BY C. JASON SMITH, PhD

Off the Map in Egypt

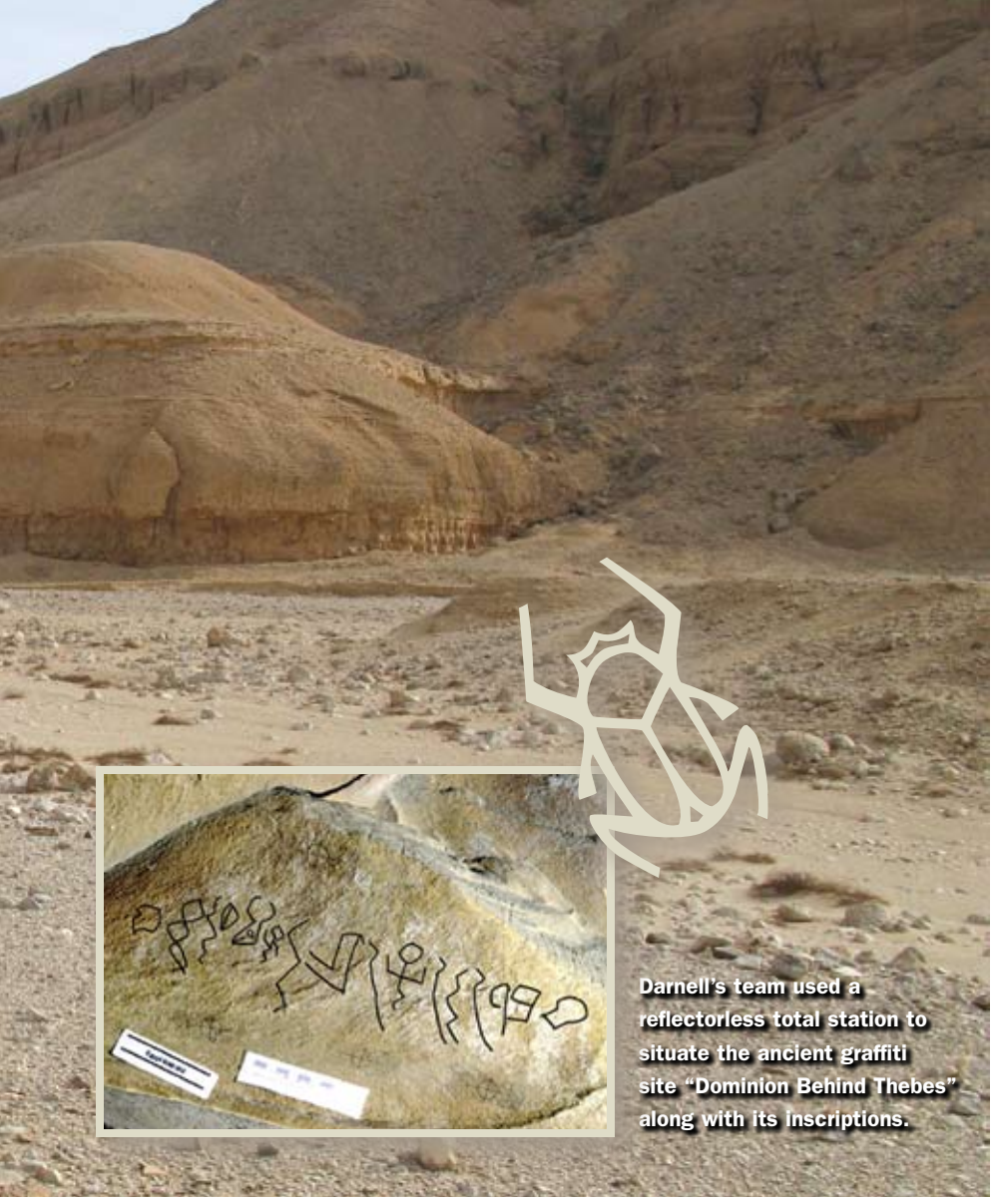
A premier team of Yale Egyptologists uses advanced total station technology to uncover ancient history in the Western Desert.

Several viper trails marked the sand before them. As the Egyptologists made their way off the ancient desert road toward the limestone cliffs, they hoped the serpents themselves were long gone. The first person to the wall, Dr. John Coleman Darnell of the Department of Near Eastern Languages & Civilizations at Yale University and director of the Yale Egyptological Institute in Egypt, was surprised to find the surface covered with rough hieroglyphic inscriptions in seemingly random patterns. Based on his past experience in the field, Darnell thought he knew what the markings were–graffiti. The wall was a common stopping place for the caravan drivers, merchants and guards who traveled along the road between Thebaïd and Kharga Oasis 5,000 years ago, and the inscriptions–more than 500 of them counted so far–held small messages for future travelers.

Using standard archaeological methods, the measuring, recording and interpreting of inscriptions on this wall alone could take several months to complete. But Darnell, who likes to wear the traditional pith helmet of the explorer, was not using traditional methods for this survey. His team was packing a surveying total station with advanced measurement capabilities–a technological edge that would make quick work of this fascinating new find.

The Western Desert

In the popular imagination, thanks to famous explorers like John Carter and classic films such as "The Ten Commandments" and "Cleopatra," Egypt is generally understood to be an ancient land of mystery whose roots run back to the keystones of human civilization. It is the Egyptologists who dedicate themselves to uncovering the hidden past of this magnificent yet hard land.



Darnell's team used a reflectorless total station to situate the ancient graffiti site "Dominion Behind Thebes" along with its inscriptions.

Photos courtesy of professor John Coleman Darnell.

Darnell's team is working in the Western Desert, which is in the northeastern region of the Sahara. About the size of the state of Texas (approximately 270,000 square miles or 700,000 square kilometers), the Western Desert is a harsh environment of extremes that lies to the west of the Nile in Egypt, Libya and northwestern Sudan. Depending on the time of year and the location, the temperature can rise to more than 115 F in the midday heat and drop to the low 40s at night. The varied terrain includes the shifting sand dunes of the Great Sand Sea, which can reach thousands of feet high, vast featureless plains of rock, and stony plateaus, the tallest of which approaches 6,500 feet (about 2,000 meters). Occasionally, a geographic depression serves as an oasis where small populations of hearty individuals have been eking out a living for thousands of years. But for the most part, the Western Desert, declared a "frontier area" by the government, is desolate.

This desert could be considered frontier territory for archaeologists, too. "The archaeological map for the region is still quite bare due to the density of visible remains in the Nile Valley and the logistical difficulties of working in many portions of the Western Desert," Darnell says. Yet, numerous treasures await the Egyptologists who are willing to venture off the beaten path.

Simplified Surveying

One of the most tedious jobs for the Egyptologists on the ground, as for any archaeologist, is measuring and recording sites. Intensive surveys, for example, have traditionally involved teams of archaeologists walking slowly side by side across a site marking every possible find with a small flag. These artifacts are individually recorded and described in detail, and the records are then packed off for later review and interpretation.

The onsite work is just part of the vast record-keeping machine that records, analyzes and archives thousands of observations, measurements and locations–a massive web of work that surrounds each field expedition and binds them all together with the larger archaeological record. But without this painstakingly detailed effort, pieces of the puzzle could be misplaced or misinterpreted or whole sites could be lost in the vastness of the desert. Making the task even more complex is that archaeologists need to think in three dimensions. Generally, the farther down into the ground they go, the further back in the historical record they travel.

For centuries, this work has been accomplished with the same basic technologies–rulers, plumb bobs, photographs and maps–using methods that take a substantial amount of time and require meticulous record keeping both onsite and back at the universities, institutes and museums. In 2003, after years of using these traditional methods, Darnell wondered if total station technology could help speed up the process and the accuracy of their work.

The Western Desert of Egypt holds treasures such as the Ghueita Temple, a sandstone structure that dates back to the reigns of Darius I and Ptolemy III.

Digital Imaging and the Professional Surveyor

The technologies used by professor John Coleman Darnell and his team in the remote Western Desert have numerous practical applications for professional surveyors seeking to expand their capabilities. A *POB* Product Profile written by Joseph V.R. Paiva, PhD, PE, PS, when the GPT-7000i series was first introduced in 2005 summarized the benefits of the digital imaging total station technology:

> Being able to visualize the work being done has always been one of the surveyor's significant challenges. Being able to move quickly and accurately depends greatly on an individual's ability to judge whether the points being mapped or laid out are properly spatially related. With the GPT-7000i, each measurement taken is represented on the screen image. Even if the instrument is rotated away from the point, so that a different part of the horizon is on the screen, the surveyor only needs to rotate the instrument back to see the point again in proper context. This review of the work can also be done in image viewing mode; the surveyor can see all images and registered observations, regardless of where the camera is pointing—it doesn't even have to be set up at the station from which the images were taken. Whether they are mapping or setting out, users can apply functions to represent points with different symbols or to connect them with lines to develop a more visually sensible overview of the work. When the work to be done is stakeout, the points to be staked can be visualized on the screen too, after the instrument and the image have been properly oriented and coordinated.

For the complete article, go to www.pobonline.com.

The Egyptologists use a digital imaging total station and advanced software to generate a virtual 3D model of the Ghueita Temple.

After identifying several local equipment distributors, Darnell got in touch with Robert Orris of Superior Instrument in Milldale, Conn., who assessed the needs of the group. While the professors and their graduate students had a specialized understanding of surveying techniques appropriate for their work, they were not professional engineers or surveyors. They needed to be able to use the equipment with limited support in the field.

Orris recommended the Topcon GPT-2005 reflectorless total station, which would allow the team to obtain prismless measurements at distances of about 500 feet (150 meters) even at difficult-to-access sites. Orris then provided training sessions with the professors and various students, both in a classroom setting and in the field, to prepare the group for their upcoming expedition in the Western Desert.

Once on location, the team used the survey equipment to map the ancient desert caravan roads that run from Thebaïd to Kharga Oasis. But surveying the road involved much more than just drawing lines on the map. Along the way, they also identified ancient campsites and military outposts, some dating back 5,000 years. That meant finding buildings and, of course, potsherds–a lot of potsherds. "Broken pots were seldom recovered [by their original owners] as the shards could not be reused," Darnell explains. "They often were left where they fell."

With the total station, Darnell's team was able to record the 3D location of each potsherd or artifact. Gone was the time-consuming onsite record keeping that would have to be interpreted months—or even years—later, often by a completely different team. With the total station technology and related software, a simple point-and-shoot process allowed the Egyptologists to see almost instantaneous results in the form of 3D maps, location charts and 3D building plans.

They also used the total station to situate the ancient graffiti site–which they named "Was ha Waset" meaning "Dominion Behind Thebes"–and its specific inscriptions. More than 500 inscriptions have been documented so far. The ability to produce a 3D record with a point-and-shoot technique saved countless hours of measuring, locating and recording the inscriptions. "The total station transformed the archaeologist's efforts from laborious manual measurements with tape and plumb bob," Orris says. "This allowed for precise measurements in a fraction of the time."

Additionally, instead of plotting out a grid pattern of the site on paper, the archaeologists were able to lay out their grid using the total station, which made processing all of the information within the grids and creating detailed plans much easier. And, of course, the team members could easily find their way back to an exact inscription for further work. "We all used the equipment," Darnell says. "The graduate students picked up the techniques very quickly."

Dr. John Coleman Darnell (center) and his team of Egyptologists are uncovering the ancient past in the Western Desert.

Looking to the Future

In 2005, Orris called Darnell with news about a new total station—the GPT-7000i series. "This upgrade of the total station provided a digital image to correspond with points shot on the ground or a vertical surface, such as a building," Orris explains. According to Orris, this technological advance allowed digital imagery and measurements to be combined for the first time. Darnell's team was working on a number of different projects and didn't really get the chance to evaluate the new technology until two years later. However, as soon as Darnell saw the capabilities of the new instrument, he decided to make the switch.

Using the GPT-7005i (the 5-second instrument), Darnell and his team documented the Ghueita Temple, a sandstone structure that dates back to the reigns of Darius I and Ptolemy III. After assembling their data with Rhino CAD software, they were able to generate a 3D model of the temple that could be examined from any angle–all while sitting in a hotel room in Cairo. "We were really surprised," Darnell says. "We knew it was possible to use the software that way but really never imagined it would be so easy." In the models themselves, you can "walk" right through the building and see the placements of all the major architectural elements. "It was really impressive," Darnell says.

The team also plans to implement the Topcon ImageMaster software in the near future, which will allow the Egyptologists to use digital photos with their point-captures to produce fully detailed 3D replicas of their sites. "That's another huge leap forward for them," Orris says.

With the 3D images, combined with advanced software, archaeologists from around the world will soon be able to work simultaneously "onsite" from any Internet connection. And this is only the beginning. Darnell's team has high hopes that the future of digital imaging total station technology will continue to help the Egyptologists uncover the ancient past.

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