BELOW THE SURFACE

BY BOB SKIPPER

DR. NICHOLAS CRAWFORD, A WESTERN PROFESSOR OF GEOGRAPHY AND GEOLOGY AND THE DIRECTOR OF WKU'S CENTER FOR CAVE AND KARST STUDIES, HAS BEEN USING MICROGRAVITY SINCE 1985 TO GET AN IDEA OF WHAT LIES UNDERGROUND IN WARREN COUNTY'S EXTENSIVE KARST REGION.

One of his assistants, Leigh Ann Croft, a research hydrologist, has been taking microgravity readings on Dishman Lane in Bowling Green, Kentucky, where a large section of new road collapsed. These readings give her and her fellow researchers an indication of the extent of the collapse, and of whether or not a larger collapse could be expected.

Dishman Lane, Dr. Crawford said, crossed a room in State Trooper Cave where part of the roof had already collapsed. Storm water runoff likely caused the rock to shift, and that portion of the road collapsed. As a public service, Dr. Crawford and the center's staff used microgravity and electrical resistivity to map the area around the collapse. "We feel confident that the collapse is not going to extend further," he said.

This is the kind of applied research in which Dr. Crawford and the Center are engaged. "We work on real-world problems. We work out in the field," he said.

Dr. Crawford first began using microgravity when the EPA came to Bowling Green to investigate fumes rising from the ground.

"We had toxic vapors rising out of the caves under the city and getting into homes, businesses and two elementary schools," he said. "We started looking for a geophysical technique that would allow us to find the caves under Bowling Green."

A fellow researcher recommended microgravity and, using the EPA's Superfund, they rented a LaCost and Romberg Microgravity Meter—only 50 to 60 machines were available in the world at that time. Microgravity readings would indicate the voids and a drilling rig would drill into them.


PHOTO BY SHERYL HAGAN-BOOTH

Leigh Ann Croft, a research hydrologist, takes microgravity readings using a LaCost and Romberg Microgravity Meter.

"We went down the streets of Bowling Green using microgravity and we were able to pick up caves," Dr. Crawford said. On two occasions they drilled 30-inch holes and sent cavers into the system. "We mapped about a mile and a half of Robinson Cave using that technique."

Dr. Crawford began refining his technique, combining microgravity with other detection methods such as electrical resistivity, which involves injecting an electric current into the ground and measuring the resistivity. Soils transmit a current easily whereas air, found in a cave or other void, is highly resistive.

The techniques have been in demand. Dr. Crawford and others from the Center have used them to investigate a sinkhole collapse under Interstate 65 near Elizabethtown and under a NASA building at Red Stone Arsenal in Huntsville, Alabama; to locate a monitoring well near a factory in Frankfort; to locate 20,000 gallons of gasoline that had spilled into the karst aquifer in Albany, Georgia; and to investigate the sinking of a town in Alabama.

They also mapped several miles of the caves under Bowling Green, Dr. Crawford said. And, the Center has used the techniques to investigate numerous sinkhole collapses, particularly ones that have occurred under buildings and highways.

Their technique caught the attention of NASA and the Federal Emergency Management Administration. After the terrorist attacks on the World Trade Centers on September 11, 2001, Dr. Crawford was contacted by NASA and FEMA about using microgravity to locate pockets in the rubble.

"They wanted us to try to use it at that location to see if there was any chance of us picking up any void spaces where people might still be trapped," he said. "For approximately a month, my suitcase was packed and my car was loaded up with the instruments and we were ready to take off to go up there to do what we could."

However, the call didn't come. The problem was that the terrain was rugged with steel jutting up 300 feet and a huge hole in the middle.

"The New York Fire Department was in charge of the site and they didn't want to stop their frantic efforts to dig it out and find people physically for us to try some experimental technique that may or may not work," he said. "They were actually going to have to put me in a bucket with the machine and lower it with a crane place by place because there was no way to go across."

Those difficulties led to another idea.

"We have been thinking a lot about this, that maybe we could use our technique of microgravity and electrical resistivity to find voids after earthquake disasters, looking for people trapped in collapsed buildings," Dr. Crawford said, adding he also submitted a proposal to Ft. Knox to develop military applications to find bunkers, tunnels and caves.

"The military has a need for being able to see what's underground. But one problem we have with the microgravity machine is that it's pretty slow and you have to physically be able to move across the landscape."

Dr. Crawford has received a large grant through the Innovative Commercialization Program of the Kentucky Science and Technology Corporation to develop a robotic system for measuring microgravity. The possibilities could include suspending the machine on a steel cable over a collapsed building and using a laser to measure the depth of the ground surface, or using a remote-controlled car.

"We're looking at inventing a robotic system for taking these readings where we could actually take them behind enemy lines and areas that are too rugged to take the readings using some other technique," he said.

In the meantime, students working for the Center are gaining experience while helping solve real problems. One such student, Jeremy Richardson, is completing his master's thesis using the techniques to investigate a flood-prone parking lot on the WKU campus.

"He's trying to map the Lost River Cave and look for a location to drill a storm water drainage well," Dr. Crawford said. "He is also designing a filtration and wetland treatment system for the first flush of storm water runoff, so we don't just dump it into the cave, but try to do something about the water quality as well." That first flush, he said, contains most of the pollutants such as motor oil and gasoline, he said.

That same technique may be used as U.S. 31W is widened to four lanes through Bowling Green, Dr. Crawford said.

Dr. Crawford would like to see this technique used to find potential problems before roads and other projects are built. He has proposed using microgravity and electrical resistivity measurements on the site of the proposed Kentucky Trimodal Transpark near Oakland before the runway is built.