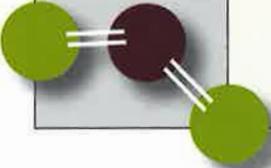


Richard Esposito, right, of Southern Company Services, goes over a chart by the Geological Survey of Alabama with (from left) graduate student Dino Theodorou and faculty members Gary Cheng and Peter Walsh. UAB researcher Alan Shih is also a team member on the project.



With concerns deepening over the nation's energy security, a U.S. Department of Energy project being led by UAB is attracting growing interest. The collaboration between the UAB School of Engineering, Southern Company, and Denbury Resources involves pumping carbon dioxide into wells to increase oil production.

The purpose of this project is to evaluate the capacity of the Citronelle Oil Field in Mobile County—the largest and oldest oil field in the state—for storage of CO₂,” explains UAB mechanical engineering research professor Peter Walsh, Ph.D. “Southern Company is interested in evaluating its options for carbon dioxide sequestration, with a view toward permanent storage of CO₂ produced during combustion of coal and natural gas in its power plants, to help offset the accumulation of CO₂ in the atmosphere.”

Additionally, Walsh says that the Citronelle Oil Field is nearing the end of the secondary stage of oil recovery, in which water is used to drive oil through the underground rock formation to the wells where it is extracted. “Replacing the water with carbon dioxide will enhance oil-recovery technique,” Walsh explains. “When CO₂ comes into contact with crude oil, it swells the oil, helping to drive it from the formation, and if the pressure is sufficiently high, the oil and CO₂ dissolve in each other, forming a single fluid having a lower vis-

cosity than the oil by itself. The lower-viscosity fluid migrates more rapidly through the formation to the wells, enhancing oil recovery and its rate of production.”

According to Southern Company geologist Richard Esposito, the project presents the opportunity to work in a geology-related field that is in its early phases of research and development. “The injection of CO₂ into geological formations for enhanced oil recovery has been done since the mid-1970s,” he says, “but the storage of carbon dioxide in geologic

formations for environmental purposes is a relatively new science. It is possible this sequestration may play an important role in the future storage of CO₂. Also, the enhanced recovery can help relieve our dependency on foreign oil and maintain local jobs as well as provide tax revenue to the state. Many mature oil fields would otherwise be considered uneconomical and would close down."

Esposito points out that the economic returns in the Citronelle Oil Field alone could potentially recover up to 36 million barrels of oil at a market value of approximately \$2 billion. Even at current oil prices, the economic viability of the Citronelle Oil Field without CO₂-enhanced oil recovery is likely less than 10 years since current production is less than 59,000 barrels per month.

Another aspect that Walsh says makes the technology even more attractive is the possibility of using the oil reservoir, after production using CO₂ is complete, as a site for permanent storage of carbon dioxide created during the manufacture of cement or during combustion of fossil fuels. In this scenario, the porous rock where the oil was originally located would be filled with CO₂ back to the pressure that existed when oil was discovered. Storing CO₂ rather than releasing it into the air would reduce the rate at which carbon dioxide is accumulating in the atmosphere as the result of both natural and industrial processes. "Though it has not been proven that the observed warming of the planet is caused by the increase in atmospheric CO₂ concentration, this should not be interpreted, in my opinion, as an excuse for lack of action," Walsh says. "It is never good policy to allow the waste products of our activities to accumulate. We shouldn't have waited for fish to disappear to begin regulating the release of sewage and industrial waste to our rivers."

Esposito adds, "The debate on the causes and potential effects of global warming are very controversial. Regardless of what you believe, advanced technologies should be developed

and proven in case they are needed in the future. Geologic carbon sequestration looks to be a promising science—one of a suite of options to accomplish the sequestration of greenhouse gases. This will generate information that will help transition this technology from pilot-scale to full-scale commercialization, if needed."

"What makes the application of CO₂-enhanced oil recovery in the Citronelle Oil Field challenging is the complex structure of the oil-bearing rock formation," Walsh adds. "It is a different type of rock, and has a much more complicated spatial distribution, than in the West Texas and Eastern New Mexico oil fields where the CO₂-enhanced oil recovery technology has been most successful."

Team members, including Jack Pashin, director of the energy investigations program at the Geological Survey of Alabama, and engineers, geologists, and field personnel from Denbury Resources (the Dallas-based owner and operator of the Citronelle field) will analyze the formation with a view to maximizing oil production, as well as for permanent geologic storage of CO₂. They will collaborate with Peter Clark and Eric Carlson, experienced petroleum engineers from the University of Alabama; Shen-en Chen, a specialist in seismic measurements for analysis of underground formations from the University of North Carolina at Charlotte; and UAB faculty members Gary Cheng, Ph.D., and Alan Shih, Ph.D., and graduate students Dino Theodorou and Kshitij Neroorkar, who will perform mathematical calculations of oil, water, and CO₂ flows in the formation.

The team hopes to start injection operations in the final quarter of 2007 or early 2008. Overall, the biggest challenge of the highly technical, \$6-million project will be coordinating the research efforts. "All this has to be interfaced with Denbury Resources, which owns and operates the oil field," Esposito explains. "We are breaking new ground."

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