

Geysers, U.S.

KEY STATS:

- Number of SHR wells drilled: 1
- Deepest well: 3,352 m
- Hottest well: 400°C

PROJECT DETAILS:

Reservoir Lithology

The Geysers geothermal system is mainly composed of fractured metamorphosed greywacke, but metamorphosed basalt and shale are also present.

Geological Setting

The Geysers field is hosted within reservoirs of metamorphosed basalt, shale, and greywacke. Localized Holocene silicic intrusive activity is documented with granitic intrusions (“felsite”) encountered at a depth of ~4.0km (Schmitt et al. 2003; Jeanne et al., 2015). Structurally, fractures within the Geysers are closely related to a shear zone network composed of eight northwest-striking (N130) shear zones along with three northeast-striking (N050) shear zones (Norton and Hulen, 2001; Jeanne et al., 2015).

Tectonic Setting

Strike Slip, Transform System: The Geysers geothermal reservoir is located east of the San Andreas Fault system, which overprints and deforms Mesozoic accreted terranes and magmatic arc systems. Prior to the onset of the transform faulting and the modern Pacific margin, long-lived subduction occurred until the Pacific-Farallon Ridge started to subduct under the North American Plate (Stock & Atwater 1988). The San Andreas system is a right lateral

transform system. The formation of the San Andreas fault characterizes the switch from subduction to a transform-related margin at ~8 Ma as subduction diminished (Atwater and Stock, 1998). No faults in or adjacent to The Geysers have recorded faulting activity within the last 15,000 years (Garcia et al., 2015). Local seismic activity is primarily driven by withdrawing steam and heat, resulting in rock contraction (Gomberg and Davis, 1996).

Projects/Players

Calpine & Wild Horse Geothermal, LLC

Notes

- The re-drill of Prati-32 was completed as part of the Northwest Geysers EGS Demonstration Project. The project goal was to enhance the permeability of high-temperature, low-permeability rocks through the thermal stimulation of fractures (Walters et al., 2013).
- The goal was to create an enhanced geothermal system capable of producing 5 MW.
- Testing and reporting of the project was delayed until the production liner of Prati State 31 is repaired with a high alloy steel or titanium liner.
- Prati State 31 and Prati 32 were completed as a production-injection well pair (respectively) into low-permeability, conductively-heated rock with temperatures as high as 400°C. Plans for producing the EGS steam to a proposed power plant are indefinitely delayed because no PPA from a major utility is available.

Key References

- Atwater, T., Stock, J., (1998). Pacific-North America Plate Tectonics of the Neogene Southwestern United States: An Update. *International Geology Review*, 40(5), 375–402. doi:10.1080/00206819809465216
- Garcia, J., Hartline, C., Walters, M., Wright, M., Rutqvist, J., Dobson, P.F., Jeanne, P., (2016). The Northwest Geysers EGS Demonstration Project, California. Part 1: Characterization and reservoir response to injection. *Geothermics* (2015), <http://dx.doi.org/10.1016/j.geothermics.2015.08.003>
- Garcia, J., Walters, M., Beall, J., Hartline, C., Pingol, A., Pistone, S., and Wright, M., Overview of the NorthWest Geysers EGS demonstration project. Stanford University, Stanford, California, January 30 - February 1, SGP-TR-194
- Gomberg, J., and Davis, S., (1996). Stress/strain changes and triggered seismicity at The Geysers, California. *Journal of Geophysical Research: Solid Earth* 101.B1, 733-749.
- Hartline, C., Walters, M., Wright, M., Rawal, C., Garcia, J., and Farison, J., (2019). The Northwest Geysers Enhanced Geothermal System Demonstration Project, The Geysers, California, <https://www.osti.gov/servlets/purl/1523288>
- Humphreys, E., Hessler, E., Dueker, K., Farmer, G. L., Erslev, E., Atwater, T., (2003). How Laramide-Age Hydration of North American Lithosphere by the Farallon Slab Controlled Subsequent Activity in the Western United States. *International Geology Review*, 45(7), 575–595. doi:10.2747/0020-6814.45.7.575
- Jeanne, P., J. Rutqvist, A. P. Rinaldi, P. F. Dobson, M. Walters, C. Hartline, and J. Garcia (2015), Seismic and aseismic deformations and impact on reservoir permeability: The case of EGS stimulation at The Geysers, California, USA, *J. Geophys. Res. Solid Earth*, 120, doi:10.1002/2015JB012142.
- Kruszewski, M., and V. Wittig (2018). Review of failure modes in supercritical geothermal drilling projects *Geotherm Energy* (2018) 6:28
- Norton D. L. and Hulen J. B. (2001) Preliminary numerical analysis of the magma-hydrothermal history of The Geysers geothermal system, California, USA. *Geothermics* 30, 211–234.
- Peacock, J.R., Mangan, M.T., Walters, M., Hartline, C., Glen, J., Earney, T., Schermerhorn, W., (2019). Geophysical characterization of the heat source in the Northwest Geysers, California. *Proceedings, 44th Workshop on Geothermal Reservoir Engineering* 7 SGPR-214. K. Okamoto, et al. *Geothermics* 82 (2019) 267–281, 28.
- PROCEEDINGS, Thirty-Seventh Workshop on Geothermal Reservoir Engineering
- Reinsch T, Dobson P, Asanuma H, Huenges E, Poletto F, Sanjuan B., (2017). Utilizing supercritical geothermal systems: a review of past ventures and ongoing research activities. *J Geotherm Energy*. 5:16.
- Rutqvist, J., Jeanne, P., Dobson, P.F., Garcia, J., Hartline, C., Hutchings, L., Singh, A., Vasco, D.W., Walters, M., (2015). The Northwest Geysers EGS Demonstration Project, California – Part 2: Modeling and interpretation. *Geothermics*, <http://dx.doi.org/10.1016/j.geothermics.2015.08.002>
- Schmitt, A.K., Grove, M., Harrison, T.M., Lovera, O., Hulen, J., Walters, M., (2003). The Geysers-Cobb Mountain magma system, California (Part 2): timescales of pluton emplacement and implications for its thermal history. *Geochim. Cosmochim. Acta* 67, 3443–3458.
- Stanley, W.D., Benz, H.M., Walters, M.A., Villaseñor, A., Rodriguez, B.D., (1998). Tectonic controls on magmatism in The Geysers–Clear Lake region: Evidence from new geophysical models. *GSA Bulletin*; September 1998; v. 110; no. 9; p. 1193–1207
- Walters, M.A., (2013). Demonstration of an Enhanced Geothermal System at the Northwest Geysers Geothermal Field, CA. Demonstration of an Enhanced Geothermal System at the Northwest Geysers Geothermal Field, CA https://www.energy.gov/sites/prod/files/2014/02/f7/egs_calpine_peer2013.pdf

Well Name	Year Drilled (planned)	Entities/ Players	Depth (targeted) Meters/Feet	Pressure (targeted) MPa / PSI	Temperature (targeted) °C / °F	Latitude WGS84	Longitude WGS84
Prati-32 (re-drill)	2010	Calpine & Wild Horse Geothermal, LLC	3,396 m / 11,142 ft	n/a	400°C / 752°F	38.839082	-122.836282

Clean Air Task Force (CATF) is a global nonprofit organization working to safeguard against the worst impacts of climate change by catalyzing the rapid development and deployment of low-carbon energy and other climate-protecting technologies.

CATF's Superhot Rock Energy team is a group of scientists, industry practitioners, and policy experts dedicated to decarbonizing the energy sector through superhot rock energy. Our goal is to achieve demonstration and commercialization of superhot rock energy anywhere in the world, providing affordable access to the largest untapped energy source on the planet.

This factsheet is part of a CATF project mapping regions of the world where superhot rock energy has high potential. Learn more, and see all of our factsheets, at catf.us/shrmap/