

The Archaeological Society of New Mexico

# CLIMBING THE ROCKS

Papers in Honor of  
Helen and Jay Crotty

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## NEW TECHNOLOGY: GIS AND GPS IN ROCK ART SURVEY AT PETROGLYPH NATIONAL MONUMENT

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In June, 1990, Petroglyph National Monument (PETR) was established by presidential decree to "preserve, for the benefit and enjoyment of present and future generations... the nationally significant West Mesa Escarpment, the Las Imagines National Archeological District, a portion of the Atrisco Land Grant, and other significant natural and cultural resources, and to facilitate research activities associated with the resources" (Public Law 101-313). Although a number of national parks and monuments have significant rock art present, Petroglyph National Monument is the only unit of the National Park System to be established primarily for the preservation and interpretation of rock art. Petroglyphs are images scratched or pecked on rock surfaces, whereas pictographs are painted images. The petroglyphs are positioned on a 17-mile volcanic escarpment on the west side of Albuquerque, New Mexico at west longitude 106 degrees 36 minutes and north latitude 34 degrees 3 minutes.

Although the petroglyphs have been photographed for many years, the first rock art survey of the escarpment was done in the late 1960's by the Albuquerque Archeological Society under the direction of Colonel Jim Bain, a pioneer in rock art recording in New Mexico. Some 1500 petroglyphs were recorded, and this survey became the basis for the creation of Petroglyph Park by the city of Albuquerque. In 1985, Dr. Matthew Schmader (Schmader and Hays 1986) and staff of the Albuquerque Department of Open Spaces conducted a survey of 1100 acres of the escarpment and recorded some 10,500 images and 67

archeological sites. As a consequence of this survey, the escarpment was listed on the National Register of Historic Places. This initial survey provided the data which showed the area to be of great cultural significance and worthy of being placed in the National Park System (NPS).

Concurrently with the establishment of the Monument, the NPS established a Geographic Information Center under the direction of Dr. Milford Fletcher at the University of New Mexico in Albuquerque. This center, the National Park Service Intermountain GIS Unit, met early and often with the new Resources Management staff and the first Superintendent, Mr. Steve Whitsall. The first meetings were to determine if the Monument staff could use Global Positioning units (GPS) and computers for mapping petroglyphs and other management purposes. One difference between past rock art surveys and this one is that of locating the petroglyph. The traditional method to locate and survey a petroglyph is to establish datum points and use a tape and compass to determine the distance and angle from the datum point to the petroglyph. To relocate any one figure one must locate the datum point and reconstruct the distance and bearing information. With global positioning units each petroglyph or panel has a distinct geographic coordinate, which can be relocated independently of any other features. Global Positioning Systems are computerized radio wave receivers which receive signals from several of 26 orbiting satellites. By an intricate set of mathematical calculations, the GPS unit can determine the geographic coordinates of

the receiver. In the recording process a petroglyph or panel is located and a file of some 150 points is recorded on a roving GPS unit. This file is then compared with a base station file taken at the same time and the estimated error is calculated and applied to the roving file. All points are differentially corrected and all 150 points are then averaged to one location. The accuracy of GPS data varies, but raw data are accurate to about 10 meters whereas corrected data have an accuracy of plus or minus one meter. The inaccuracy of raw data stems from several factors which are outlined in many GPS technical manuals (see Trimble Navigation Limited 1995). One early use of global positioning units was by Denise Smith (1998) who, with technical assistance from the Intermountain GIS Center, used GPS technology to accurately locate petroglyphs at the Abo Unit

of Salinas Pueblo Missions National Monument near Mountainair, New Mexico.

To prepare for the Petroglyph National Monument survey, the GIS center staff conducted some initial research, obtained some of the first ever created digital orthophoto quarter-quads (DOQQ's) and began obtaining digital data from the city of Albuquerque. Digital ortho quads are high-resolution aerial photographs which have been geographically referenced--that is, the image has been stretched or compressed to remove distortions of the image and to fit on-the-ground geographic coordinates. As a consequence, the image has a horizontal resolution of plus or minus one meter, and provides an excellent photographic base map upon which to place petroglyph locations (Figure 1). Although the technology was new when the Petroglyph National

Monument project was started, geographically referenced digital photography is now available over the Internet in many locations. The Earth Data Analysis Center in at the University of New Mexico has a web site where statewide digital imagery is available free of charge. The results of the initial studies, along with the establishment of the first public GPS Community Base station in New Mexico, showed that with appropriate software and hardware it was possible to locate petroglyphs to an accuracy of plus or minus one meter and overlay their locations on the photographic base map (Fletcher and Sanchez, 1994). The GIS center bought several



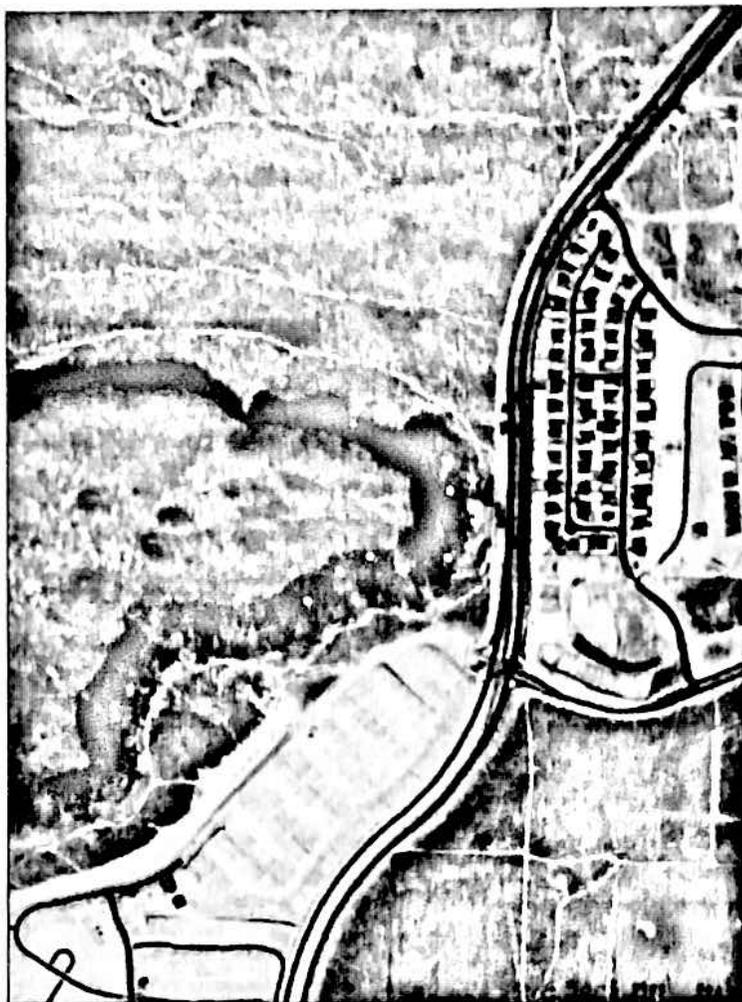
**Figure 1**  
*Digital Ortho Photo of west side of Albuquerque. Approximate boundary of Petroglyph National Monument is outlined in white.*

Trimble GPS units, a top-of-the-line Micron computer and considerable software which were all transferred to the Monument for staff use. Several Monument staff members received appropriate training in GPS technology and the computer software.

At about the same time frame, the Rock Art Field School, an arm of the Archeological Society of New Mexico under the direction of Dr. Helen Crotty and her husband Jay, held a rock art recording field school at the Monument to teach volunteers how to record rock art. Over the years, the Rock Art Field School has trained dozens of volunteers from New Mexico and West Texas on the intricacies of recording rock art.

So, by mid-1990 the stage was set for the largest rock art recording project in the history of New Mexico. The main elements required were a trained cadre of volunteers to conduct the survey, geographically referenced aerial photography for a base map, several GPS units on hand at the Monument for recording petroglyph locations, a community base station to use in differentially correcting the raw data from the roving GPS units, and new Geographic Information System software from Environmental Systems Research Institute, Inc. called ArcView.

Not only was this to be the largest rock art survey to be conducted to date, two new technologies were to be utilized. The first was to use global positioning units to locate each petroglyph or panel. The use of GPS and GIS in this survey provides a unique geographical location for each locus, or rock with petroglyphs on it. This location is then linked to all the information recorded in the field about the physical location, special features, description, category, technique used, and repatination. The field drawing and photograph are attached to each locus. Most impor-



**Figure 2**  
*Enlargement of one portion of Petroglyph National Monument showing locations (white circles) of petroglyphs with linear designs and facing north.*

tant, the spatial database is completely searchable electronically. Many of the questions that arise when discussing petroglyphs can be addressed with queries of the database. For example, Figure 2 shows the results of a search of the data base in a small area south of Rinconada Canyon. The database was searched for petroglyphs which are categorized as linear designs which face north. Seven petroglyphs meet these criteria, and are displayed as white dots on the digital photograph. As an aside, notice the proximity of housing to the petroglyph site. This close association of

urban dwellers to a significant national cultural resource is of considerable concern to NPS management since it leads to an impossible problem of access and egress. As of September 2002 there have been 8,541 differentially corrected global positioning points taken at Petroglyph National Monument (Gretchen Ward, Cultural Resource Specialist, PETR, personal communication, 2002).

The other use of new technology was in the use of a computer program to analyze data. In the early 1990's Environmental Systems Research Institute (ESRI) modified their popular mainframe software ArcInfo to run on personal computers. The new software was called ArcView, and is particularly suited to handle large data sets and display values in geographic coordinates. ArcView has many of the features of its parent software ArcInfo but runs on a PC rather than a mainframe. ArcInfo is very commonly run software in cities and counties across the nation, and these public entities are often a source of data for use in ArcView. For example, many counties have detailed soils maps in ArcInfo format, which is easily imported into ArcView.

The value of this approach is seen in the publication of two master's theses which have been completed using data from the survey. The first, by Kerri Mich (2000), addressed three questions. Many of the results were not quite what was expected, according to traditional rock art theory. Does a discernible pattern exist in the images or is their placement random? The images are indeed clustered, as one can tell by looking at plots of image locations, now backed with nearest neighbor analysis statistics. It is fairly obvious that images are clustered, as they are even recorded in "concentrations". Does the placement of an image of one category affect the placement of an image of a second category? The results from this analysis suggest that they do not. It appears that petroglyphs are found in areas that for some reason are more suitable for petroglyphs, rather than

certain images occurring together in certain places.

Is vandalism in the national monument related to trail proximity? Yes, but the amount of vandalism and graffiti in close proximity to trails is also dependent on the topography of the area. In areas of long, steep escarpments, units 9 and 10, over 50% of the incidents of vandalism are within 15 meters of the trail at the bottom of the escarpment. The rest are within 15 meters of the top of the escarpment, where there used to be easy access by jeep trail. In areas of short, gradual escarpments, units 23 and 28 for example, graffiti is more widespread, as people don't need trails to get to the top of the escarpment. However, there are more trails running from the bottom to the top of the escarpment, so the majority of graffiti is within 15 meters of trails.

Do the images have any connection to the directional orientation of the rock surface chosen by the artist? Many of the theories about how images are oriented to different things such as visibility, cardinal directions, or prominent landmarks do not seem to be supported by the findings at PETR. It is significant, however, that the majority of images in the four units studied face south, southeast, and east. Why? Is it more relevant the direction that the artist faces than the direction the rock art faces? Perhaps petroglyphs are placed in areas where the artist has a good view. Are concentrations of petroglyphs found in areas with better views? Or is the slope the biggest factor, in the way rocks rest on the surface of the slope, or even in the way the slope gives the artist a place to stand or sit while working? It would be interesting to see if the direction the images face change with data from the rest of the monument, especially in units where the escarpment faces north rather than predominantly south.

The second master's thesis used data from Petroglyph National Monument and five additional rock art sites in New Mexico (Saville 2001). The focus of this study was to use existing

and newly collected data to compare the designs and techniques of kachina images in the rock art record as well as evaluate the landscape context of such images across the Rio Grande Valley and Eastern Mountain region. At Petroglyph National Monument a sample area was made of petroglyph concentration PC28B:07 in Piedras Marcadas Canyon. Data from the petroglyph inventory were used within the ArcView environment to determine the frequency and distribution of kachina images and particular attributes of these images in this provenience. Queries and individual shape files for visual analysis were made for each of the fourteen variables examined in the study. These variables include eyes, nose, mouth, outline, headdress, teeth, ears, facial decoration, symmetry, rock surface, rock incorporation, relation to other elements, direction facing, and technique. Results of the GIS analysis indicate that although a number of design variations are present, kachinas were most commonly pecked into the basalt boulders with round outlines and simple three-dot faces oriented south or southeast. Kachinas in this resource rich landscape are clustered between watercourses, low on the escarpment, and facing a water catchment basin/agricultural field.

The design of the survey incorporates many of the conventional techniques for recording rock art. Each petroglyph is measured, photographed, drawn and other data are collected such as the direction it faces, height above ground, etc. (Brody, J this volume). Each petroglyph is catego-

rized into several categories such as human or animal figures, degree of repatination, vandalism, etc.

The use of GPS and the computer program ArcView brings new tools to the analysis of rock art. Since each petroglyph or panel has its own unique geographic location, they can be linked to all the other information recorded in the field about the physical location, special features, description, category, technique used, and repatination. Photographs and field drawings are linked to each petroglyph and the computer can query the spatial database electronically.

Under the direction of Jack and Ann Francis, the survey of Petroglyph National Monument is in its sixth year, and there have been more than 24,000 elements recorded of which 534 are associated features--grinding slicks, rock alignments, etc. And 19,000 are actual petroglyphs. The survey serves as a baseline for the number of petroglyphs in the monument, the current extent of vandalism, and the types of petroglyphs inventoried. The locations of the rock art, including photographs and drawings, should prove helpful for future cultural resource studies. The condition of the petroglyphs, as reflected in the photos, will be utilized by law enforcement professionals when evaluating vandalism reports and by cultural resource staff to assess erosion. As a more complete survey of all units in the park is completed, resource managers will be able to query the database to support the planning, resource management, law enforcement, and maintenance programs for PETR.

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