CALTRANS' FUTURE: LIDAR, THREE-DIMENSIONAL MAPPING

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In a span of 30 years, Caltrans has utilized the Department's survey instruments for cultural resource mapping. In 1979, the Brunton compass was the instrument of choice. Gradually, cast-off equipment such as alidades, plane tables, and transits were acquired. By the mid 1980s, the Division of Surveys was enlisted to complete detail mapping on integrated aerial imagery. Laser transits, GPS, and GIS came next. Remote sensing was also incorporated. Now a new tool is available, LiDAR three-dimensional mapping. Sending out light waves, like RADAR sends out sound waves, objects can be mapped and integrated in other 3-D design software.

The California Department of Transportation (Caltrans) has exemplary professional archaeologists, and over the course of 30 years, the department has published professional research and has led the nation in innovative studies. Along separate lines, District 11 Surveys Division in San Diego has led the state with keeping professionals employed, utilizing outreach to bring in new young graduates into the fold, and resisting the trend to out-source surveying jobs. These professionals have always assisted the cultural resource staff in mapping and have trained others in new software mapping applications. With state-of-the-art precision instruments and a professional customer service orientation, District 11 Surveys Division has maintained Caltrans field crews and has been successful gaining not only District support but accolades from the entire state of California.

In the Spring of 2008, the Cultural Resource Branch in District 11 was introduced to LiDAR mapping by Karen Koklich, PLS, GISP. The archaeologists have relied on this dedicated and knowledgeable lady to keep up-to-date with new GIS software. When presented with this new LiDAR technology, an immediate applied use came to mind. The technology could be employed at a site that has a large number petroglyphs and was deteriorating at a very rapid rate. This site is partially within the State's easement right-of-way area in District 11. The ownership of the 20-acre site is split between the Department of the Interior's Bureau of Land Management (BLM) and Bureau of Reclamation (BOR). The site recordation form for this southern Californian desert petroglyph site is 474 pages in length and documents 12 rock art loci, containing 229 prehistoric and historic panels (Cleland and McCorkle 2003). A National Register Nomination Form, 88 pages in total, was prepared in September of 2003 (Cleland and McCorkle 2003). The site was avoided by a Caltrans project and was also adjacent to large pipeline project which also needed encroachment permits from Caltrans to proceed. Mitigation for that pipeline project included the completion of the National Register Nomination Form. The desire to get more hands-on use of the equipment, the ability to show the broad applications of what can be done with 3-D mapping, and the rapid deterioration of the petroglyph site setting motivated Caltrans to undertake this preservation project.

The LiDAR technology would record incised or pecked elements of each panel by recording individual points along the features and producing imagery more precise than photography or drawings. These data collected by the Leica ScanStation 2 (see Figure 1) can be incorporated in software that uses 3-D technology. The DTM file is a topographic scan which in turn can be incorporated into a Goggle Earth fly-over movie viewed through Quicktime. The larger DTM can be made in an AVI movie clip.

The equipment, staff (special thanks to Dave Olander, Jason Webb, and Chelsie Hopkins), and some funding were available from Caltrans District 11 Surveys Division to map/photograph this significant site for permanent curation and preservation at the National Archives with the National Register Nomination Form. Also thanks are due to the BOR, especially archaeologist Patricia Hicks, and

Figure 1. Leica ScanStation 2.

the BLM, both the El Centro Office where Carrie Simmons steered Caltrans' consultation efforts in the direction of the Native Americans involved in the pipeline project and the Yuma Office where Sandra Arnold obtain overnight permission for Caltrans to undertake this mapping project.

Native Americans groups were consulted, and permission was obtained to present this paper. Dissemination of the final product of the LiDAR project will be determine by the Fort Mojave, Quechan, Cocopah, Chemehuevi, and Colorado River Tribes. Linda Otero of the Fort Mojave Tribe and the Aha Macav Cultural Society spoke with me concerning the spiritual nature of this site and had reservations about the final product. The very reason why it is thought that the LiDAR techniques would be most appropriate to capture the site's setting and context, Ms. Otero felt may be negatively impacting the spiritual values of the site. Natural processes of deterioration may be a part of the scheme of the creators, and to infringe on these processes may upset the spiritual balance of the place.

Although BLM has placed signs (see Figure 2) and has cut off vehicle access with post and cables, graffiti and removal of panels have occurred. Vandalism has impacted the site since the stagecoaches first visited. Additionally, early in the morning (2:45 a.m.) on October 16, 1999, a magnitude 7.0 (Mw) earthquake occurred in the Mojave Desert, 32 mi. north of Joshua Tree, California. The earthquake was detected by all of the stations operated by the Nevada Seismological Laboratory. The Caltech web site names the earthquake the Hector Mine earthquake, and it surely impacted the fragile limestone panels underlain by friable sediments (see Figure 3). Heavy equipment used at a quarry north of the site may have also contributed to the deterioration of the site.

The initial documentation of the site began with notes, photos, and sketches completed in the 1930s by Malcolm Rogers and that are still housed at the Museum of Man in San Diego. Subsequently, numerous papers have been completed that discuss particular aspects of certain panels (Hedges 1973; Hedges and Hamann 1987:9-16; White 1993, 1994). From the original 1975 site record filed by BLM, the site documentation now includes a 474-page site form, an 88-page National Register Nomination Form, and numerous artist renderings with associated photographs of the panels contained in a chapters in *A View across the Landscape of the Lower Colorado Desert*: *Cultural Resource Investigations for the North Baja Pipeline Project* (Cleland and Apple 2003). Although the documentation is extensive, none of it can really give an impression of the impact of the sense of space and feeling of this extraordinary resource. The LiDAR 3-D mapping and Goggle Earth SketchUp were thought to be tools that could best capture these attributes.

A work plan was developed with the premise that for every day in the field, three days would be needed to accomplish the post-processing. Each control station was mapped using GPS Pathfiner Pro Network, and then the scanner was stationed. A fish-eye camera was mounted on the same station, and 360-degree photos were taken after the scans were completed. The scanner also has an internal 360-degree camera so an image can be taken and used while scanning.

The data that can be collected from the LiDAR Scan projects include "point clouds," which are

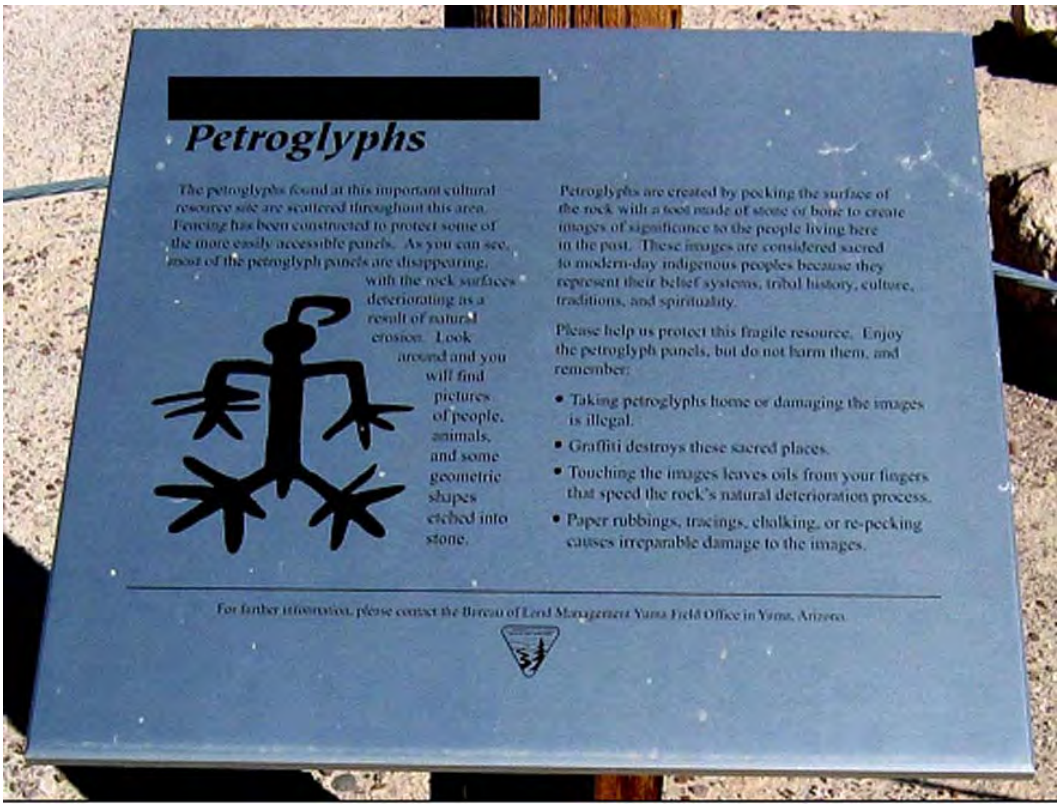

Figure 2. BLM sign at site.

Figure 3. Deteriorating panels.

geometric information consisting of clouds of points. The coordinate system can be relative (not tied to earth coordinates) or absolute (coordinates of observation stations that are known). Redundant observations produce a better product, so collecting data from several instrument setups with overlapping areas is needed. These data then can be input into CADD/GIS software. Photos from the large panoramic fish-eye lens camera that mounts onto the instrument tripod can be collected either before or after the point clouds are collected. Movies, Mov files, using the data collected from the instrument, can give one a 270-degree view by using interactive "movies" that use Quicktime software. The user can move, pan, and zoom around in an interactive movie. The perspective view of the user is from the instrument location. Animated AVI files are created from a compilation of data (i.e., photos, point cloud data, aerial imagery). This is a movie that runs from beginning to end, no user input. The perspective view of the user can be from inaccessible locations. The final product for this project will use all the data to be manipulated in Google Earth SketchUp software.

The use of the equipment for this project was viewed as a hands-on learning experience for the District personnel. Although this effort was far from perfect, it is evident that the time used to complete the LiDAR mapping was relatively short compared to photographing and sketching each of the 229 panels. Caltrans is currently working with the Native American community to disseminate this final product to other venues besides being stored at the National Archives with the National Register Nomination Form. An example of the LiDAR technology in a two-dimensional form is shown in Figures 4 and 5, which show a photograph and a scanned image of the same petroglyph panel respectively.

This example of the LiDAR mapping will hopefully encourage others to apply the 3-D recording technology to sites in their region.

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Figure 4. Photograph of petroglyph panel.

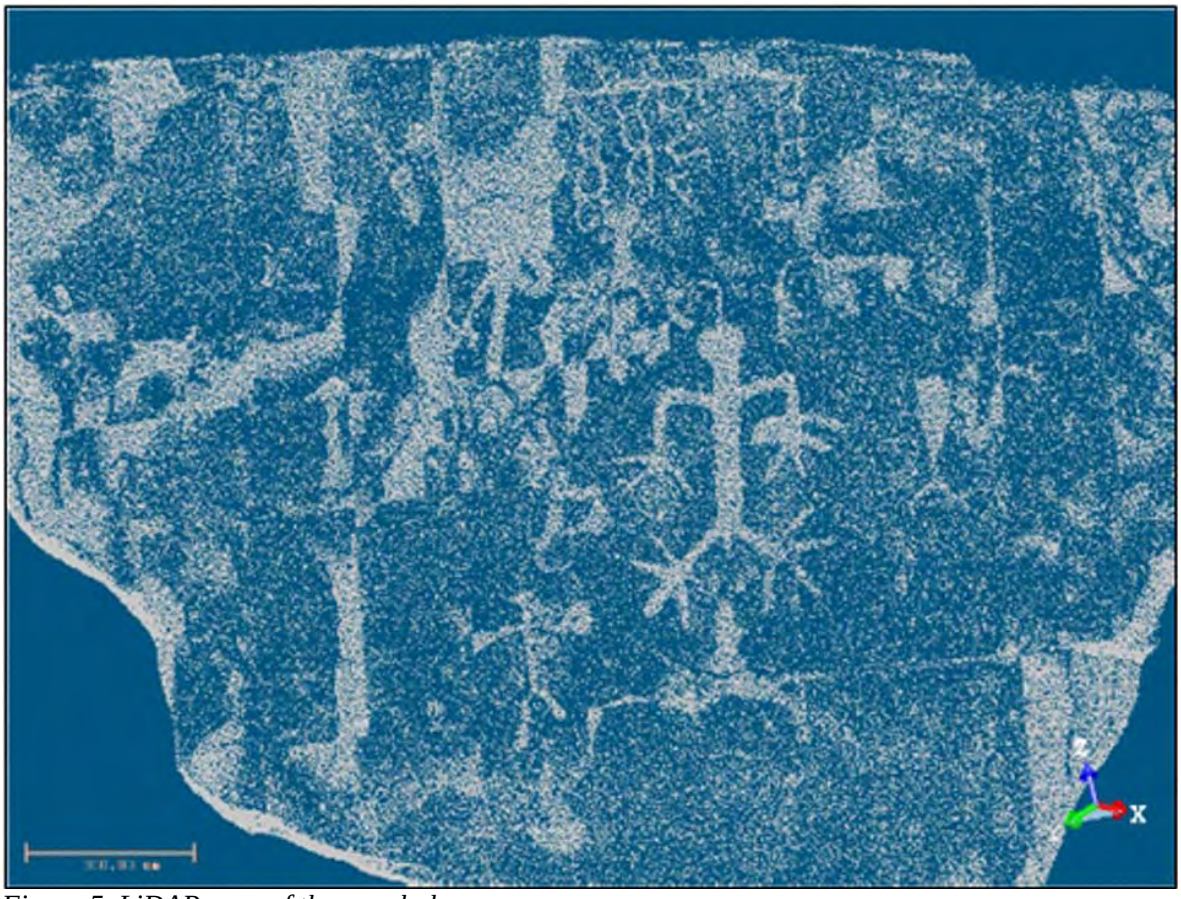

Figure 5. LiDAR scan of the panel above.