines was now set in a form that would carry it through the depression, a world war, and up to its next major transition. The Bureau and the Mining Analytical Laboratory, both public service organizations, along with the teaching departments, made up the Mackay School of Mines.

In 1963, the Bureau moved into offices in the new Scrugham Engineering and Mines Building constructed directly east of the old Mackay School of Mines Building. Dean Scheid, through persistent negotiations with Nevada legislators, had managed to have an entire wing of the new building earmarked for the use of the Nevada Bureau of Mines and the State Analytical Laboratory. The Bureau in 1987 (and presently in 2012) occupies most of the four floors of the mines wing of this building.

Directors and Acting Directors since 1971:

Vernon E. Scheid, 1971–72
John H. Schilling, 1972–87
James L. Hendrix, 1987–88, Acting Director
Harold F. Bonham, Jr., 1993–95, Acting Director
Jonathan G. Price, 1988–1993, and 1995–2012, Director and State Geologist
James E. Faulds, 2012–present, Director and State Geologist

Titles, Organizational Directors, and Dates Served in Historical Sequence from 1865–1987:

State Geologist, 1865
(Position not filled)

State Mineralogist, 1866–78
Richard H. Stretch, 1866
A.F. White, 1867–70
H.R. Whitehill, 1871–78

State Analytical Laboratory, 1895–1985
Directors:
Robert D. Jackson, 1895–1899
Charles P. Brown, 1899
George J. Young, 1900–14
Francis Church Lincoln, 1914–24
Walter S. Palmer, 1924–51
Vernon E. Scheid, 1951–72
John H. Schilling, 1973–85

Nevada Bureau of Mines, 1929–71
Directors:
John A. Fulton, 1929–39
Jay A. Carpenter, 1939–51
Vernon E. Scheid, 1951–71

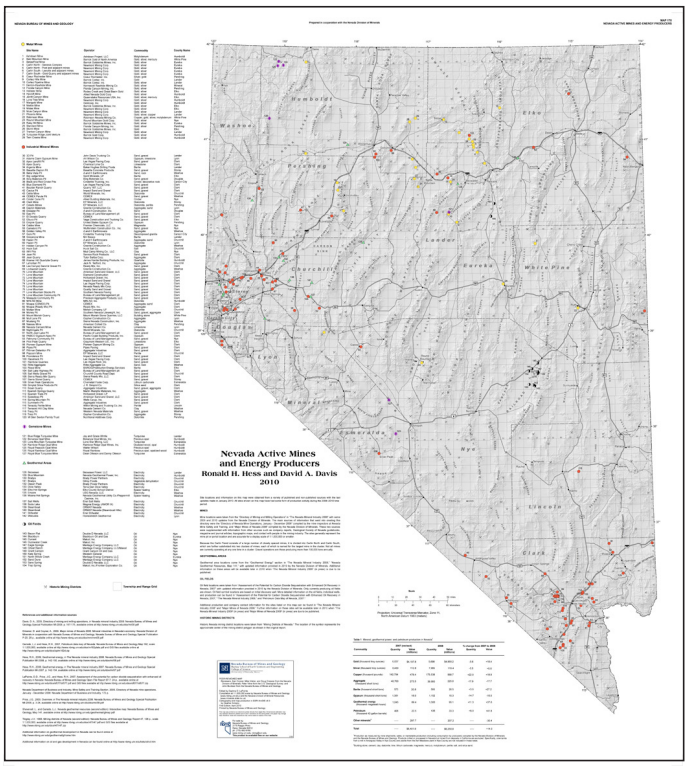
For the complete history of the Nevada Bureau of Mines and Geology, see the following link on the **Nevada Bureau of Mines and Geology website**
http://www.nbmg.unr.edu/_docs/HistoryOfNBMG.pdf

Mineral Industry

Nevada's mining industry set an all-time record in 2011 for total value of all mined commodities. The total value was about $9.48 billion, a $2.0 billion increase from 2010. The value was driven by gold, which contributed about $8.51 billion, based on the actual gross proceeds reported to the Nevada Department of Taxation. The average price of gold in 2011 was $1,572 per troy ounce according to Kitco. Nevada led the nation in 2011 in the production of gold, barite, lithium compounds and magnesium compounds. Nevada produced a wide variety of other mineral and energy commodities such as clays, copper, diatomite, dolomite, geothermal energy, gypsum, lapidary and gem stones, limestone, molybdenite, oil, perlite, salt, silica sand, silver, and specialty aggregates.

12-cm-long gypsum crystals from the Robinson district, White Pine County. Large deposits are mined in Nevada for use in wallboard, plaster of Paris, and portland cement. *Photo by J. Scovil*

Newmont's Gold Quarry Mine, Eureka County. *Photo by Mike Visher*



M170 - *Nevada active mines and energy producers*, by Ronald H. Hess and David A. Davis, 2010. Data compilation at 1:1,000,000. Map 170, 32x36-inch color plate and GIS zipfile. Available free on the NBMG website at **http://pubs.nbmg.unr.edu/NV-active-mines-energy-produc-p/m170.htm.** See also: OF10-5, *Nevada active mines and energy producers with mining district names*; and E-49, *Nevada active mines and energy producers*.

Find additional reports and data on Nevada's mineral industry at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Mining/index.html

Mineral Industry

NBMG Geologist Spotlight

John Muntean
Research Economic Geologist
Nevada Bureau of Mines and Geology

Publication Citations

Muntean, J.L., 2010, Major precious metal deposits in Nevada mineral industry 2009: Nevada Bureau of Mines and Geology Special Publication MI-2009, p. 68–100.

Muntean, J.L., 2010, Other metallic deposits in Nevada mineral industry 2009: Nevada Bureau of Mines and Geology Special Publication MI-2009, p. 85–87.

Muntean, J.L., Cassinerio, M.D., 2011, Patterns of lithology, structure, alteration and trace elements around high-grade ore zones at the Turquoise Ridge gold deposit, Getchell district, Nevada: Geological Society of Nevada, p. 949–977.

Muntean, J.L., Cline, J.S., Simon, A.C., Longo, A.A., 2011, Magmatic-hydrothermal origin of Nevada's Carlin-type gold deposits: Nature Geoscience, p. 122–127.

Muntean, J.L., Cline, J.S., Simon, A.C., 2011, The Carlin gold system in Nevada—a perfect storm resulting from ideal crustal architecture, metasomatized lithospheric mantle, and tectonic trigger: Society for Geology Applied to Mineral Deposits, p. 100–102.

Muntean, J.L., Patterson, L.M., 2011, Multi-element geochemistry across a Carlin-type gold district—Jerritt Canyon, Nevada: Geological Society of Nevada, p. 1119–1151.

Muntean, J.L., Taufen, P.M., 2011, Geochemical exploration for gold through transported alluvial cover in Nevada—Examples from the Cortez Mine, Economic Geology, v. 106, p. 809–833.

John Muntean on the History Channel, March 9, 2010

NBMG geologist, John Muntean, was interviewed for a four-part History Channel special on gold that aired on March 9, 2010.

Find additional information on John Muntean's research at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/staff/johnmuntean.html

Mineral Industry

NBMG Publication Spotlight

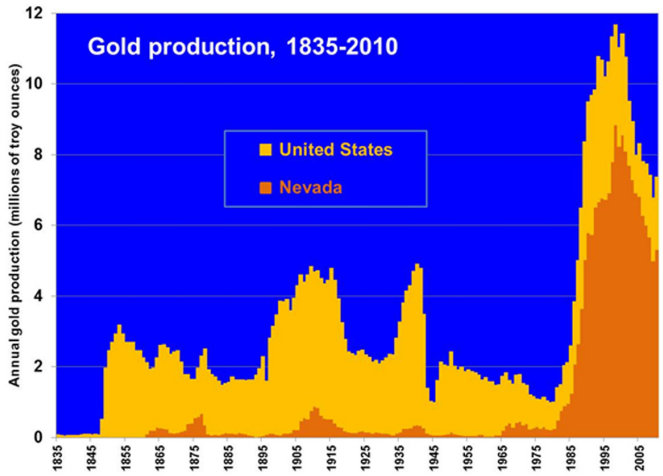
Nevada Bureau of Mines and Geology Special Publication MI-2010 and MI-2011

Starting in 1979, NBMG has issued annual reports that describe mineral and geothermal activities and accomplishments in Nevada, and include statistics of known gold and silver deposits.

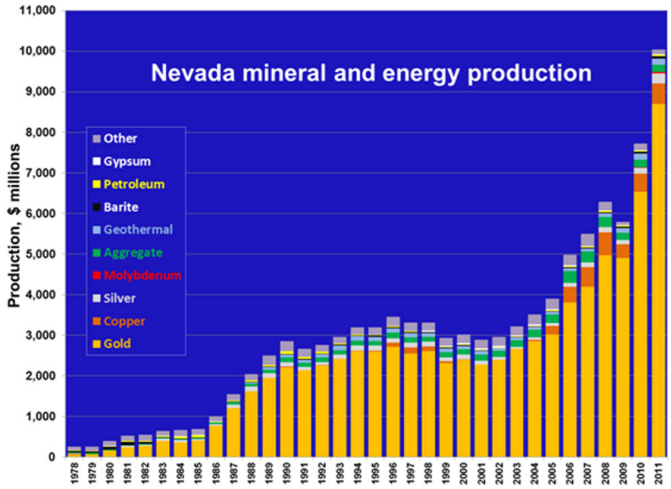
This is a web-only publication available free on the NBMG website:

Special Publication MI-2010, 151 pages
https://pubs.nbmg.unr.edu/The-NV-mineral-industry-2010-p/mi2010.htm

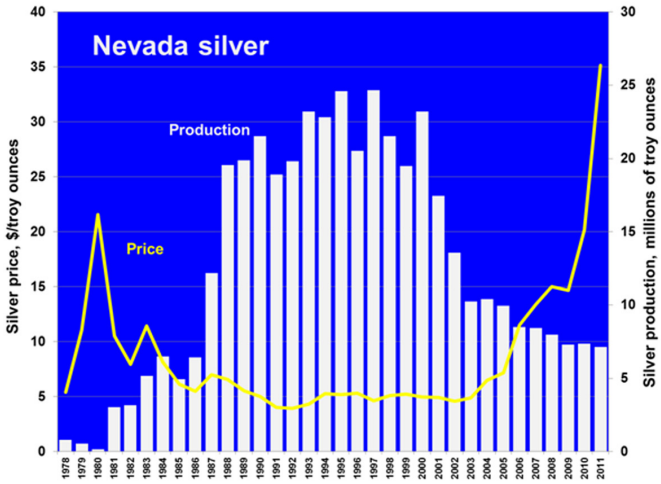
Special Publication MI-2011, 160 pages
https://pubs.nbmg.unr.edu/The-NV-mineral-industry-2011-p/mi2011.htm



Graph of historical U.S. and Nevada gold production from 1835 to 2010.



Graph showing annual dollar value of various mineral and energy commodities produced from Nevada from 1978 to 2011.



Graph of Nevada gold production and price of gold (US dollars per troy ounce) from 1978 to 2011.

Find a listing of the annual Nevada Mineral Industry reports at the
Nevada Bureau of Mines and Geology website
http://pubs.nbmg.unr.edu/Mineral-Industry-s/1860.htm

Mineral Industry

NBMG Publication Spotlight

***Major Mines of Nevada 2011, Mineral Industries in Nevada's Economy*, by Mike Visher and Alan Coyner**

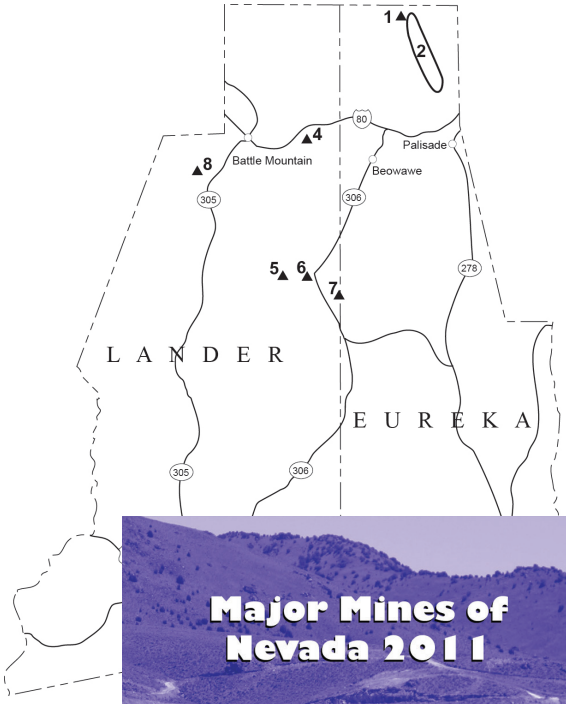
Published by the Nevada Bureau of Mines and Geology for the Nevada Division of Minerals:
http://minerals.state.nv.us

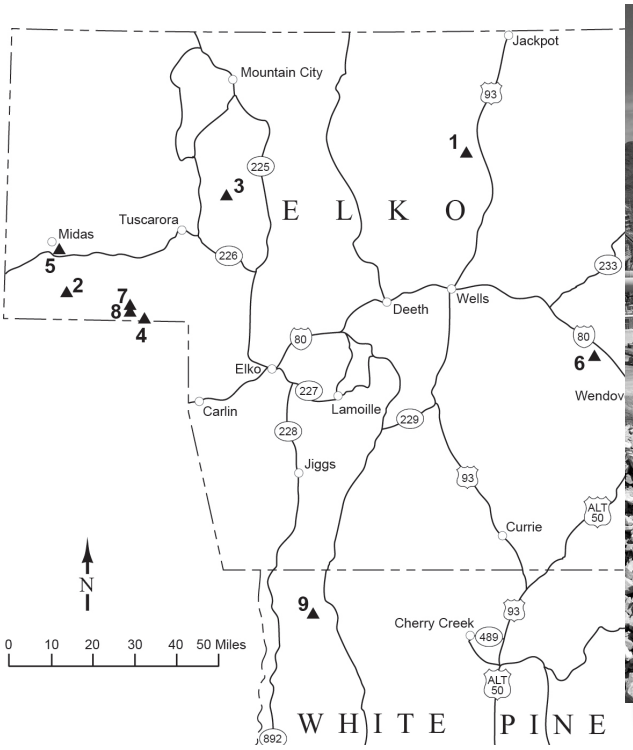
This annual series of reports on the major mines and mills in Nevada lists the names and addresses of operators, numbers of employees, and annual production. Map locations of all major mines are shown and an overview of mineral production and its effect on Nevada's economy is presented.

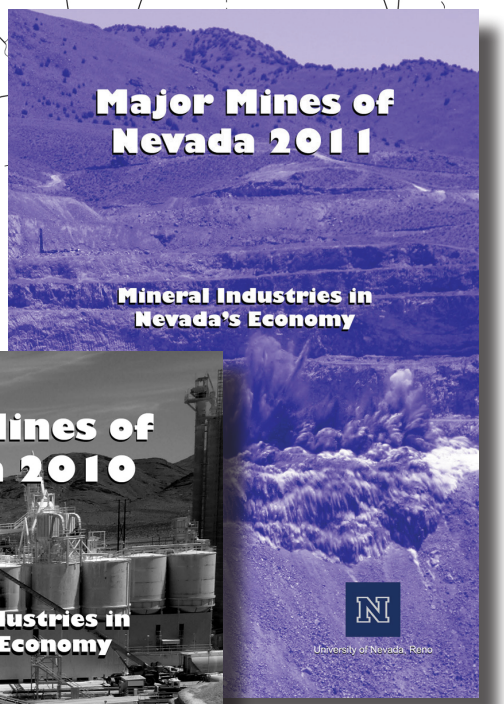
Available on the Web:

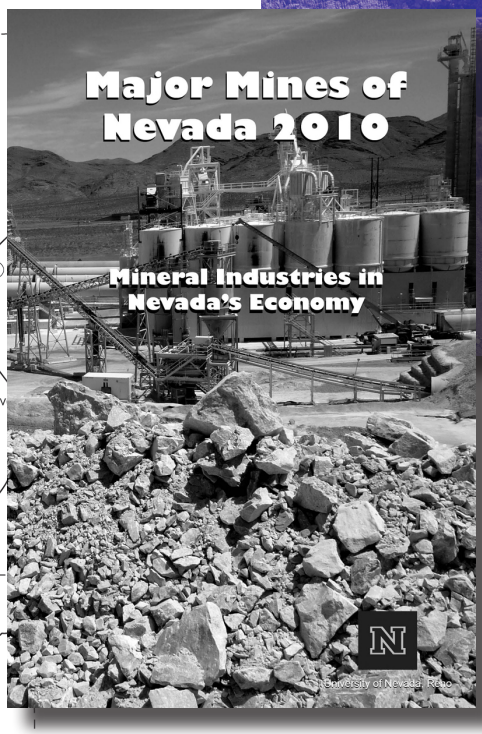
Special Publication P-22 (2010), 28 pages.
https://pubs.nbmg.unr.edu/Major-mines-of-Nevada-2010-p/p022.htm

Special Publication P-23 (2011), 28 pages.
https://pubs.nbmg.unr.edu/Major-mines-of-Nevada-2011-p/p023.htm









Find a listing of the annual Nevada Mineral Industry reports at the
Nevada Bureau of Mines and Geology website
http://pubs.nbmg.unr.edu/Pamphlets-s/1862.htm

Mineral Industry

Online Mining District File Collection with Index, Search Index, Search Engine, and Other Nevada Mineral-and Energy-Related Files

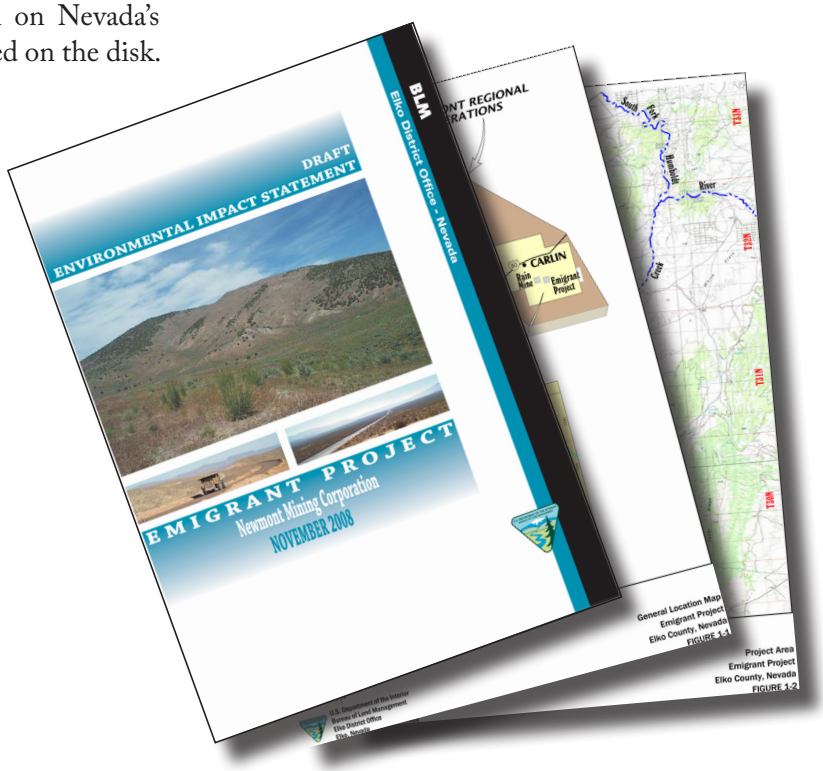
NBMG Open-File Report 10-8 – *NBMG Mining District File Collection with Index, Search Engine, and Other Nevada Mineral-and Energy-Related Files* (2nd edition), compiled by Ronald H. Hess, Martha Henson, David A. Davis, Richard O. Meeuwig, Kristen A. Scott, and Karen Boldi, 2010, on portable hard drive.

The NBMG mining district files consist largely of historical and current maps, reports, articles, photographs, correspondence, assays, production reports, and reserve information on all aspects of mining in Nevada. Most have been donated to NBMG over the years from individuals, companies, and other government agencies. Over the last several years, NBMG has undertaken digital conversion of these paper documents to scanned images.

A variety of other statewide maps, reports, and GIS data that provide additional background information on Nevada's mineral and energy resources are also included on the disk.

Some of the background materials include older NBMG bulletins that describe Nevada's mining districts; oil and gas well exploration data, logs, and production records; digital copies of 1:100,000-scale USGS topographic maps covering the state; map of mineral and energy producers in the state; the 2008 Nevada mineral industry review; and other mineral-, energy-, and mining-related documents and data sets.

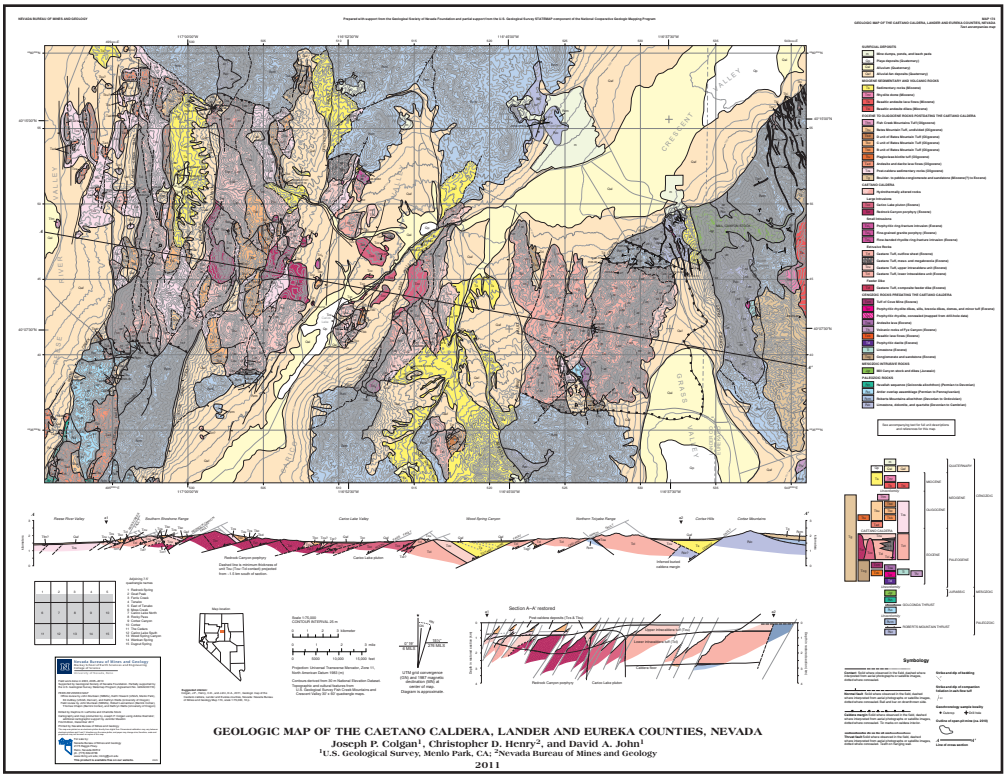
An online version of the mining district index, search engine, and files are accessible on the NBMG website at **http://www.nbmg.unr.edu/Collections/MiningDistricts/MiningDistricts.html**



Find the online version of the mining district files at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Collections/MiningDistricts/MiningDistricts.html

Geologic Mapping

Geologic maps are two-dimensional representations of a vast amount of three-dimensional geologic information. They convey the age, composition, and spatial relationships among rocks and sediments at and near the Earth's surface. Geologic mapping has enormous benefits for documenting, analyzing, and planning for natural hazards such as earthquakes and landslides, for urban, industrial, and land-use planning, and for the exploration and extraction of natural resources. In Nevada, a state with rapidly-expanding urban areas, zones of high earthquake activity, and active mining and geothermal industries that are fundamental to the state's economy, geologic mapping is of exceptional importance.



A 1:75,000-scale, color geologic map of the 34 Ma Caetano caldera, Lander and Eureka counties, Nevada with descriptions of 41 geologic units and one cross section.

Rhyolitic lava outcrop south of Massacre Lake, Washoe County.
Photo by Jack Hursh

Find additional information on Nevada geologic mapping projects at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Maps&Data/index.html

Geologic Mapping

NBMG Geologist Spotlight

Chris Henry (right) and Joe Colgan (USGS) mapping geology in the West Gate quadrangle, southern Clan Alpine Mountains, Nevada. *Photo by David John.*

Chris Henry
Research Geologist
Nevada Bureau of Mines and Geology

I do geologic mapping supplemented with analysis of structure, igneous rocks, and mineralization to figure out magmatic, tectonic, and mineralization processes to benefit Nevada. Much of my research focuses on the origin of mineral deposits, including their large- and small-scale geologic setting, relationship to structures and igneous activity, and timing, so as to help geologists and mining companies explore for additional deposits that can be mined, employ Nevadans, and pay taxes to support Nevada. I also do mapping in urban and tectonically active areas, such as Reno and the Walker Lane, to identify faults that could generate earthquakes and cause significant damage and physical harm.

Chris Henry leads a 2011 Geological Society of America field trip discussion on the geology of the East Humboldt Range above Wells, Nevada, site of a major earthquake in 2008. *Photo by David Greene.*

Publication Citations

Henry, C.D., McGrew, A.J., Colgan, J.P., Snoke, A.W., and Brueseke, M.E., 2011, Timing, distribution, amount, and style of Cenozoic extension in the northern Great Basin, *in* Lee, J., and Evans, J.P., editors, Geologic field trips to the Basin and Range, Rocky Mountains, Snake River Plain, and terranes of the U.S. Cordillera: Geological Society of America Field Guide 21, p. 27–66.

Vikre, P.G., and **Henry, C.D.**, 2011, Quartz-alunite alteration cells in the ancestral southern Cascades magmatic arc: Geological Society of Nevada, Great Basin Evolution and Metallogeny, 2010 Symposium Volume, Reno/Sparks, Nevada, p. 701–745.

Henry, C.D., and Colgan, J.P., 2011, The regional structural setting of the 2008 Wells earthquake and Town Creek Flat basin—implications for the Wells earthquake fault and adjacent structures, *in* dePolo C.M., and LaPointe, D.D., editors, The 21 February 2008 Mw 6.0 Wells, Nevada Earthquake: Nevada Bureau of Mines and Geology, Special Publication 36, p. 53–64.

Henry, C.D., and Thorman, C.H., 2011, Geologic map of the Wells earthquake area, Elko County, Nevada, *in* dePolo C.M., and LaPointe, D.D., editors, The 21 February 2008 Mw 6.0 Wells, Nevada Earthquake: Nevada, Nevada Bureau of Mines and Geology, Special Publication 36, appendix A.

Ramelli, A.R., **Henry, C.D.**, and Walker, J.P., 2011, Preliminary revised geologic maps of the Verdi, Reno, Vista, Mount Rose NE, Steamboat, and Washoe City 7.5' quadrangles, Reno urban area, Nevada: Nevada Bureau of Mines and Geology, Open-File Report 11-7.

Colgan, J.P., **Henry, C.D.**, and John, D.A., 2011, Geologic map of the Caetano caldera, Lander and Eureka counties, Nevada: Nevada Bureau of Mines and Geology Map 174, p. 10.

Henry, C.D., and Faulds, J.E., 2010, Ash-flow tuffs in the Nine Hill, Nevada, paleovalley and implications for tectonism and volcanism of the western Great Basin, USA: Geosphere, v. 6, p. 339–369.

Find additional information on Chris Henry's research at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Staff/Henry.html

Geologic Mapping

NBMG Geologist Spotlight

Sean Long investigating a fold in the geology at Secret Creek Gorge between the Ruby Mountains and the East Humboldt Range in Elko County. *Photo by Sean Long.*

Sean P. Long
Research Assistant Professor
Nevada Bureau of Mines and Geology

I am a structural geologist, and my primary research interest focuses on the evolution and dynamics of contractional deformation in orogenic belts. I utilize a variety of techniques, including geologic mapping, construction of balanced cross-sections, geochronology, thermochronology, and thin-section scale structural analysis. In Nevada, my primary research interests focus on understanding the geometry, timing, and magnitude of contractional deformation that occurred during the Sevier orogeny, including the construction and subsequent extensional collapse of the orogenic plateau that may have once existed across much of Nevada. I have active, mapping-based projects in eastern Nevada that aid exploration efforts for gold and for oil and gas. I am also the director of the UNR Summer Field Camp course in the Department of Geological Sciences and Engineering. The primary focus of this course is to teach undergraduate students how to make geologic maps.

Publication Citations

Long, S., 2011, Magnitude and spatial patterns of erosional exhumation in the Nevadaplano, eastern Nevada and western Utah—insights from a Paleogene paleogeologic map: Eos Trans., American Geophysical Union 92 (56), Fall Meet. Suppl., Abstract T11B-2314.

Long, S., McQuarrie, N., Tobgay, T., Grujic, D., and Hollister, L., 2011, Geologic map of Bhutan: The Journal of Maps, v. 2011, p. 184–192, 1:500,000-scale, doi:10.4113/jom.2011.1159.

Long, S., McQuarrie, N., Tobgay, T., and Hawthorne, J., 2011, Quantifying internal strain and deformation temperature in the eastern Himalaya, Bhutan—implications for the evolution of strain in thrust sheets: Journal of Structural Geology, v. 32, p. 579–608, doi:10.1016/j.jsg.2010.12.011.

Long, S., McQuarrie, N., Tobgay, T., and Grujic, D., 2011, Geometry and crustal shortening of the Himalayan fold-thrust belt, eastern and central Bhutan: Geological Society of America Bulletin, v. 123, p. 1427–1447, doi:10.1130/B30203.1.

Long, S., McQuarrie, N., Tobgay, T., Rose, C., Gehrels, G., and Grujic, D., 2011, Tectonostratigraphy of the Lesser Himalaya of Bhutan—implications for the along-strike stratigraphic continuity of the northern Indian margin: Geological Society of America Bulletin, v. 123, p. 1406–1426, doi:10.1130/B30202.1.

Tobgay, T., **Long, S.**, McQuarrie, N., Ducea, M., and Gehrels, G., 2010, Using isotopic and chronologic data to fingerprint strata—the challenges and benefits of variable sources to tectonic interpretations, the Paro Formation, Bhutan Himalaya: Tectonics, v. 29, TC6023, doi:10.1029/2009TC002637.

Long, S., and McQuarrie, N., 2010, Placing limits on channel flow—insights from the Bhutan Himalaya: Earth and Planetary Science Letters, v. 290, p. 375–390, doi:10.1016/j.epsl.2009.12.033.

Award

Arnold Guyot Teaching Award from Princeton University Geosciences Department, 2010.

Find additional information on Sean Long's research at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/staff/Long.html

Geologic Mapping

NBMG Geologist Spotlight

Nick Hinz mapping in the Reese River geothermal area in Lander County. *Photo by Nick Hinz.*

Nicholas H. Hinz
Research Geologist
Nevada Bureau of Mines and Geology

My research focuses on regional studies of Basin and Range extensional tectonics in both northern and southern Nevada and of dextral shear associated with the Walker Lane in western Nevada using detailed geologic mapping, structural analyses of faults and folds, geochronology, paleomagnetic analyses, and existing drill-hole and geophysical data sets. As a subset to studying Basin and Range tectonics, much of my research also focuses on investigating the structural controls of geothermal systems within the Great Basin region for the purpose of developing successful exploration strategies.

Nick Hinz mapping in the Eldorado Mountains, Clark County. *Photo by Nick Hinz.*

Publication Citations

Hinz, N.H., Faulds, J.E., and Stroup, C., 2011, Stratigraphic and structural framework of the Reese River geothermal area, Lander County, Nevada—a new conceptual structural model: Geothermal Resources Council Transactions, v. 35, p. 827–832.

Faulds, J.E., **Hinz, N.H.**, Coolbaugh, M.F., Cashman, P.H., Kratt, C., Dering, G., Edwards, J., Mayhew, B., McLachlan, H., 2011, Assessment of favorable structural settings of geothermal systems in the Great Basin, Western USA: Geothermal Resources Council Transactions, v. 35, p. 777–784.

Hinz, N.H., and Faulds, J.E., 2011, Preliminary geologic map of the Reese River geothermal area, Lander County, Nevada: Nevada Bureau of Mines and Geology Open-File Report 11-3, 1:24,000 scale.

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Hinz, N.H., Faulds, J.E., and Oppliger, G.L., 2010, Preliminary geologic map of the Lee-Allen geothermal area, Churchill County, Nevada: Nevada Bureau of Mines and Geology Open-File Report 10-6, 1:24,000 scale with 1:8,000 scale inset.

Hinz, N.H., Faulds, J.E., Moeck, I., Bell, J.W., and Oldow, J.S., 2010, Structural controls of three blind geothermal resources at the Hawthorne Ammunitions Depot, west-central Nevada: Geothermal Resources Council Transactions, v. 34, p. 785–790.

Bell, J., and **Hinz, N.**, 2010, Young Walker basin faults provide new insights into structural relations controlling geothermal potential at the Hawthorne Army Weapons Depot, central Nevada: Geothermal Resources Council Transactions, v. 34, p. 751–754.

Moeck, I., **Hinz, N.**, Faulds, J., Bell, J., Kell-Hills, A., and Louie, J., 2010, 3D geological mapping as a new method in geothermal exploration—a case study from central Nevada: Geothermal Resources Council Transactions, v. 34, p. 807–812.

Find additional information on Nick Hinz's research at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/staff/Hinz.html

Geologic Mapping

NBMG Publication Spotlight

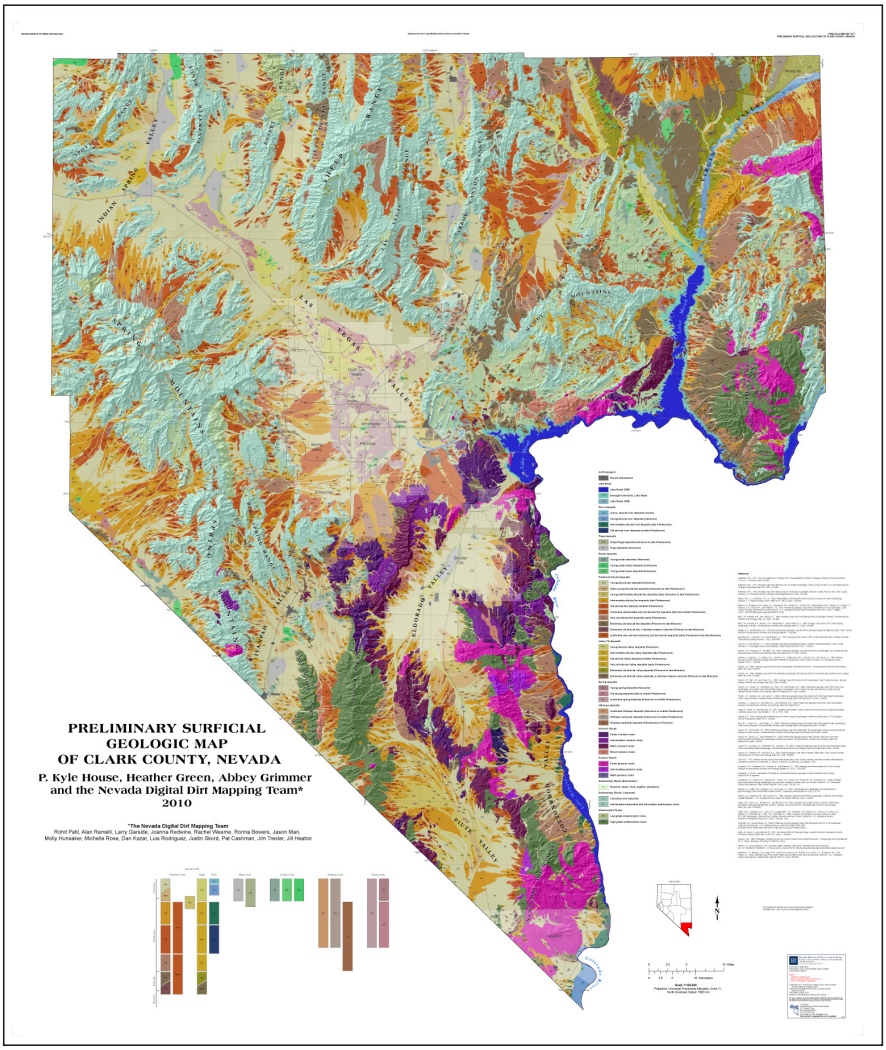
NBMG Open-File Report 10-7
Preliminary Surficial Geologic Map of Clark County, Nevada

Preliminary Surficial Geologic Map of Clark County, Nevada, by P. Kyle House, Heather Green, Abbey Grimmer, and the Nevada Digital Dirt Mapping Team, 2010

scale 1:150,000 (49”x58”)

This map is the only county-wide surficial geologic map with more than a few units ever to be produced by NBMG (it covers 20,000 sq. km).

This map is available for free on the NBMG website in the Open-File Reports listings at: **https://pubs.nbmg.unr.edu/Prel-surficial-geol-Clark-Co-p/of2010-07.htm**



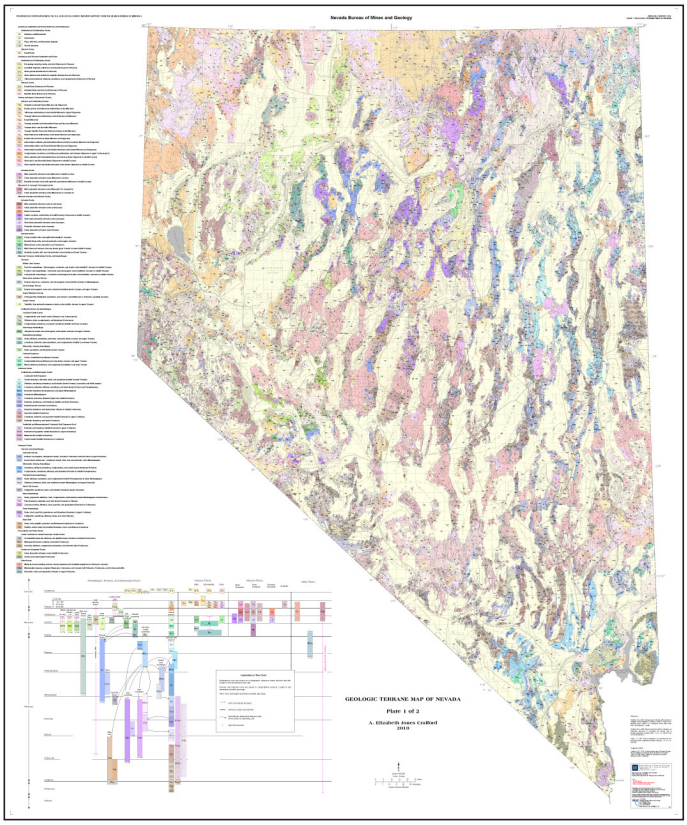
Find additional publications about Nevada geology at the
Nevada Bureau of Mines and Geology website
http://pubs.nbmg.unr.edu

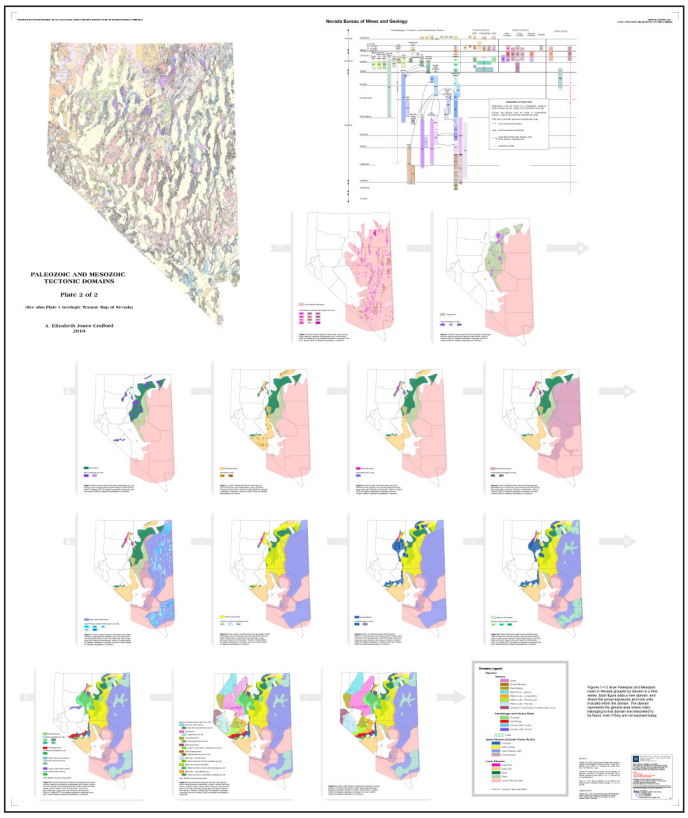
Geologic Mapping

NBMG Publication Spotlight

NBMG Open File Report 10-4
Geologic Terrane Map of Nevada (2 plates)
by A. Elizabeth Crafford, 2010

Plate 1 is a 1:500,000-scale, 54x65-inch color map, illustrating the Paleozoic and Mesozoic geologic history of Nevada as defined by Crafford (2007). Plate 2 (54x64-inch color) is a series of 1:3,000,000-scale time slices illustrating tectonic events between the evolving continental margin in Nevada and accreted terranes outboard of the margin. The maps are derived primarily from the Geologic Map of Nevada 1:500,000-scale compilation by Stewart and Carlson (USGS, 1978) and the 1:250,000-scale county geologic maps (NBMG, various dates), plus other sources.





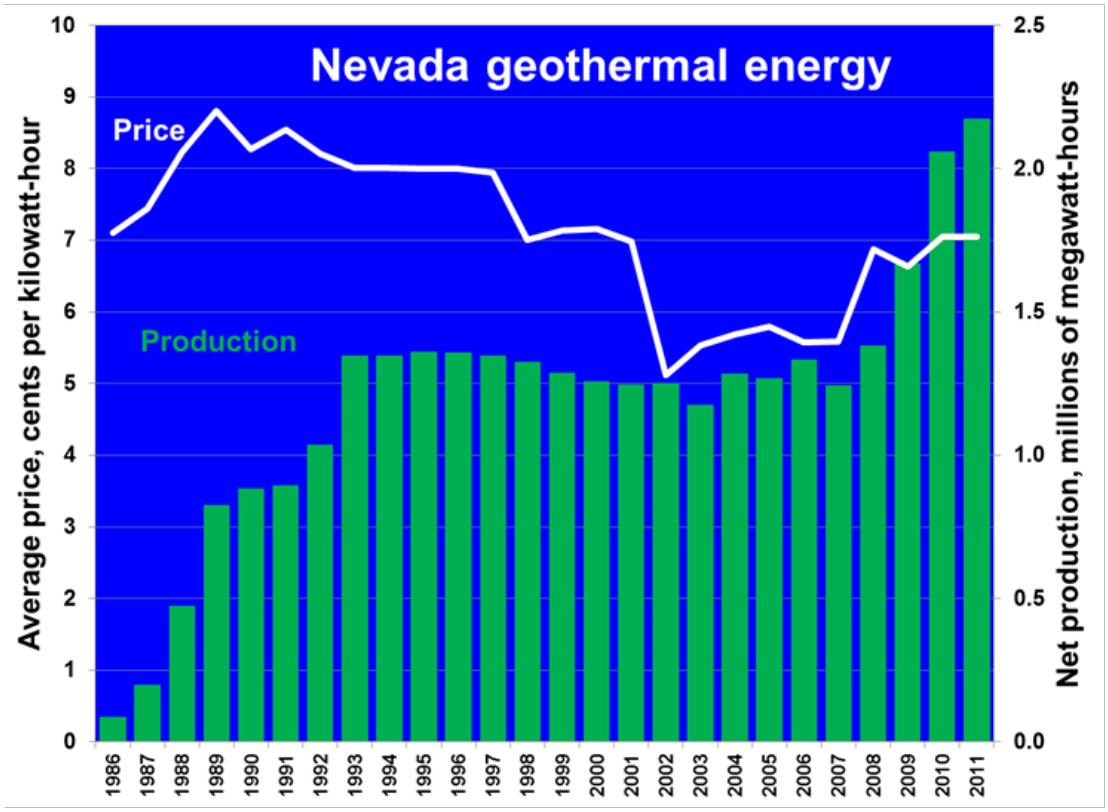
Find additional Nevada statewide geology maps at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Maps&Data/StatewideGeologicMaps.html

Geothermal Energy

Geothermal energy is used at numerous places in Nevada for generating electricity, space heating, domestic warm water, recreation, dehydrating vegetables, and other agricultural applications. Nevada geothermal energy producers sold a record amount of electricity in 2011 with approximately 21 plants operating at 13 sites.

Programs in the U.S. Department of Energy, energy bills passed by the Nevada and California legislatures, and activities of researchers at the University of Nevada, Reno are stimulating geothermal development in Nevada. One new plant went into production early in 2011 (Ormat's Jersey Valley plant in Pershing County), and several new plants are under construction or planned to meet Nevada's renewable energy portfolio standard.

At a 2005 meeting of a task force set up by the Western Governors' Association to assess geothermal resource potential, geothermal energy experts estimated that by 2025 Nevada could add approximately 1,500 to 2,900 megawatts of geothermal power-generating capacity. If this potential were realized, and if energy prices continue to rise, geothermal power could become a billion-dollar per year business in Nevada. Current projects under development in Nevada should result in construction of between 2,100 and 2,400 megawatts of capacity within 10 years. Production capacity stood at 475.6 megawatts at the end of 2011.



Geothermal energy production from Nevada (millions of megawatt-hours) and price of geothermal energy (U.S. cents per kilowatt hour) from 1986 to 2011.

Find additional maps and data on Nevada's geothermal energy at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Geothermal/index.html

Geothermal Energy

NBMG Geologist Spotlight

Fly Geyser, Washoe County. *Photo by Jim Faulds.*

James E. Faulds
Research Professor
Nevada Bureau of Mines and Geology

My geothermal research has focused on the structural controls of geothermal systems in the Great Basin region, particularly what fault patterns and types of faults are most favorable for geothermal activity. Characterizing the favorable settings of known geothermal systems is particularly important, because estimates suggest that ~75% of the geothermal resources in the Great Basin region are blind or hidden, with no surface hot springs or steam vents. For the past 10 years, I have therefore been analyzing geothermal systems in the western U.S. and western Turkey, and I am currently preparing a catalogue of the structural settings of >400 geothermal systems in the Great Basin region. By characterizing the favorable settings for geothermal activity and utilizing innovative technologies, such as 3D modeling, my research has contributed to developing more successful exploration strategies for geothermal systems, particularly for blind systems. New grants for my geothermal program in the 2010–2011 period exceeded $2M. This program also has an important educational component and supported 6 graduate students during this period. In addition, I taught a geothermal exploration course in 2011 with an enrollment of 20 graduate and undergraduate students.

Publication Citations

Faulds, J.E., Coolbaugh, M.F., Benoit, D., Oppligier, G., Perkins, M., Moeck, I., and Drakos, P., 2010, Structural controls of geothermal activity in the northern Hot Springs Mountains, western Nevada—the tale of three geothermal systems (Brady's, Desert Perk, and Desert Queen): Geothermal Resources Council Transactions, 34: 675–683.

Faulds, J.E., Moeck, I., Drakos, P., and Zemach, E., 2010, Structural Assessment and 3D Geological Modeling of the Brady's Geothermal Area, Churchill County (Nevada, USA)—a preliminary report: Thirty-Fifth Workshop on Geothermal Reservoir Engineering, Stanford University, SGP-TR-188: 5.

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Faulds, J.E., 2011, Improved techniques for geothermal exploration (byline article): North American Clean Energy, v. 5, no. 6, p. 73–74.

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Bruhn, D., Manzella, A., Vuataz, I., **Faulds, J.**, Moeck, I., and Erbas, K., 2010, Chapter 2: Exploration Methods, *in* Huenges, E., ed., Geothermal Energy Systems: WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany, ISBN: 978-3-527-40831-3, p. 37–113.

Find additional information on James E. Faulds' research at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Staff/Faulds.html

Nevada Geodetic Laboratory

The Nevada Geodetic Laboratory (NGL) conducts research in the field of space geodesy to study scientific problems that have both regional and global significance. The NGL uses the Global Positioning System (GPS) and Interferometric Synthetic Aperture Radar (InSAR) to study tectonic and geothermal activity across Nevada. The NGL also studies global patterns in surface mass loading and global-scale plate tectonic problems.

The NGL is located within the Nevada Bureau of Mines and Geology and interacts closely with the Nevada Seismological Laboratory and the Department of Geological Sciences and Engineering at the University of Nevada, Reno.

Surprise Valley, California looking east toward the Hays Canyon Range, Washoe County, Nevada. Geodesists at the Nevada Bureau of Mines and Geology can precisely measure very slow movement of the Earth's crust with GPS (white antenna disk in photo). When compared with measurements of other GPS stations elsewhere, they can very precisely map deformation that leads to future earthquakes. *Photo by Corné Kreemer.*

Installing a GPS site near the Sierra Nevada crest requires bolting a solar panel to an exposed section of rock near the summit of Ward Peak. Lake Tahoe and Carson Range in background. *Photo by Jean Dixon.*

Find additional information on the **Nevada Geodetic Laboratory** at the website **http://geodesy.unr.edu**

Nevada Geodetic Laboratory

NBMG Geodesist Spotlight

Geoff Blewitt next to the continuous GPS station on top of Slide Mountain. *Photo by Jean Dixon.*

Geoffrey Blewitt
Research Professor
Nevada Bureau of Mines and Geology

In my research, I strive to develop end-to-end techniques to acquire, process, and model GPS data in the most accurate way possible, and to apply the results to various geophysical problems. I manage NGL's 200-CPU data computing facility that processes data from just about all 10,000 GPS stations in the world. Using GPS signals for positioning with millimeter accuracy requires that I apply physical models of Earth's changing shape and rotation in space, satellite dynamics, microwave propagation, atmospheric refractivity, atomic clocks, antennas, and even general relativity. In 2004, I started installing NGL's MAGNET GPS network that today has nearly 400 GPS stations spanning Nevada, eastern California, and parts of Arizona and Utah. MAGNET is used to map strain in the Earth's crust in the Nevada region for seismic hazard assessment, to model earthquakes before, during, and after the main shock, and to help target geothermal resources.

Publication Citations

Minster, J.B., Altamimi, Z., **Blewitt, G.**, Carter, W.E., Cazenave, A., Dragert, H., Herring, T.A., Larson, K.M., Ries, J.C., Sandwell, D.T., Wahr, J.M., and Davis, J.L., 2010, Precise geodetic infrastructure—national requirements for a shared resource: The National Academies Press, ISBN-10:0-309-15811-7, ISBN-13: 978-0-309-15811-4, 142 p.

Church J., Aarup, T., Woodworth, P., Wilson, W., Nicholls, R., Rayner, R., Lambeck, K., Mitchum, G., Steffen, K., Cazenave, A., **Blewitt, G.**, Mitrovica, J., and Lowe, J., 2010, Sea-level rise and variability—synthesis and outlook for the future, eds. J. Church, P.L. Woodworth, T. Aarup, and S. Wilson, Wiley-Blackwell, *in* Understanding sea-level rise and variability, p. 402–419, ISBN: 978-1-443-3451-7.

Blewitt, G., Bar-Sever, Y., Gross, R., Hammond, W.C., Hsu, V., Hudnut, K., Khachikyan, R., Kreemer, C.W., Meyer, R., Plag, H.-P., Simons, M., Song, T., Sundstrom, J., and Webb, F., 2010, GPS-aided real-time earthquake and tsunami (GREAT) alert system: Abstracts of the IGS Workshop, Newcastle, UK.

Blewitt, G., Altamimi, Z., Davis, J., Gross, R., Kuo, C.-Y., Lemoine, F.G., Moore, A.W., Neilan, R.E., Plag, H.-P., Rothacher, M., Shum, C.K., Sideris, M.G., Schone, T., Tregoning, P., and Zerbini, S., 2010, Geodetic observations and global reference frame contributions to understanding sea-level rise and variability, eds., J. Church, P.L. Woodworth, T. Aarup, and S. Wilson, Wiley-Blackwell, *in* Understanding sea-level rise and variability, p. 256–284, ISBN: 978-1-443-3451-7.

Argus, D.F., **Blewitt, G.**, Peltier, W.R., and Kreemer, C.W., 2011, Rise of the Ellsworth mountains and parts of the East Antarctic coast observed with GPS: Geophysical Research Letters, 38: L16303, doi:10.1029/2011GL048025.

Blewitt, G., 2011, A new technique to enhance global GPS accuracy and resolution for Earth science: NASA Annual Reports.

Blewitt, G., 2011, Revealing the nature of contemporary uplift and collapse in the Sierra Nevada–Great Basin System, NSF Annual Reports.

Find additional information on Geoffrey Blewitt's research at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Staff/Blewitt.html

Nevada Geodetic Laboratory

NBMG Geodesist Spotlight

Bill Hammond in the Smoke Creek Desert, near GPS station SMOK. GPS measurements estimate that this valley widens by approximately 1 mm/yr. *Photo by Bill Hammond.*

William C. Hammond
Research Professor
Nevada Bureau of Mines and Geology

In my research, I precisely measure active crustal deformation using geodetic techniques such as the Global Positioning System (GPS) and Interferometric Synthetic Aperture Radar (InSAR). From these measurements I infer the style and distribution of Earth surface deformation that is a direct consequence of continent-scale tectonic processes. My main interest is in relating these motions to the organization of seismogenic faulting, and inferring the source of stresses in the lithosphere. With geodesy we can better understand the processes that control gradual deformation of the western U.S. continental interior, and hence better understand the physics of Earth deformation and the source of potentially damaging earthquakes.

Publication Citations

Blewitt, G., Kreemer, C.W., **Hammond, W.C.**, and Plag, H.P., 2010, Separating tectonic, magmatic, hydrological, and landslide signals in GPS measurements near Lake Tahoe, Nevada-California, Abstracts IGCP 2010 Meeting, Reno, Nevada.

Hammond, W.C., and Kreemer, C.W., 2010, The overall geodetic picture, Reno, Nevada: Friends of the Pleistocene Field Trip Guide, p. 13.

Hammond, W.C., Kreemer, C.W., Blewitt, G., and Plag, H.P., 2010, The effect of viscoelastic relaxation on estimates of interseismic crustal strain accumulation at Yucca Mountain, Nevada: Geophysical Research Letters, 37: L06307, doi:10.1029/2010GL042795.

Hammond, W.C., Li, Z., Plag, H.P., Kreemer, C.W., and Blewitt, G., 2010, Integrated InSAR and GPS studies of crustal deformation in the western Great Basin, western United States: International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science, v. 28, p. 8.

Hammond, W.C., Blewitt, G., and Kreemer, C., 2011, Block modeling of crustal deformation of the northern Walker Lane and Basin and Range from GPS velocities: Journal of Geophysical Research, v. 166.

Hammond, W.C., Blewitt, G., Kreemer, C.W., Murray-Moleda, J.R., and Svarc, J.L., 2011, GPS constraints on crustal deformation before and during the 21 February 2008 Wells, Nevada M6.0 earthquake, *in* dePolo C.M., and LaPointe, D.D., editors, The 21 February 2008 Mw 6.0 Wells, Nevada Earthquake: Nevada Bureau of Mines and Geology, Special Publication 36, p. 181–196.

Hammond, W.C., Brooks, B.A., Bürgmann, R., Heaton, T., Jackson, M., Lowry, A.R., and Anandakrishnan, S., 2011, The scientific value of high-rate, low-latency GPS data: Eos feature article, v. 92(15), doi:10.1029/2011EO150001, p. 125–132.

Bormann, J., Wesnousky, S., **Hammond, W.C.**, and Sarmiento, A., 2010, Holocene earthquakes on the Wassuk Range fault zone—paleoseismic observations from the Rose Creek Fan, Hawthorne, Nevada, USA: Geothermal Resources Council Transactions, v. 34, p. 391–395.

Li, Z., **Hammond, W.C.**, Blewitt, G., Kreemer, C.W., and Plag, H.P., 2011, Vertical tectonic signals from integrated InSAR and GPS observations—Southern Walker Lane and Sierra Nevada: NCEO Science highlight.

Find additional information on William Hammond's research at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Staff/Hammond.html

Nevada Geodetic Laboratory

NBMG Geodesist Spotlight

Corné Kreemer next to one of the continuous GPS stations in the Basin and Range that he uses for his deformation modeling. *Photo by Corné Kreemer.*

Corné Kreemer
Research Associate Professor
Nevada Bureau of Mines and Geology

In my research, I use GPS velocity data and other kinematic indicators to precisely map out where and how deformation is occurring in the Earth's crust right now. These models of the deformation field reflect where strain rates are building up and where they are likely to be released in future earthquakes. My research directly contributes to seismic hazard reduction efforts, in the Great Basin and beyond. Moreover, I like to place my models results in the context of where and how deformation has occurred in the past, how surface deformation relates to the motion and deformation of the underlying mantle, and how lithospheric forces can be thought responsible for the deformation field.

Publication Citations

Bird, P., **Kreemer, C.W.**, and Holt, W.E., 2010, A long-term forecast of shallow seismicity based on the global strain rate map: Seismological Research Letters, v. 81, p. 184–194.

Flesch, L.M., and **Kreemer, C.W.**, 2010, Gravitational potential energy and regional stress and strain rate fields for continental plateaus—examples from the central Andes and Colorado Plateau: Tectonophysics, doi:10.1016/j.tecto.2009.07.014, v. 482, p 182–192.

Kreemer, C.W., Blewitt, G., and Bennett, R.A., 2010, Present-day crustal deformation in the Intermountain West measured by GPS (Invited): Abstract T42C-01, American Geophysical Union Fall Meeting, San Francisco, California.

Kreemer, C.W., Blewitt, G., and Bennett, R.A., 2010, Present-day motion and deformation of the Colorado Plateau: Geophysical Research Letters, 37: L10311, doi:10.1029/2010GL043374.

Kreemer, C.W., Blewitt, G., and Hammond, W.C., 2010, Evidence for an active shear zone in southern Nevada linking the Wasatch fault to the Eastern California shear zone: Geology, 38, 5, p. 475–478, doi: 10.1130/G30477.1.

Kreemer, C.W., and Hammond, W.C., 2010, Geodetic constraints on the slip rate of the Mohawk Valley Fault Zone, California: U.S. Geological Survey.

Le Pichon, X., and **Kreemer, C.W.**, 2010, The Miocene to Present kinematic evolution of the eastern Mediterranean and Middle East and its implications for dynamics: Annual Review of Earth and Planetary Sciences, v. 38, p. 323–351.

Blewitt, G., and **Kreemer, C.W.**, 2011, Fast network solutions using precise point positioning with ambiguity resolution for all geodetic GPS stations in the world: Geophysical Research Abstracts, v. 13, EGU2011-12570-1.

Awards

Geodesy Section Award from American Geophysical Union, 2010.

Mackay Faculty Achievement Award from University of Nevada, Reno, 2011.

Find additional information on Corne Kreemer's research at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Staff/Kreemer.html

Nevada Geodetic Laboratory

NBMG Publication Spotlight

Kreemer, C., Blewitt, G., and Hammond, W.C., 2010, *Evidence for an active shear zone in southern Nevada linking the Wasatch Fault to the Eastern California Shear Zone*, Geology, v. 38, p. 475–478.

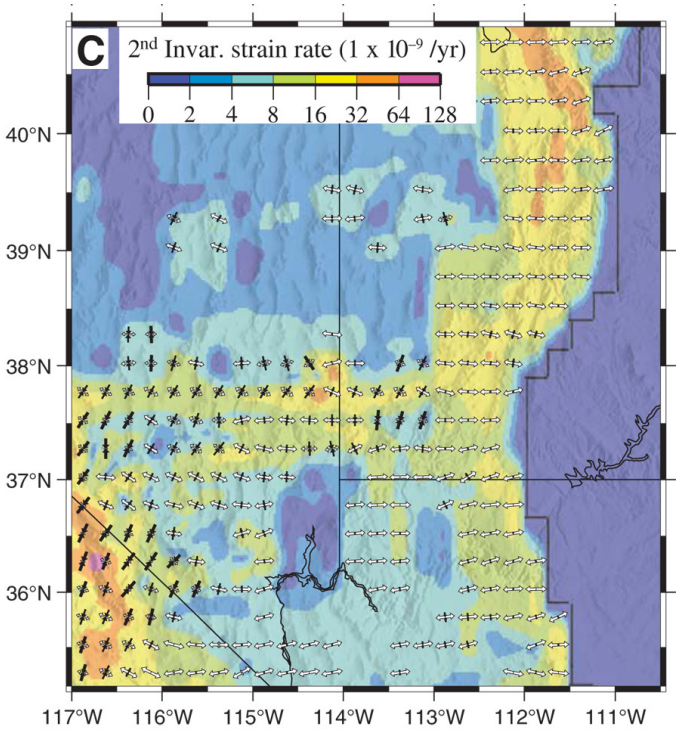


Figure 1C. Strain rate map of southern Nevada made from a compilation of GPS measurements and seismic data. Color scale indicates rate of crustal deformation that is a proxy for seismic hazard, with hotter colors showing higher rates of deformation.

NBMG Publication Spotlight

Hammond, W.C., Blewitt, G., Kreemer, C., 2011, *Block modeling of crustal deformation of the northern Walker Lane and Basin and Range from GPS velocities*, Journal of Geophysical Research, v. 166.

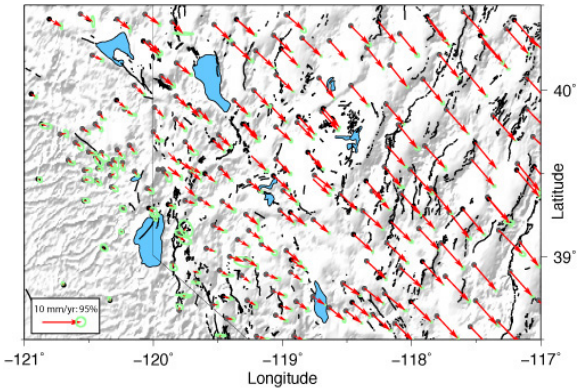


Figure 3. GPS velocity field showing crustal deformation of the Northern Walker Lane and Basin and Range. Velocities indicate motion with respect to the Sierra Nevada microplate so stations west of Lake Tahoe have near zero velocity. Geodetic and geologic data were used to evaluate fault slip rates in this zone of complex crustal deformation. Active faults are shown with black lines.

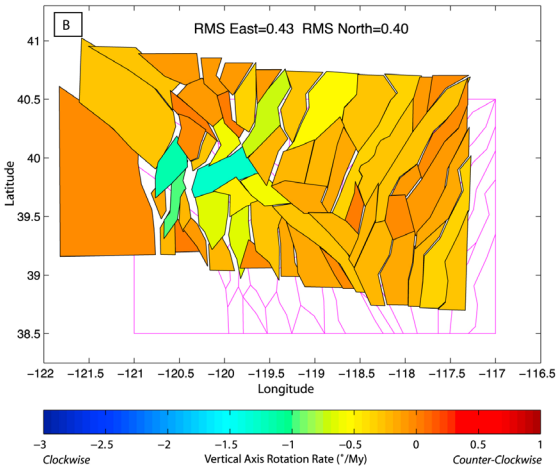


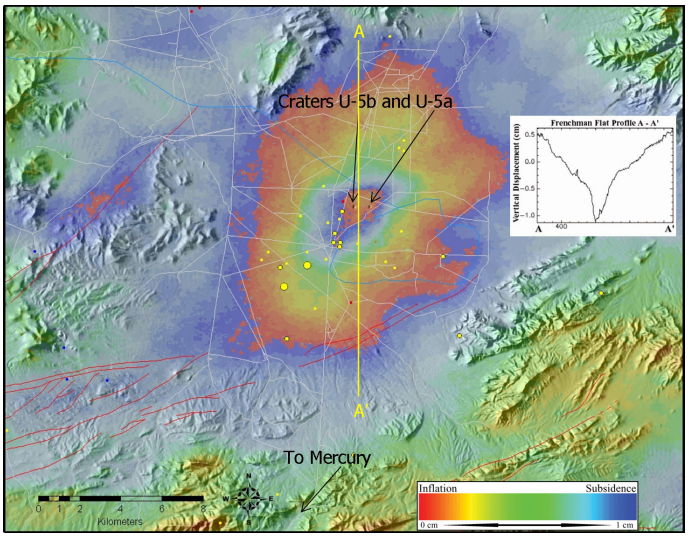
Figure 10B. A block model representation of the deformation of the Walker Lane, exaggerated by a factor of 10^7. Block color indicates vertical axis rotation rate. Area is the same as shown above in Figure 3. Movement is with respect to stable North America.

Find additional information on the **Nevada Geodetic Laboratory** at the website **http://geodesy.unr.edu**

InSAR Laboratory

Interferometric synthetic aperture radar (InSAR) is a rapidly evolving remote sensing technology that uses C-band (5.6 cm wavelength) satellite radar data collected since 1992 to measure sub-centimeter-scale ground movement, most commonly in surface deformation studies related to earthquakes, volcanoes, and groundwater-related land subsidence.

Two radar scenes each covering about 10,000 km2 and taken at different times are closely compared for small changes in radar phase of the waves reflected from fixed objects that have moved on the ground. The small shifts in radar phase can be measured with a pixel resolution of about 10 m, allowing deformation patterns to be detected over large regions with a high degree of spatial detail.



Interferogram for period Feb 1998 to Feb 1999 showing deformation (subsidence) associated with the 1999 Frenchman Flat earthquake (M 4.8), Nevada Test Site.

InSAR lab research facilities

The lab is equipped with a full range of computing hardware and software dedicated exclusively to InSAR processing, including multiple Linux, Unix, and PC workstation platforms. The lab can routinely process InSAR data using any of three software packages: DIAPASON developed by the French Space Agency (CNES); ROI_PAC developed by the NASA Jet Propulsion Lab (JPL); and GAMMA developed by Gamma Remote Sensing.

Current Projects

- Subsidence and earth fissuring due to heavy pumping in Pahrump Valley.
- Aquifer system response to heavy pumping on municipal wells in the Virgin Valley (Mesquite).
- Reconnaissance InSAR study of eastern Nevada groundwater basins designated for potential groundwater export to Las Vegas Valley.
- Hydrostratigraphy and InSAR study of the Kelly Creek Basin-Pumpernickel Valley area, funded by Newmont Gold Mining Corporation.
- InSAR study of the aquifer system response to mine de-watering in the Boulder Valley area, funded by Barrick Goldstrike Mining Corporation.
- InSAR study of subsidence and earthquakes in the Yucca Mountain-Amargosa Valley-Ash Meadows-Death Valley region.
- Earthquakes and groundwater subsidence detected by InSAR in the Reno-Carson City-Lake Tahoe area, funded by the US Geological Survey Earthquake Hazard Reduction Program.

Find additional information on the **Nevada InSAR Laboratory** at the **Nevada Bureau of Mines and Geology website** **http://www.nbmg.unr.edu/insar_web/insar.htm**

InSAR Laboratory

John Bell
Research Professor
Nevada Bureau of Mines and Geology

Publication Citations

Bell, J.W., and House, P.K., 2010, Geologic map of the Grimes Point quadrangle, Churchill County, Nevada: Nevada Bureau of Mines and Geology Map 173, 1:24,000 scale, 24 p. text.

Bell, J.W., 2010, Active faulting and neotectonics at Nevada geothermal sites: Year-end 2009 project report to Department of Energy.

Bell, J.W., 2010, InSAR studies of the Reno area and regional valleys: Final research project report to the Washoe County Department of Water Resources.

Bell, J.W., 2010, Low-sun-angle photography studies, active faulting, and surficial geology, Hawthorne Army Weapons Depot and Fallon NAS BR-16: Final research report to Department of Navy.

Bell, J.W., 2010, Operation and results from the UNR1 GPS station April 2009 to March 2010: Year-end Report to the Las Vegas Valley Water District/ Southern Nevada Water Authority.

Bell, J.W., and Hinz, N.H., 2010, Young Walker basin faults provide new insights into structural relations controlling geothermal potential at the Hawthorne Army Weapons Depot, central Nevada: Geothermal Resources Council Transactions, v. 34, p. 751–754.

Bell, J.W., and Katzenstein, K., 2010, InSAR analysis of mine de-watering in the Turquoise Ridge-Twin Creeks area: Final research project report to Barrick Gold of North America and Newmont USA.

Awards

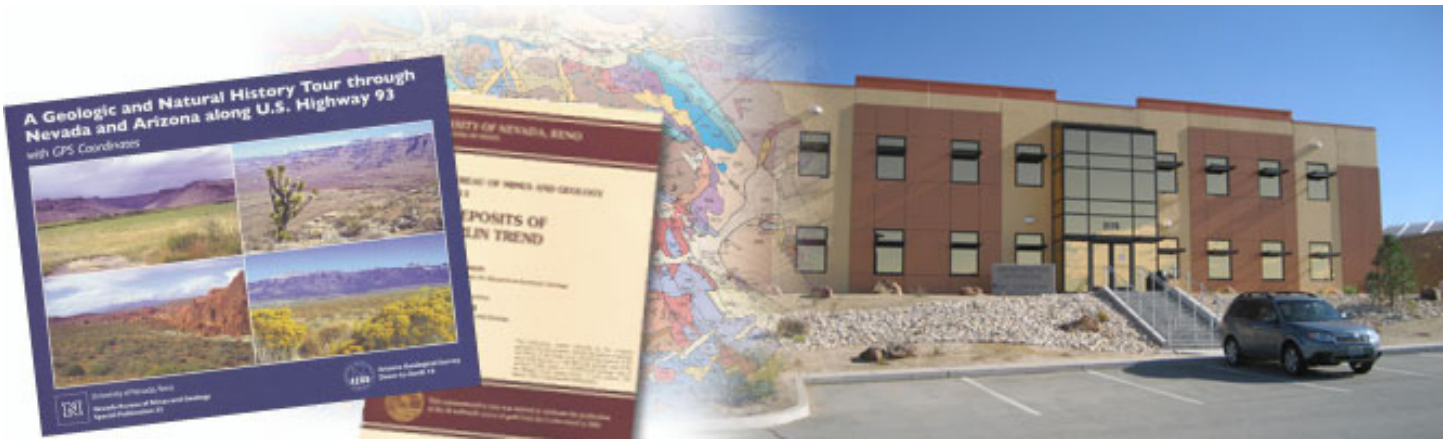
Best Presentation Award, Geothermal Resources Council, 2010, Young Walker basin faults provide new insights into structural relations controlling geothermal potential at the Hawthorne Army Weapons Depot, central Nevada, Bell, J.W. (presenter/first author) and Hinz, N.H. (coauthor).

Awarded Best Presentation Award from Geothermal Resources Council, 2011.

Find additional information on John Bell's research at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Staff/Bell.html

Great Basin Science Sample and Records Library

GBSSRL



The Nevada Bureau of Mines and Geology Publication Sales and Information Office and the Geological Society of Nevada office are located at the Great Basin Science Sample and Records Library (GBSSRL) at 2175 Raggio Parkway, Reno, NV 89512.

You can purchase or obtain the following information at the GBSSRL:

- NBMG geologic maps and reports
- U.S. Geological Survey geologic maps and publications
- U.S. Geological Survey topographic maps
- Aerial photographs
- Cuttings, core, and well records for oil, gas, and geothermal
- General geological and mining information

Well cuttings and core samples are archived in the GBSSRL warehouse. *Photo by Charlotte Stock.*

Geologists from Colorado examine well cuttings at the GBSSRL. *Photo by Charlotte Stock.*

Hours of operation
Tuesday–Friday,
8:00 a.m. to 3:00 p.m., PST

Phone: (775) 682-8766
Fax: (775) 784-6690
E-mail: nbmg@unr.edu

Find additional information on the Great Basin Science Sample and Records Library at the **Nevada Bureau of Mines and Geology website**
http://www.nbmg.unr.edu/GBSSRL/index.html

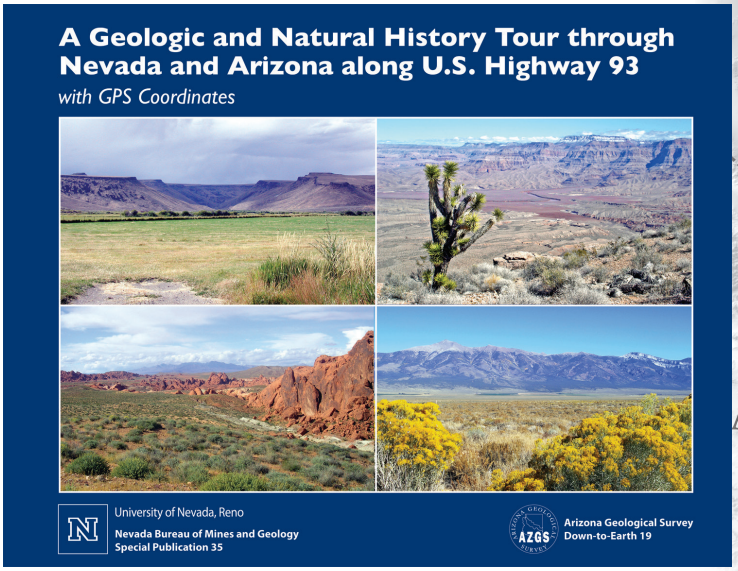
NBMG Special Publication Spotlight

Nevada Bureau of Mines and Geology Special Publication 35/Arizona Geological Survey Down-to-Earth 19

A Geologic and Natural History Tour through Nevada and Arizona along U.S. Highway 93, with GPS Coordinates by Joseph V. Tingley, Kris A. Pizarro, Christopher Ross, and Philip A. Pearthree, illustrations by Kris A. Pizarro, publication design by Shelly A. deLaureal and Jack P. Hursh, 2010.

This book is the latest in a series of guidebooks published by the Nevada Bureau of Mines and Geology and is cosponsored by the Arizona Geological Survey. In this new guidebook are stories of the rocks, plants, animals, and historical places and events as they unfold along U.S. Highway 93 between Wickenburg, Arizona and Jackpot, Nevada. The tour begins in Arizona's Sonoran Desert, travels through parts of the Mojave Desert, crosses the Great Basin, and ends at Nevada's northern border. Interesting side trips take you to mining towns, a national recreation area, a national park, the northern edge of the Basin and Range Province, and even a spot where you can see evidence of an "alien" from space. The guidebook is published in 8.5- by 11-inch, landscape, spiral-bound format. The work is illustrated with sketches, over 260 black and white photos, and 12 spectacular color plates that document features described in the text. Detailed route maps are included. A table in the back lists GPS coordinates that correspond with sites of interest noted throughout the text.

NBMG Special Publication 35, 175 pages.



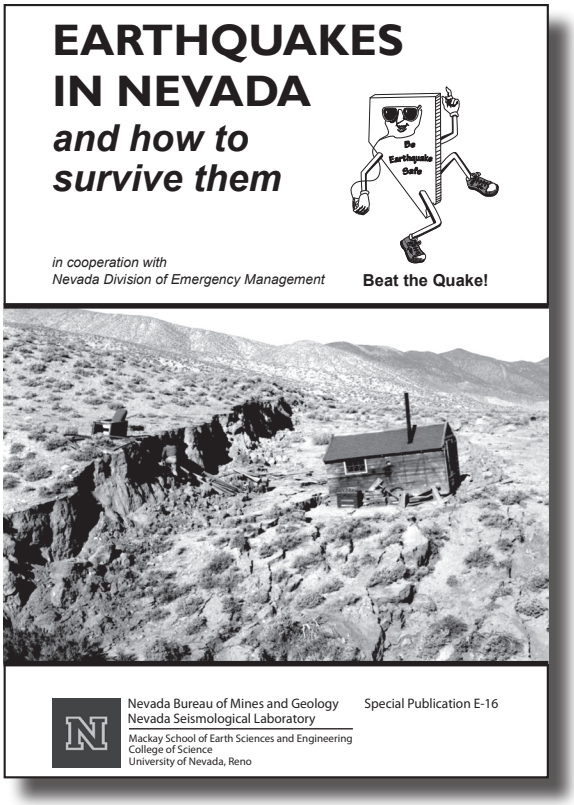
Find information on ordering copies of NBMG Special Publications at the
Nevada Bureau of Mines and Geology website
https://pubs.nbmg.unr.edu/Special-Publications-s/1865.htm

Geologic Hazards and Public Safety

NBMG Publication Spotlight

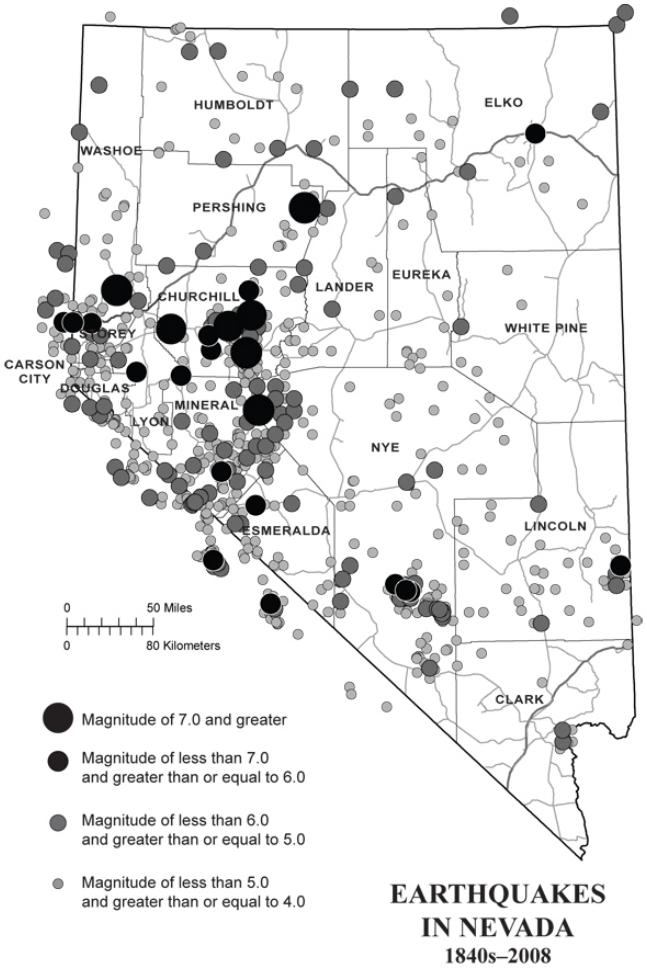
NBMG E-16 - *Earthquakes in Nevada and how to survive them*, seventh edition, January 2010, 8 pages. Available free on the NBMG website: http://pubs.nbmg.unr.edu/Earthquakes-in-Nevada-and-how-t-p/e016.htm.

A Spanish version is free at: http://pubs.nbmg.unr.edu/Terremotos-en-Nevada-y-como-sob-p/e027.htm.



Nevada is at risk of numerous geohazards which are detailed below. NBMG scientists continue to research these hazards to help us learn how to protect ourselves from danger.

The Great Basin Science Sample and Records Library (GBSSRL) houses information on many of these geohazards. All materials in the following collections are open for free public viewing during GBSSRL office hours, and the staff will help locate and pull files for a fee. Many related publications are also available through our Publications Sales Office and for free on our website.



Earthquakes in the Nevada region recorded from the 1840s to 2008. (Nevada Seismological Laboratory)

Find additional information on Nevada geologic hazards and public safety at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Geohazards/index.html

Geologic Hazards and Public Safety

NBMG Publication Spotlight

NBMG Special Publication 27 - *Living with Earthquakes in Nevada*, by Craig M. dePolo, Lucy K. Jones, Diane M. dePolo, and Susan Tingley, Third Edition, 2010, 38 pages in color.

This handbook identifies the earthquake threat to Nevada and reviews earthquake safety, how to be prepared for earthquakes, and mitigation of hazards from shaking and fault offset.

Available free on the NBMG website: **http://pubs.nbmg.unr.edu/Living-with-earthquakes-in-NV-p/sp027.htm.**

The State of Nevada is located in "earthquake country." It lies within the Basin and Range province, one of the most seismically active regions in the United States. Along with California and Alaska, Nevada ranks in the top three states subject to the most large earthquakes over the last 150 years.

The Genoa fault plane with vertical grooves was caused by normal-slip movement. Over the last 150 years, Nevada has been the third most active state in the Union in the number of large earthquakes. Since the 1850s, over 63 earthquakes with potentially destructive magnitudes of 5.5 or greater have occurred in the state.

Given the many "earthquake-generating" faults in Nevada, the geodetic deformation measured between the mountains, and the many historical earthquakes, it is clear that earthquakes will continue to occur in the state. *Photo by Chris Henry*

For an extensive list of available publications and information on earthquakes, see the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Geohazards/index.html

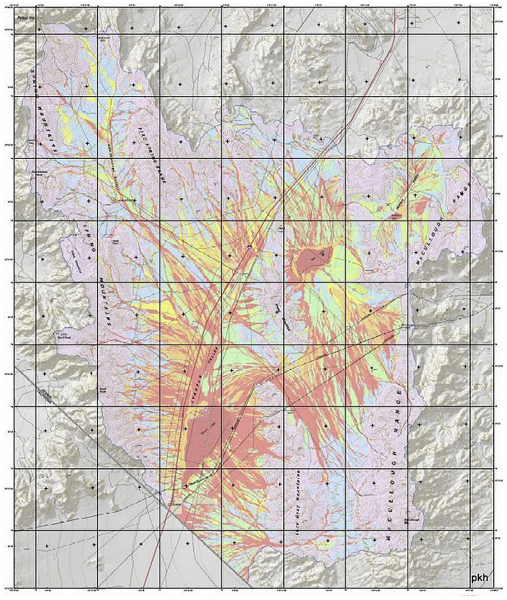
Geologic Hazards and Public Safety

NBMG Publication Spotlight

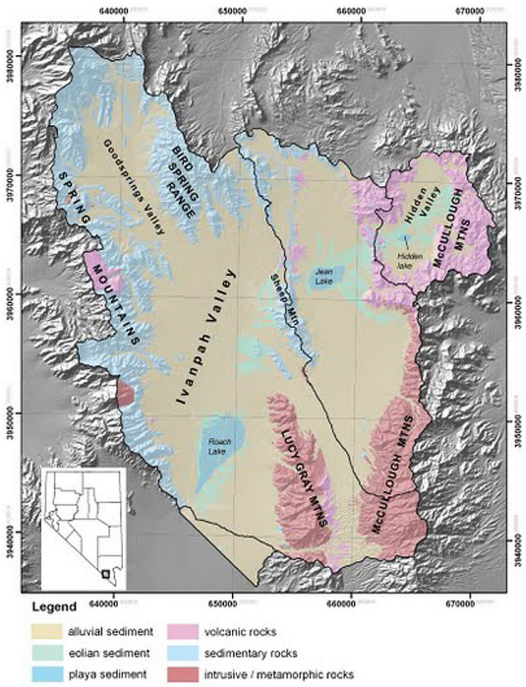
NBMG Report 53d
Geologic assessment of piedmont and playa flood hazards in the Ivanpah Valley area, Clark County, Nevada

by P. Kyle House, Brenda J. Buck, and Alan R. Ramelli (2010)

A comprehensive surficial geologic mapping effort was undertaken to support the development of a series of relative flood hazard maps of the Ivanpah Valley area, Clark County, Nevada. The study area spans approximately 1030 square kilometers (398 square miles) and is defined by all of three and part of one internally drained basins between Las Vegas and Primm, Nevada. The proximity of the study area to Las Vegas makes it a likely site of urban and suburban development in the near future, and it is currently being considered for the construction of a major airport facility. The geologic study focused on the delineation of surficial deposits of alluvial, aeolian, and playa sediments ranging in age from recent to late Miocene (approximately 5.6 million years old). Mapping emphasized the discrimination of active alluvial and playa surfaces from relict, inactive surfaces for the purpose of developing a relative flood hazard characterization to provide a baseline physical data set to guide floodplain management and more detailed studies related to hazard mitigation efforts in the area. Ideally, the maps will help planners understand the distribution of flood hazard conditions in the valley and direct mitigation efforts and engineering studies to areas with the highest potential for flooding. Study results indicate that 60% of the total study area (236 square miles) is composed of surficial geologic deposits. Within that subset, nearly 75% (175 square miles) is subject to a relative flood hazard level deemed greater than "none", and nearly 53% of that area (125 square miles) is classified as having a hazard status high enough to represent a significant concern for floodplain management. A series of 9 maps and a complete digital GIS dataset accompany this report.



Relative flood hazard map of the Ivanpah Valley study area.



Simplified geologic map of the study area showing the distribution of general surficial units and bedrock types.

Find additional information on Nevada geologic hazards and public safety at the
Nevada Bureau of Mines and Geology website
https://pubs.nbmg.unr.edu/Geol-flood-hazards-Ivanpah-DVD-p/r053d.htm

Geologic Hazards and Public Safety

NBMG Special Publication Spotlight

Nevada Bureau of Mines and Geology Special Publication 36 - *The 21 February 2008 Mw 6.0 Wells, Nevada earthquake*.

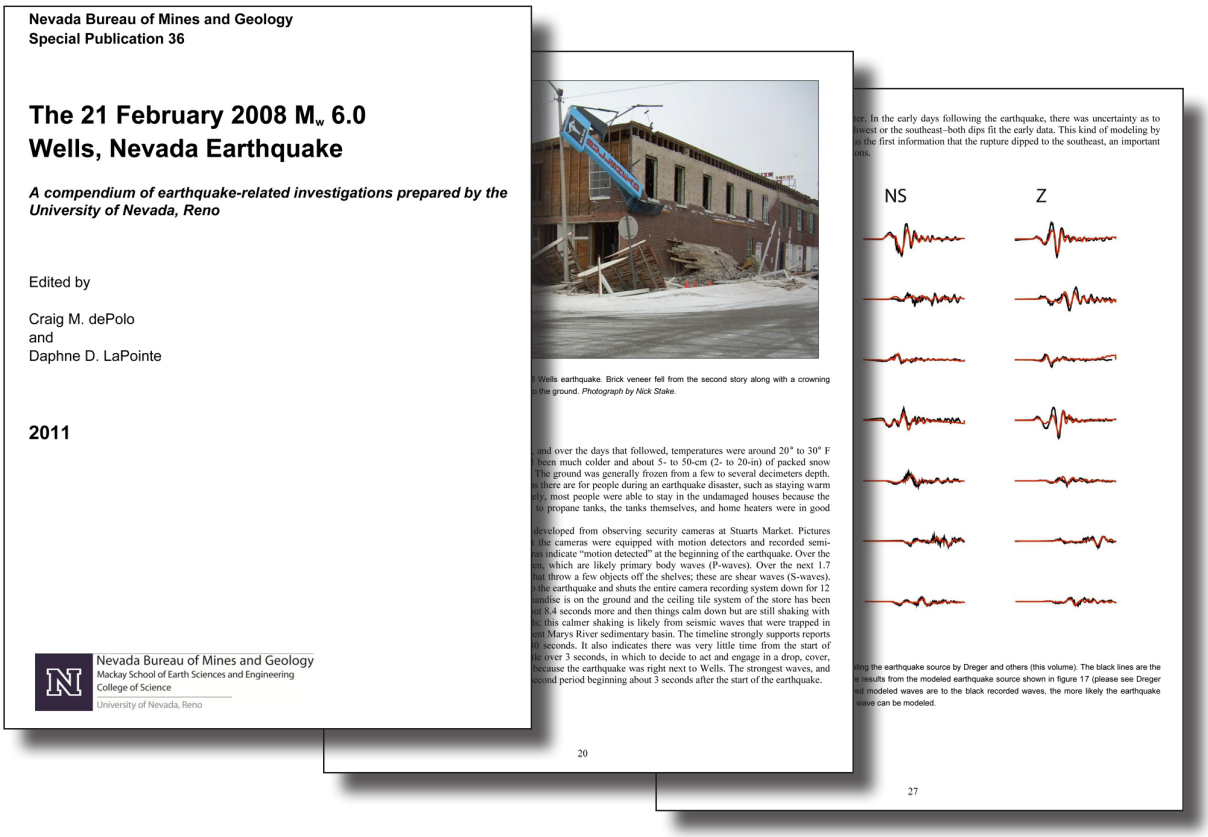
A compendium of earthquake-related investigations prepared by the University of Nevada, Reno, edited by Craig M. dePolo and Daphne D. LaPointe, 2011.

Special Publication 36, DVD
Also available in paper copy - SP36p.

Available free on the NBMG website at:

https://pubs.nbmg.unr.edu/The-2008-Wells-earthquake-p/sp036.htm **or**

http://data.nbmg.unr.edu/Public/freedownloads/sp/sp036/index.html



Find information on ordering a copy of NBMG Special Publication 36 at the
Nevada Bureau of Mines and Geology website
https://pubs.nbmg.unr.edu/The-2008-Wells-earthquake-p/sp036.htm

Science Education and Outreach

NBMG plays an important role in educating the public on many geologic topics that directly affect Nevada through educational publications, teacher workshops, field trips and other outreach opportunities.

Teacher Workshops

Staff members regularly participate in the highly effective and popular teacher-education workshops that are sponsored by the Nevada Mining Association and jointly supported by the Nevada Division of Minerals.

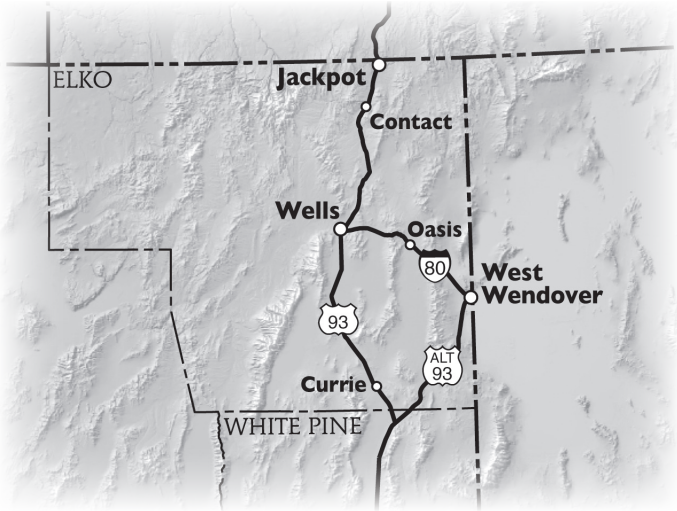
D.D. LaPointe, NBMG Research Geologist, leads a discussion on geology at the 2011 Earth Science Week field trip to the Lahontan Mountains area.

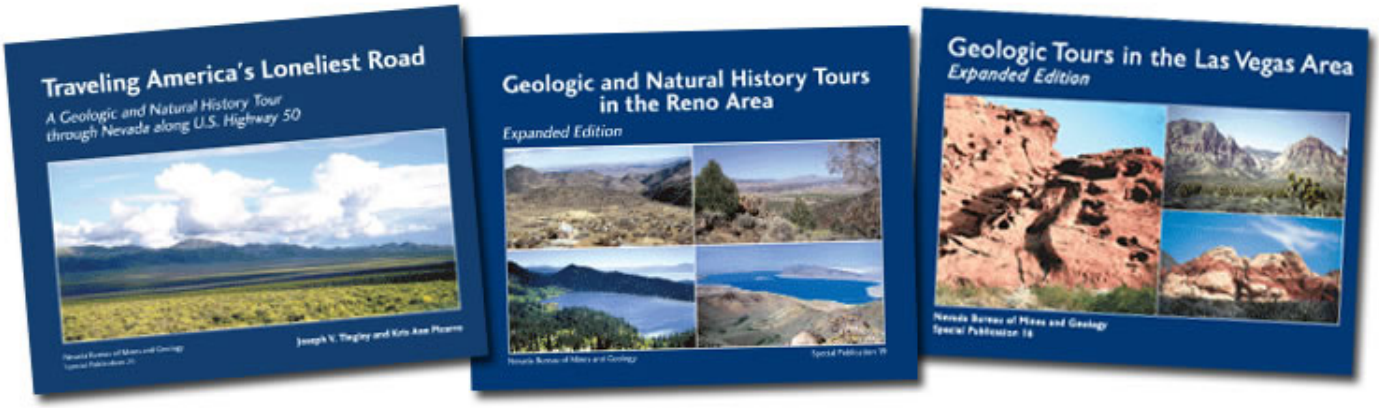
Field Trips

NBMG helps coordinate field trips and other activities for the public and for K-12 teachers and students during Earth Science Week (second full week of October) and Earthquake Awareness and Preparedness Week (late February or early March).

Geologic Tourbooks

NBMG also produces publications specifically for the general public, such as our popular field guides on the geology and natural history of the Las Vegas, Reno-Carson City-Lake Tahoe regions, and U.S. Highways 50 and 93.





Find additional information on NBMG's science education and outreach opportunities at the **Nevada Bureau of Mines and Geology website**
http://www.nbmg.unr.edu/ScienceEducation/ScienceEducation.html

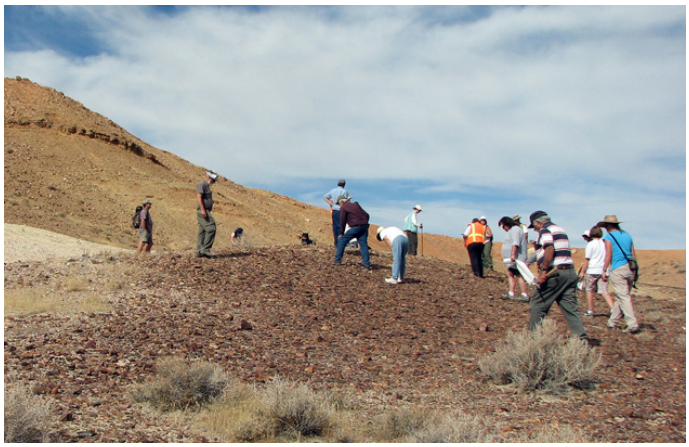
Earth Science Week Field Trips

The Nevada Bureau of Mines and Geology annually hosts a geology field trip free and open to the public. This field trip is in conjunction with National Earth Science Week (second full week of October) which encourages people everywhere to explore the natural world and learn about the geosciences. Participants see how geologists use geologic maps to unravel the history of Nevada geology, assess earthquake hazards from evidence of recent faulting, and evaluate the potential for mineral resources. Participants are given the opportunity to collect mineral specimens.

A field trip guide is published each year by the Nevada Bureau of Mines and Geology and given to the field trip participants.

Field trip guides from past trips are available for free on the NBMG website in the Educational Series (E-Series) listings: **http://www.nbmg.unr.edu/ScienceEducation/Geotripping.html**

2010 Earth Science Week field trip, internal view of tipped over tufa mound at Winnemucca Lake.



Participants collect mineral specimens during the 2011 Earth Science Week field trip to the Lahontan Mountains area.

Nevada wonderstone pebbles polished by the wave action of Lake Lahontan found during the 2011 Earth Science Week field trip to the Lahontan Mountains area.

Find additional information on Earth Science Week field trips at the **Nevada Bureau of Mines and Geology website**
http://www.nbmg.unr.edu/ScienceEducation/Geotripping.html

Website Hosting Services

Extensive resources produced by NBMG can be accessed at the Nevada Bureau of Mines and Geology's website:

www.nbmg.unr.edu.

In addition, NBMG provides website hosting and website editing services to several state organizations including the following:

Nevada Earthquake Safety Council

www.nbmg.unr.edu/nesc/index.html

The mission of the Nevada Earthquake Safety Council is to advise the Nevada Earthquake Risk Reduction Program. The Council facilitates public input, develops consensus about seismic issues within the public and private sectors, and is the public advisory body for the State seismic safety policy.

NBMG faculty and staff that served in 2010 and 2011 on the NESC council: **Craig dePolo** (Executive Director), **Terri Garside** (Executive Assistant), **Jon Price** (Secretary).

Nevada Hazard Mitigation Planning Committee

www.nbmg.unr.edu/nhmpc/nhmpc.htm

The purpose of the Nevada Hazard Mitigation Planning Committee is to advise the Nevada Department of Emergency Management concerning hazard mitigation assistance, which includes planning, projects, and policies.

NBMG faculty and staff that served in 2010 and 2011 on the NHMPC: **Terri Garside**, **Jon Price** (Chair).

Nevada Petroleum Society

www.nbmg.unr.edu/nps/index.html

The purpose of the Nevada Petroleum Society is to foster the development and growth of the petroleum industry in Nevada; promote a high level of professionalism and ethics among the membership through programs of continuing education; foster cooperation and understanding between the petroleum industry in Nevada and officials in federal, state, and local government; and encourage and sponsor the dissemination of information through meetings, field trips, publications, and by the support of academic endeavors.

NBMG faculty that served in 2010 and 2011 as officers of the NPS: **Jim Faulds** (President).

Nevada State Mapping Advisory Committee

www.nbmg.unr.edu/smac/smac.htm

The Governor of Nevada established the State Mapping Advisory Committee (SMAC) in 1983 to advise the U.S. Geological Survey (USGS) on state priorities for map products and to inform maps users about the status of mapping programs and the availability of map products. The Governor named the Director of the Nevada Bureau of Mines and Geology as the chair of SMAC.

NBMG faculty and staff that served in 2010 and 2011 on the SMAC: **Jon Price** (Chair), **Ron Hess** (Executive Secretary, 2010), **Jennifer Mauldin** (Executive Secretary, 2011–present).

Nevada State Board on Geographic Names

The mission of the Nevada State Board on Geographic Names is to coordinate and approve proposed geographic names within the state for official recommendation to the United States Board on Geographic Names.

NBMG faculty and staff that served in 2010 and 2011 on the NSBGN: **Jordan Hastings**, **Jack Hursh** (Executive Secretary).

A 2011 joint meeting of the Nevada Earthquake Safety Council and the Utah Seismic Safety Council.

Find additional resources and links at the
Nevada Bureau of Mines and Geology website
http://www.nbmg.unr.edu/Links.html

Awards

Awards received by NBMG faculty and staff:

Bell, J.W.

Best Presentation Award, Geothermal Resources Council, 2010, Young Walker basin faults provide new insights into structural relations controlling geothermal potential at the Hawthorne Army Weapons Depot, central Nevada, Bell, J.W. (presenter/first author) and Hinz, N.H. (coauthor).

Awarded Best Presentation Award from Geothermal Resources Council, 2011.

dePolo, C.M.

2010 Western States Seismic Policy Council Award in Excellence in Research for the Quaternary Fault Map of Nevada, NBMG Map 167.

Johnson, G.L.

Second place for cartography of "Geothermal Resources in Nevada," Nevada Geographic Information Society, 2011.

Kreemer, C.W.

Geodesy Section Award from American Geophysical Union, 2010.

Mackay Faculty Achievement Award from University of Nevada, Reno, 2011.

LaPointe, D.D.

Mackay Award for Excellence from Mackay School of Earth Sciences and Engineering, 2011.

Long, S.

Arnold Guyot Teaching Award from Princeton University Geosciences Department, 2010.

Mauldin, J.

Alice Kellames Award for Outstanding Classified Service, Mackay School of Earth Sciences and Engineering, University of Nevada, Reno, 2011.

First place for cartography of "Geologic Map of the Wells Area, Elko County, Nevada," Nevada Geographic Information Society, 2011.

Muntean, J.L.

Awarded First Place Best Student Paper Award from Geological Society of Nevada Symposium, 2010.

Awarded Second Place Best Student Paper Award from Geological Society of Nevada Symposium, 2010.

Awarded Second Place Best Student Poster Award from Geological Society of Nevada Symposium, 2010.

Mousel-Feltner Award for Excellence in Research by the University of Nevada, College of Science, 2011.

Price, J.G.

President's Citation from Mining and Metallurgical Society of America for chairing the organizing committee for the 4 February 2010 symposium on Minerals for a Green Society in Washington, D.C.

Public Service Award in Honor of Eugene and Carolyn Shoemaker from Geological Society of America, awarded at the 2010 annual meeting of the Geological Society of America; this award is made for contributions that have materially enhanced the public's understanding of the earth sciences, or significantly served decision-makers in the application of scientific and technical information in public affairs and public policy related to the earth sciences.

President's Award from Nevada Organization of Building Officials - for contributions to a safe built environment for the citizens of Nevada, 2011.

Richardson, M.

Second place, for cartography of "Geothermal Resources in Nevada," Nevada Geographic Information Society, 2011.

Shevenell, L.A.

Selected for the American Association of State Geologists Geothermal Data Project Science Advisory Board (5 member national panel), 2010.

Invited by White House staff to attend an invitation-only event with President Barack Obama, April 21, 2011, Reno, Nevada.

Invited by KenGen (the Kenya Electrical Generation Company) to serve on their international Geothermal Board of Consultants to advise them on geothermal development in Kenya.

Selected by the International Atomic Energy Agency to conduct a geothermal assessment of Eritrea, Africa.

Selected for the American Association of State Geologists Geothermal Data Project Science Advisory Board (5 member national panel), 2011.

See accompanying citations list for a complete set of NBMG 2010–2011 activities.