# *Nevada's Immense Mineral and Geothermal Endowment: Legacy of a Long Journey through Hot Water and Major Orogenic Events*



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Nevada is richly endowed in mineral and geothermal resources. It typically leads the nation in non-fuel mineral production and is the primary producer of gold, lithium, and barite while also generating large amounts of other precious and base metals, multiple critical minerals, and various industrial minerals. Nevada also hosts enormous amounts of geothermal resources and is currently number two in the nation (after California) in generating geothermal power. Most studies suggest that Nevada has more geothermal resources than any state.

This immense mineral and geothermal endowment results from a complex geologic history replete with multiple tectonic events conducive for hydrothermal activity. For example, a long period of convergent tectonism from the late Paleozoic through the early Tertiary included subduction of oceanic lithosphere (mainly the Farallon plate) with attendant arc magmatism. Varying rates of convergence and angles of subduction shifted arc magmatism back and forth across the region, resulting in widely scatted mineralization. Typical intermediate composition arc magmatism was then punctuated by voluminous felsic volcanism associated with the poorly understood ignimbrite flareup, which swept southward across Nevada in Eocene to Miocene time and locally adorned Paleozoic shelf carbonates with large quantities of disseminated gold, thus generating the Carlin-type gold deposits. Multiple calderas or supervolcanoes spewed huge amounts of ash-flow tuffs that flowed down and filled paleovalleys to the east and west from a high topographic divide in central Nevada. Some of these paleovalleys extended westward to the Pacific Ocean in what is now central California. In mid-Tertiary time ~30 Ma, the North American and Pacific plates came into contact as the East-Pacific rise approached in the wake of subduction of much of the Farallon plate beneath North America. Relative motion between the North American and Pacific plates induced development of a transform plate boundary, with the right-lateral San Andreas fault accommodating the bulk of this motion. As the western Cordillera evolved from a convergent to a transform plate boundary, voluminous magmatism continued but was accompanied by major ~E–W extension across much of Nevada. Magmatism (including the ignimbrite flareup in some areas) continued and was partly induced by foundering of parts of the subducted Farallon plate and development of a slab gap, which placed relatively warm asthenosphere (previously insulated by the subducting slab) against the base of the lithosphere, thus triggering melting of mantle lithosphere. Extension was driven by relaxation of compressional stress coupled with gravitational collapse of overthickened crust produced by late Paleozoic to early Tertiary shortening.

As North America continued to override more of the Farallon plate in Neogene time, the transform boundary increased in length and strike-slip deformation stepped inland, fully transferring parts of North America to the Pacific plate (e.g. Baja California) and eventually initiating dextral shear in the late Miocene on the east side of the Sierra Nevada in the Walker Lane and eastern California shear zone. As the transform boundary lengthened, volcanism waned and retreated to the northwest, leaving most of Nevada devoid of volcanism since the Pliocene. Since the early Miocene, more than 400 km of right-slip has accumulated on the San Andreas fault system while parts of Nevada have extended >100%. Due to crustal extension, Nevada has been the fastest growing state for the past ~15 million years, and even today about 2 acres per year are added to the state thanks to regional extension. High geothermal gradients and abundant active normal faults resulting from the regional extension bestow Nevada with plentiful geothermal resources, placing it at the center of one of the largest geothermal provinces on Earth. Ongoing research is refining geothermal exploration techniques and targeting blind or hidden geothermal systems, which have no surface manifestations (e.g. hot springs) and probably represent the bulk of geothermal resources in the region. This research includes characterizing favorable structural settings for hydrothermal systems, integrating geological and geophysical signatures through play fairway analysis, and applying machine learning techniques.

***Biography:*** James Faulds is a Professor with the Nevada Bureau of Mines and Geology (NBMG) at the University of Nevada, Reno (UNR). NBMG is a research and public service unit of UNR and is the state geological survey of Nevada. Faulds is a structural geologist with more than 35 years of experience. He has been with UNR and NBMG since 1997, first as Professor and also serving as NBMG Director/Nevada State Geologist from 2012 to 2024. Prior to coming to UNR, he was an Assistant Professor at the University of Iowa from 1992 to 1997. He earned his B.S. at the University of Montana, M.S. at the University of Arizona, and Ph.D. at the University of New Mexico. His research has focused on how fault systems initiate and evolve through time, as well as the structural settings and exploration strategies for geothermal systems. His geothermal journeys have included short-term appointments with the BRGM in France, both GNS Science and the University of Canterbury in New Zealand, and University of Bern in Switzerland while on sabbaticals. He has published over 100 papers and dozens of geologic maps, taught a variety of courses in the geosciences, and served as advisor for more than 30 graduate students.