Better data tools for a bigger geothermal future

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To fully realize the potential of harnessing energy from the heat within the earth will require a far more detailed understanding of what's going on down there than scientists currently have. And beyond naturally occurring geothermal systems, man-made ones that emulate them could, by some conservative estimates, produce a total of 100 gigawatts of cost-competitive electricity over the next 50 years. But to get there, energy providers will need sophisticated systems for gathering and analyzing data about the rock mechanics and hydrology at work.

UW-Madison geoscientists and engineers are working with industry partners and the U.S. Department of Energy to integrate several data-gathering approaches into a highly detailed monitoring system for geothermal wells. A team that includes Geological Engineering and Geoscience Professor Kurt Feigl and Geological Engineering Associate Professor Dante Fratta, Geoscience Assistant Professor Mike Cardiff, Geoscience Professor Cliff Thurber, and Geoscience Professor Herb Wang, has converged on Brady Hot Springs in Nevada with a combination of satellite imaging techniques and fiber-optic cable. The researchers have turned this relatively small geothermal field into a proving ground for a system that ideally can be scaled up in wider and deeper fields.

Feigl says the project is the first in North America to use fiber-optic cables to measure rock properties in a geothermal field, though it's common for energy companies to use the technology in oil exploration. "Locating oil underground is tough, but in geothermal wells, the challenge is finding hot water ," Feigl says.

What's changed over the past five or six years is that advances in fiber-optic cable now allow it to produce incredibly detailed seismic and temperature data. The cables produce new data about 500 times per second, yielding about a terabyte of data per day. "We have one channel every meter, whereas a typical seismic survey would have one channel every 30 or 40 meters," says Joe Greer, business development manager for Silixa, one of the industrial partners involved in the project.

The project's scope spans from fundamental geoscience to maximizing the production of electricity from geothermal wells. Feigl says there's still a great deal to be learned about fractures and deformation in rocks. This information will in turn help DOE and industry partners Silixa and Ormat Technologies follow the hot water through a complex underground landscape—and pursue the long-term goal of commercializing EGS more broadly.

The information will also help industry develop enhanced geothermal systems (EGS), man-made geothermal wells created by injecting additional fluid into naturally heated rock areas that are not already saturated with fluid. This process opens up existing fractures in the rock, allowing the water to circulate through the area and transport the geothermal heat so that it can be converted into electricity.

"We have a real opportunity to create better, more efficient reservoirs, and that could lead to the deployment of EGS on a broader scale," says Lauren Boyd, the EGS program manager for DOE. "We have to understand what our fracture network looks like before we try to create a reservoir."

Greer also points to the dynamic nature of EGS reservoirs and the need it creates for data-rich analysis. "There is one big advantage in fiber optics, and that is that if you want to go back and look at it again in a time-lapse survey, and re-image it and see what's changed, you can eliminate a lot of error," he says.

Boyd and her colleagues say that DOE chose to fund the project in part because of the UW-Madison team's unique combination of strengths in geoscience and data analysis.

"It was very clear that Kurt and his team have a really clear understanding of these challenges that we're facing, and it brings a creative approach to integrating technologies," Boyd says.

Provided by Medical College of Wisconsin

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