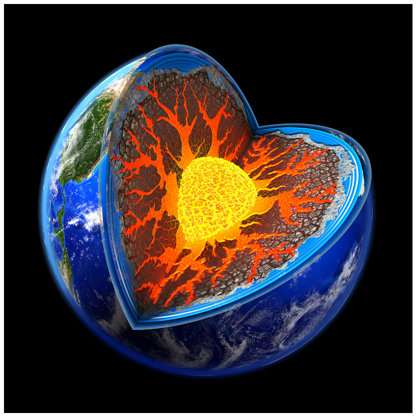
LSU CCT's researcher Blaise Bourdin collaborates with Chevron exploring harvesting heat from hot dry rocks beneath the Earth's surface



The modern world relies on a vast energy supply to fuel everything from transportation and communication, to security and health delivery systems. As traditional resources deplete, renewable sources become increasingly more important. One of them is geothermal, or the heat of the Earth's core.

Conventional geothermal energy is already widely used today. It relies on finding subterranean reservoirs of heated water where magma comes close to the surface. Enhanced geothermal systems, on the contrary, can harvest energy from hot dry rocks beneath the Earth's surface in artificially created reservoirs. The idea is to generate a network of cracks in the rocks, then inject cold water and let it circulate through the cracked formation. The resulting steam can then be used to produce electricity.

The lack of predictive understanding and numerical simulation of the techniques employed for creating these networks of fractures is what brought Blaise Bourdin, associate professor in the LSU Department of Mathematics and an adjunct faculty at the LSU Center for Computation & Technology (CCT), to this problem.

In 2008, Bourdin received a National Science Foundation grant, "Applications of Variational Fracture: Enhanced Geothermal Systems" for his research in fracture mechanics.

"Because I am a pragmatic mathematician, I would rather work on a problem that is mathematically challenging and elegant, but also has practical applications. That's what drove me to studying reservoir stimulation."

Bourdin's work is based on the Variational Approach to Fracture. Unlike classical approaches, this method makes no assumptions on where cracks grow and can easily handle interactions between multiple pre-existing and developing cracks.

"We do not need to worry about the direction of the fractures," Bourdin said. "We say, let's just study how they grow. We see that they can merge, split, and do whatever they want in any possible direction, and this is a strength of our approach," he added.

While working on the NSF proj ect, Bourdin met representatives of Chevron who offered to collaborate and extend the original scope of the project, issuing him a grant in 2010. Thus, the academic theoretical research supported by the NSF led to industrial collaboration.

Bourdin serves as the principal investigator (PI) of the project, while the co-PIs are Christopher White and Mayank Tyagi, both faculty in the LSU Department of Petroleum Engineering. Tyagi holds a joint appointment with CCT; White has an adjunct appointment with CCT.

Chevron is one of the world's leading producers of conventional geothermal energy today, and in addition to that, the company is assessing enhanced geothermal systems, studying how energy from hot dry rocks under the Earth's crust can be developed profitably.

"Although we all understand the importance of the fracturing predictability, because of its complex nature, a tractable computational approach is yet to be established in the energy industry," said Keita Yoshioka, numerical geomechanics consultant in Chevron's Houston, TX, office. "Bourdin's project is beginning to shed light in this area."

It turns out the way cracks for geothermal systems are generated is very similar to the way reservoir engineering in the petroleum industry is done, so this research can be applied when drilling for oil and gas.

"The methods Bourdin has developed can model emerging complexities caused by stress fields, fracture interactions, and temperature changes," White said. "This gives us a unique capability to help industry recover more oil and gas economically."

Chukwudi Chukwudozie, a third-year doctoral candidate in petroleum engineering at LSU, is also actively involved on the project. "The easy oils are long gone, so the industry explores and produces from challenging environments," Chukwudozie said. "Companies now need engineers with broad-based skill sets who are capable of interacting with scientists with various backgrounds, which is what I am doing on this project."

There are seven billion people on Earth who use energy each day. Meeting the growing energy demand in a safe and environmentally responsible manner is one of today's key challenges. Currently, numerous organizations within the academic, federal, and commercial sectors conduct research in the field of renewable energy.

"To me, this project is a perfect example of how the CCT enables the collaboration between researchers from multiple disciplines with common interest for computational science, which can lead to rapid technology transfer and industrial applications of theoretical academic research," Bourdin said.

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