What lies BELOW

This composite photograph/sketch illustrates use of the seismic gun as the acoustic source to image the buried dinosaur skeleton, Seismosaurus, sketched below in the rigor mortis posture it assumed shortly after death.

BY CHIP MINTY

From archeologists to treasure hunters to the military, they all want geophysicist Alan Witten's help in seeing beneath the earth's surface.

Alan Witten's job as a geophysicist at the University of Oklahoma is not particularly dangerous. Only when he mixes his vocation with his avocation does his life get adventurous.

For instance, there is really nothing risky about using his expertise to explore an Anasazi cliff dwelling near the Arizona border. The danger comes when it is time to climb down, clinging to holes chiseled into the rock by Indians more than 700 years ago.

Mainstream geophysicists use their technology to search the earth's depths for oil and groundwater, or they comb the various plates and fault lines for signs of trouble. But Witten's curiosity does not run so deep. He is not interested in oil, and he is not concerned with earthquakes or volcanoes.

The Frank A. and Henrietta Schultz Chair in OU's School of Geology and Geophysics has dedicated himself to the art of

Tulsa sophomore Racheal Okotie, left, and Professor Alan Witten prepare to demonstrate to the "Adventures in Geophysics" class the principles of electromagnetic induction by using Okotie as a human radio antenna.

seeing into the ground, and he uses what he calls high-visibility geophysics to do it. He is a world-class researcher whose work focuses on ways of using geophysical principles to produce high-resolution, three-dimensional images.

He is also a rare breed of geophysicist who travels the world volunteering time and expertise to history hunters. He has charted the cramped tunnels and tiny underground rooms of a subterranean civilization that existed 6,500 years ago in what is now Israel. He has used his techniques to help archeologists excavate an ancient copper mining village in Jordan, a possible mass grave from the Tulsa race riot and dinosaur fossils in New Mexico and Oklahoma.

Witten is working to develop technology that would help the military and humanitarian agencies locate millions of land mines scattered across as many as 60 nations around the world. Constructed almost entirely of plastic, the mines kill or maim an estimated 10,000 people a year and are almost impossible to find with metal detectors. Witten and colleagues from three other universities are developing a detection system using electromagnetic induction, which can produce images of an object by using radio waves.

But, electromagnetic induction is just one of the techniques in Witten's geophysical toolbox. He uses other methods, such as diffraction tomography, vertical seismic profiling and ground-penetrating radar to sniff out targets. Point him in a general direction, and Witten can produce underground images of pirate tunnels, ancient rock walls, dinosaur fossils or anything else hidden by time and sedimentation.

His ability to see what is beneath the ground's surface has won him a reputation among archeologists, anthropologists and paleontologists. The phone rings often in his office on the ninth floor of OU's Sarkeys Energy Center with requests for his services, but he is selective about the projects he agrees to join. First, he has to know something about the site, and the property owners have to be credible. Second, there has to be something in it for him, and what he is looking for, money cannot buy.

While archeologists use Witten to find artifacts, Witten uses archeology to produce the adventure stories he needs to make geophysics come alive in his classroom. Research may be Witten's passion, but his heart is with his students.

Walking into a classroom and lecturing from a text is not the 52-year-old professor's style. Dressed in a T-shirt, baggy pants and sneakers, Witten engages students with his eyes and challenges them with his questions. He backs up his lectures with hands-on demonstrations, photographs and accounts of his research trips that make his classes a destination point, even for students who do not like science.

In Witten's class, anyone who understands how a metal ball bumps to the bottom of a pinball machine can understand why the sky is blue. When he is through lecturing on energy waves, his students know why a tidal wave would be hardly noticeable aboard a boat in the middle of the ocean but deadly to people standing on shore.

And every week or so, students find themselves in the center of Witten's demonstrations. Tulsa sophomore Racheal Okotie served as a human radio antenna while Witten explained the principles of electromagnetic induction. Witten used Okotie's body to illustrate how people constantly receive and transmit radio signals without even realizing what is happening.

Okotie, a management information systems major, was one of more than 100 students in Witten's "Adventures in Geophysics" class in spring 2002. She enrolled in the course after hearing several of her friends recommend it as a good way to meet her science requirement.

"Science is not one of my best subjects," she says, "but taking this class makes science fun. I'm a visual learner. I like to see."

Samantha Zeuch, a sophomore from Edmond, says Witten's lectures are easy to understand. "What I really like is he gets into it, and he likes to give examples. He takes an abstract idea and makes it into something you can see, touch and feel."

Cynthia Kaye, also an Edmond sophomore, does not even mind the pop quizzes. Witten tells his students they are free to use their notebooks, consult with classmates or any other resource available in the class. His only rule is they cannot ask him for the answers. *continued*

Initially, Witten hoped the quizzes would encourage class attendance, but he has found that they do much more. The quizzes help students review and reinforce what they have learned, and the collaboration brings the students closer together as a class.

The pop quizzes are an example of Witten's trial-and-error approach to teaching. "I try things that I think will work, and if they don't, I refine them. If you get a lot of blank stares, you know you're doing something wrong."

Whatever Witten's methods are, they work, says Roger Slatt, director of the School of Geology and Geophysics. "The students really get turned on with what he tells them. He has a reputation on campus for inspiring students and involving them in what he does. He's creative and goes the extra mile. He's not the only one in the department who does that, but there aren't many who do it the way he does."

Witten's unique teaching style feeds off of what Witten does outside the classroom, in research and fieldwork and even benefits from his work on a new textbook, *Geophysics in Archeology*.

The extra stipend he receives as holder

"If you get a lot of blank stares, you know you're doing something wrong."

of one of OU's endowed chairs allows him to volunteer his time to low-budget projects that could not afford to pay him otherwise. "Most people don't have the luxury of doing it the way I can do it," Witten says of his opportunities to join exotic adventures that allow him to grow as a scholar and gather experiences that make him a better teacher.

He considers the type of fieldwork he does so enriching that he takes his students on excursions of their own each semester. The destination is always the same. Each fall and spring, he and his students go to an area near Atoka in southeastern Oklahoma where Jesse James and his gang hid from the law in the 1880s.

The students use what they have learned to probe for caves and cavities in the ground. "The students get excited about the possibility of finding treasure," Witten says. "There are acres and acres and acres. (James) could have hidden anything there."

Though Witten and his students have been returning to the site for several years, they actually never have found treasure. However, they always managed to find unknown cavities or something else that is interesting. "It's just a good place to apply geophysics," the professor insists.

Searching for hidden caves, tunnels and old, abandoned hideouts is nothing unusual for Witten. He has worked with an archeological team funded by the Discovery Channel to investigate sunken ships at Ile Ste. Marie, a former pirate haven near the coast of Madagascar.

The small island served as a refuge for Captain Kidd and other pirates such as Billy One-Hand, whose Fiery Dragon is among the richest pirate ships ever discovered and excavated. Witten says the Fiery Dragon's crew scuttled her in the early 1700s, divided half a billion dollars in captured treasure and retired to France.

Witten was based on the island for two weeks, spending most of his time on nearby Pirate Island surveying a network of underground rooms and tunnels. Although it was only a short row away, getting to Pirate Island was not easy.

A local official who served as the area's chief of police informed Witten that there were still evil pirate spirits on the island, and he would have to make an offering to ensure his safety while working there. In Witten's case, the appropriate offering was a $200 camera he carried with him on the trip.

But that was only the beginning of his trouble. The wooden boat officials provided leaked, forcing Witten and the crew to bail while they rowed to keep them-

An offering to appease the ghosts of nearby Pirate Island—a $200 camera presented to the police chief of Ile Ste. Marie—was required of Alan Witten, second from left, before his party could obtain safe passage to survey the underground tunnels.

selves and thousands of dollars worth of instrumentation from sinking into the lagoon.

Witten's adventures in geophysics began in 1987 while working as a researcher at Oak Ridge National Laboratory in Tennessee. A colleague at the Los Alamos National Laboratory in New Mexico put him in touch with David Gillette, then curator of paleontology at the New Mexico Museum of Natural History, who was researching a partial set of eight fossilized bones discovered by hikers in northern New Mexico.

Gillette had concluded the bones originated from a new species of dinosaur and was working to recover more of the skeleton. But while the eight original fossils were partially exposed by erosion, Gillette would have to dig through at least three meters of hard sandstone to reach the remaining bones. The prospect was financially impractical without information that could help excavators target their search.

OU's Alan Witten has a toolbox full of geophysical techniques to produce images of objects buried beneath the earth's surface. Students in the photo above are deploying acoustic instruments that can chart the underground tunnels and rooms of a subterranean village that existed 6,500 years ago near what is now Shiqmim, Israel.

Witten saw the problem as an opportunity to use a new technique he was developing at Oak Ridge called geophysical diffraction tomography. He used the process to construct two-dimensional images of the encased fossils. He then used his images to mark several fossil locations with small flags. He also provided enough information about the size, shape and density of the fossils for Gillette to identify each bone and its orientation before he started digging.

Witten's technology allowed Gillette and his team to recover the dinosaur's trunk and a portion of its neck. The huge plant eater, estimated to have been as long as 61 meters, is believed to be the longest dinosaur ever found. Because of its great weight—an estimated 80 to 100 tons—Gillette named the new species of sauropod Seismosaurus, or Earth Shaker. The name is appropriate, Witten says, because Seismosaurus is an explicit reference to the seismic profiling measurement techniques used to locate many of the fossils.

Work on the Seismosaurus project helped establish Witten's reputation. Soon after the dinosaur project, Witten began helping the U.S. Army analyze tunnels constructed by enemy soldiers during the Korean War. Now, at least once a year, Witten travels to assist in projects ranging from archeological excavations to buried nuclear waste surveys.

While most calls come from across the country or other parts of the world, one of Witten's most recent projects originated at OU. Farland Stanley Jr., the Sandra and Brian O'Brien Presidential Professor of Classics, enlisted Witten to help him and his students excavate part of an ancient Roman city.

They traveled to Italy in the summer of 2000 to spend a month excavating sites in the former city of Cassinum. Located 80 miles south of Rome, the city was destroyed in the fifth century by Goths. Its broken remains are buried near the Abbey of Monte Cassino, famous in its own right as a World War II battleground.

Witten says the potential excavation site sprawled across as many as 20 acres, but the project was mired in adversity. Rain, government restrictions on where they could dig and an unexploded artillery round limited their progress.

It was disappointing, Witten says. "We expected to have a huge area to work, and it was sort of my ambition to map out an entire Roman City. But it really didn't quite work out that way."

But Stanley, trained in ancient history as well as archeology, says Witten's use of ground-penetrating radar allowed him and his students to make the most of their time. Stanley contends that they could have invested years digging trial trenches instead of using geophysics to get the job done in a matter of days.

Witten was able to locate the places that had the most potential for revealing buried structures. Using his images, the students saw immediate success and had a wonderful sense of gratification.

Stanley, who uses excavations to deepen his students' connection with antiquity, says, "There's a lot of romance in archeology. One of the original meanings of romance is adventure, and in archeology, there's adventure." He insists that geophysics has a place in archeology, but geophysicists like Witten are rare.

"Alan has a wonderful sense of adventure," Stanley says, "and that's important."

Scientists around the world and students in Witten's OU classrooms surely would agree.