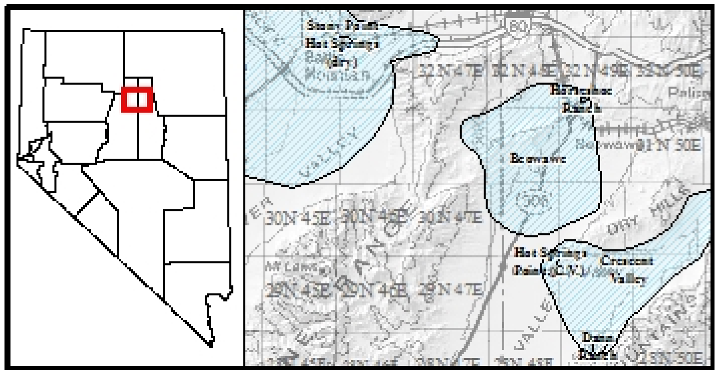
Site Description

Beowawe

(updated 2014)



Geologic setting:

Beowawe Geysers are located in southern Whirlwind Valley along the northern Nevada rift, a narrow, north-northwest trending zone of middle Miocene volcanic and hypabyssal rocks 56 to 113 km long. The zone extends from the central Shoshone Range south of Whirlwind Valley to the central Tuscarora Mountains (Stewart and Carlson, 1976). Beowawe Geysers are located where the northern Nevada rift intersects the Malpais fault and other northeast-trending lineaments (Oesterling, 1962; Trexler, 1977). The Malpais fault, an east-northeast striking normal fault, crosscuts the rift and parallels graben-bounding faults in the Midas trough and Argenta Rim (John et al., 1999). In the subsurface, Miocene volcanic rocks overlie Paleozoic chert, shale, and quartzite of the Valmy Formation. Geothermal production is from highly fractured and permeable zones in the Valmy Formation below 2,040 m, and initial reservoir temperatures were 213-216°C (Benoit and Stock, 1993). The ultimate deep reservoir is believed to be Paleozoic carbonate rocks below the Valmy Formation (Layman, 1984).

Recent movement is believed to have taken place on faults that cut the sinter terrace (Oesterling, 1962; figure). Surface geothermal manifestations are mainly confined to a 915-m segment of the Terrace Fault and a 395-m segment of the Horst Fault (figure). The rocks exposed along the Malpais ridge, south of Beowawe Geysers, are predominantly basalts and andesites. The underlying Ordovician Vinini Formation crops out in several locations, and was encountered in several drill holes (figure).

Geothermal features:

The geothermal area at Beowawe has the highest subsurface temperatures in Eureka County and, along with Bradys Hot Springs and Dixie Valley in Churchill County, the highest well temperatures in Nevada. It is among the most drilled geothermal areas in Nevada and was actively investigated by energy companies in the late 1960s and early 1970s.

Horseshoe Ranch Springs: Two hot springs (55-58°C) are located at Horseshoe Ranch 1.5 km NE of the town of Beowawe (Sec. 32, T32N, R49E). The springs flowed at ~114 L/min, sufficient for bathing and irrigation (Roberts et al., 1967; Stearns et al., 1937). By the 1980s, however, Reed et al. (1983, p. 40) reported the discharge to be 4 L/min. The springs are localized along a N70°E extension of the Malpais fault. The Malpais fault is located 11 km southwest of Horseshoe Ranch Springs, and hosts the geothermal activity at Beowawe Geysers. A Na-K-Ca geothermometer of 75.4°C (Fournier, 1981), a quartz geothermometer of 108.9°C (Fournier, 1977), and a chalcedony geothermometer of 79.5°C (Fournier, 1981) were all reported for one spring measuring 58°C (Great Basin Groundwater Geochemical Database).

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Beowawe Geysers: Surface manifestations of Beowawe Geysers are mainly confined to Secs. 8,17,18, T31N, R48E (mostly Eureka County, though Sec. 18 is in Lander County). The Geysers are in southwestern Whirlwind Valley, about 10 km west of the small community of Beowawe.

White (1998) and Roberts (1989) have described the history of geyser activity at Beowawe. The hot springs, geysers, and fumaroles have temperatures up to 94-95.5°C, and in 1932 several geysers erupted to heights of a meter or more (Nolan and Anderson, 1934). Sinter terrace geysering was disrupted in the 1960s after exploration drilling, but valley floor geysers increased their activity, erupting to heights of 1 to 2 m (Rinehart, 1968). Geyser activity completely ended after vandals blew the caps off four steam wells prior to 1972. One of the wells released steam and water in large volumes, though the duration of geysering is uncertain (Hose and Taylor, 1974). The "best guess" estimates of thermal reservoir temperatures in 1974 were 196°C for a spring sample, and 226-238°C for a steam well sample (Mariner et al., 1974). The most conspicuous feature of Beowawe Geysers is an enormous, symmetrical spring-sinter terrace some 75 m high. The top of the terrace, which measures 30 m wide and 850 m long, is remarkably level (Oesterling, 1962). The flowing springs and geothermal wells are located along a narrow, older band of sinter between the main terrace and Tertiary andesite to the south (Hose and Taylor, 1974, figure). The siliceous sinter is almost entirely comprised of opal, which is presently forming around certain pools (Nolan and Anderson, 1934). The sinter reportedly contains 300 ppm tungsten and high beryllium (R. Erickson, personal commun., 1970); tungsten is also high in the geothermal fluids (Wollenberg et al., 1975a).

Magma Power Co., Vulcan Thermal Power Co., and Sierra Pacific Power Co. drilled twelve exploratory geothermal wells in Sec. 17, T31N, R48E from 1959(?) through 1965. These wells had temperatures of 208-212°C at depths of 213-244 m, with the deepest well reaching 625 m. Three more wells were drilled between 1974 and 1978, two of them to ~1675 m and a third to 2915 m. The Magma Energy, Inc. Batz No. 1 was drilled to 1661 m in Sec. 17, T31N, R48E, near the previous wells. Two wells, the Chevron-American Thermal Resources Ginn No. 1- 13 and the Chevron U.S.A., Inc. Rossi No. 21-19, were drilled in an area 2.4 km southwest of the Geysers. These wells encountered high-temperature fluids in faulted zones near total well depth. Few data are available for any wells drilled in the 1970s.

The earlier wells at Beowawe Geysers underwent considerable testing shortly after drilling and several years thereafter (Middleton, 1961; Oesterling, 1962; Allen, 1962). Several wells produced large flows of steam and hot water from shallow depths; their temperature-depth curves are reproduced here. Although the data are at times conflicting and confusing, some wells apparently produced 181,000-227,000 kg/hr (400,000 to 500,000 lbs/hr) of fluid, with 10 to 15% steam flashover. Middleton (1961) reported about 680,000 kg/hr (1.5 million lbs/hr) of fluid at 172°C from the Vulcan No. 4 well, with 18,800 kg/hr (41,500 lbs/hr) of that being steam. The wellhead pressure was reported to be 116 lbs/in^2 (8.1 kg/cm^2) absolute. Static pressure in several of the wells is apparently in the 2.8 to 7 kg/cm^2 range, and flow pressure is reportedly 1.4 to 2.1 kg/cm^2.

The Beowawe flash power plant came on line in 1985, producing 16.7 MW from an approximately 200°C resource. Problems of well scaling (Koenig, 1970) and cold water inflow were reported, the latter due to shallow well casings and poor reinjection strategy. These issues may have contributed to productivity loss at Beowawe, measurable over several years of testing. Initial temperatures were as high as 215.6°C (Benoit and Stock, 1993), but dropped as spent brine was injected outside the reservoir. Pressure dropped

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by 110 psi in the first year of plant operation, which in turn allowed ground water inflows to cool the reservoir. The cold water stabilized reservoir pressure, but reduced the production fluid-entry temperature by as much as 21ºC over eight years (Benoit, 199, p. 574). A large new production well temporarily restored plant output but, because it accelerated the reservoir pressure decline, again reduced power production. New injection strategies minimized the gross megawatt decline rate over a period of two years (Benoit, 1997, p. 569). More data on the geothermal resource at Beowawe is summarized in GeothermEx (2004).

As a result of a May 2009 DOE funding announcement, Terra-Gen Power, LLC successfully received a $2 M award to demonstrate the technical and economic feasibility of utilizing low temperature geothermal fluids. The work ultimately resulted in the commissioning of a 2.5 MW bottoming cycle plant in January 2011 (Dickey et al., 2011).

Leasing information:

Beowawe Power LLC signed a 29-year power sales contract with Sierra Pacific Power Co., which took effect January 2006. The agreement expires in December 2025 (Terra-Gen Power, 2014). In 2006 electrical production at the plant was 132,747 MWh gross and 113,935 MWh net (Nevada Bureau of Mines and Geology, 2007). Nameplate capacity for Beowawe power production is given as 16.6 MW with 17.7 MW actually produced (Nevada Bureau of Mines and Geology, 2010).

Magma's 1,735 acres are contiguous with Terra-Gen Power's 16.6 MW dual flash plant. Magma had proposed seismic reflection, gravity, magnetics, and electrical field surveys followed by TG drilling. However, they closed their Reno offices and relinquished many of their Nevada leases in 2010-2012. The existing power plant is producing 17.7 MW of 205°C water, along with the new 2.5 MW bottoming cycle facility added to their existing dual flash plant (http://www.nbmg.unr.edu/geothermal/Exploration.html).

In 2012, TerraGen Power's Beowawe 16.6 MW dual flash plant produced 136,717 MWh gross and 115,941 MWh net (Nevada Bureau of Mines and Geology, 2012).

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