Geophysical Research Abstracts
Vol. 15, EGU2013-5782-1, 2013
EGU General Assembly 2013

Three-dimensional numerical reservoir simulation of the EGS Demonstration Project at The Geysers geothermal field

Andrea Borgia (1), Jonny Rutqvist (1), Curt M. Oldenburg (1), Lawrence Hutchings (1), Julio Garcia (2), Mark Walters (2), Craig Hartline (2), Pierre Jeanne (1), Patrick Dobson (1), and Katie Boyle (1)

(1) Lawrence Berkeley National Laboratory, UCB, Berkeley CA, USA, (2) Calpine Corporation, Middletown CA, USA

The Enhanced Geothermal System (EGS) Demonstration Project, currently underway at the Northwest Geysers, California, aims to demonstrate the feasibility of stimulating a deep high-temperature reservoir (up to 400 °C) through water injection over a 2-year period. On October 6, 2011, injection of 25 l/s started from the Prati 32 well at a depth interval of 1850-2699 m below sea level. After a period of almost 2 months, the injection rate was raised to 63 l/s. The flow rate was then decreased to 44 l/s after an additional 3.5 months and maintained at 25 l/s up to August 20, 2012. Significant well-head pressure changes were recorded at Prati State 31 well, which is separated from Prati 32 by about 500 m at reservoir level. More subdued pressure increases occur at greater distances. The water injection caused induced seismicity in the reservoir in the vicinity of the well. Microseismic monitoring and interpretation shows that the cloud of seismic events is mainly located in the granitic intrusion below the injection zone, forming a cluster elongated SSE-NNW (azimuth 170°) that dips steeply to the west. In general, the magnitude of the events increases with depth and the hypocenter depth increases with time. This seismic cloud is hypothesized to correlate with enhanced permeability in the high-temperature reservoir and its variation with time.

Based on the existing borehole data, we use the GMS™ GUI to construct a realistic three-dimensional (3D) geologic model of the Northwest Geysers geothermal field. This model includes, from the top down, a low permeability graywacke layer that forms the caprock for the reservoir, an isothermal steam zone (known as the normal temperature reservoir) within metagraywacke, a hornfels zone (where the high-temperature reservoir is located), and a felsite layer that is assumed to extend downward to the magmatic heat source. We then map this model onto a rectangular grid for use with the TOUGH2 multiphase, multicomponent, non-isothermal porous media numerical flow simulator in order to model the evolution and injection-related operational dynamics of The Geysers geothermal field. At the bottom of the domain in the felsite, we impose a constant temperature, constant saturation, low-permeability boundary. Laterally we set no-flow boundaries (no mass or heat flow), while at the top we use a fully aqueous-phase-saturated constant atmospheric pressure boundary condition. We compute initial conditions for two different conceptual models. The first conceptual model has two phases (gas and aqueous) with decreasing proportions of gas from the steam zone downward; the second model has dry steam all the way from the steam zone to the bottom. The first may be more similar to a pre-exploitation condition, before production reduced pressure and dried out the system, while the second is calibrated to the pressure and temperature actually measured in the reservoir today. Our preliminary results are in reasonable agreement with the pressure monitoring at Prati State 31. These results will be used in hydrogeomechanical modeling to plan, design, and validate the effects of injection in the system.