



Monitoring and Preservation



Why preserve?

El Morro is an important link to the past and natural deterioration of that link is a concern. Even though the inscriptions on Inscription Rock are very old, dating back to the 1600's, and the petroglyphs are anywhere from 700-1000 years old, they will not be here forever. The processes of erosion, weathering and plant growth all take their toll. Sand grains wear away, rocks crumble and fall, and lichens and clay deposits cover the historic carvings. Important inscriptions become illegible or fall from the face of the bluff. A part of the evidence of our heritage is crumbling away. The National Park Service hopes to preserve this evidence for as long as possible by assessing, monitoring and treating the inscriptions and the rocks in which they are carved.

Rockfall monitoring



The cliffs at El Morro are composed of Zuni Sandstone which is jointed, or broken into huge blocks by vertical fractures. If park rangers are aware of the loosening of one of these blocks, it may be possible to predict a large rockfall, averting danger to visitors.

Water enters the rock through joints. Freezes expand the water volume by 10%, exerting pressure on the sides of the joint. Repeated freeze-thaw cycles exert cumulative stress on the joint. Joints are also avenues for roots to penetrate the rock. As a plant or tree grows, the roots are also growing and expanding in the joint crack, sending root hairs into the smallest spaces. When water and roots open a joint, sand grains fall into the opening crack, helping to keep it spread apart. Eventually, rocks will fall from the cliffs.

The large crack just beyond marker #12 is believed to be stable, but it is monitored for any movement. To measure the crack, four bolts must be accessed by ladder. The bolts have been placed on opposite sides of the joint to serve as reference points. Park staff periodically climb up the ladder and record the distances between the bolts.

Another method the park uses to monitor this joint is a tilt meter. It was installed to record changes in the inclination of the monolith by measuring degrees of

tilt. The instrument is located high on the cliff near marker #13. Rangers connect a recording device to the wire leading from the instrument to obtain the inclination in two directions.

Since Fall 2000 when the current measuring devices were installed, the data suggest that the rock does move a bit, particularly in winter and spring with the freezes and thaws, but only in the range of tenths of millimeters. Most of the movement is in and out, as opposed to an outward trending movement. The tilt meter indicates no more than $1/4^{\circ}$ of increased lean in the last 36 months. The monolith seems stable for now, but monitoring will continue.



Inscription Monitoring



The inscriptions are carved into sandstone that is very weakly cemented—the sand particles are held together only by clay between the grains. The poor cementation of the rock made it easy to carve inscriptions, but it is also the reason the rock is deteriorating quickly.

Inscription Rock is eroded mechanically and chemically. Mechanical attack includes expansion by freeze/thaw and wet/dry cycles, growth of lichens, burrowing by animals and insects, and abrasion by wind and water. Chemical weathering includes the interaction of the rock with the chemicals in the ground water, which can lead to erosion.

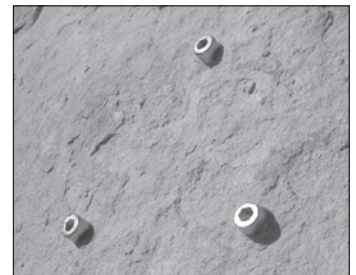
Inscriptions at the point of El Morro, near marker #14, are being eroded the most rapidly. This north-east corner bears the brunt of weathering. The cliff face is abraded by lashing rain, sleet and wind that swirls around the point.

Other inscriptions are being covered by a wash of clay. The clay is leached out of the rock above and carried by rainwater or snowmelt seeping down the face of the cliff. After the water evaporates, clay remains behind and can coat the inscriptions. The clay washes also seem to be prevalent below areas where insects have bored holes into the rock, so perhaps the insects release extra clay.

Spalling, another mechanical process, involves flaking of thin scales of rock from the face of the bluff. Spalling begins with water seeping slowly within the rock from above. The seeping water dissolves minerals that are redeposited on the rock face when the water evaporates. The crust that forms then traps water behind it. Salts repeatedly collect behind the crust and cause spalling of the rock.

In addition to all of this, lichens grow on the rock and produce acids that attack the rock structure. The cooler, shadier north side of Inscription Rock is most conducive to lichen growth, and inscriptions are slowly being covered by it. One test area that was cleaned of lichen has grown over again in five years.

To monitor the progress of natural disintegration, the Park Service has photographic and sketched records of the appearance of the inscriptions. For quantitative measurements of erosion, small reference pins were installed in several places. The distance from the pins to the surface of the rock is measured. In the five years of measuring, the rock face has, in places, eroded about 1/32 inch (0.8 mm).



Preservation and Prognosis

By now you may be wondering what is being done to preserve the inscriptions. The goal of the El Morro Inscription Preservation Program, begun in 1997, is to slow the rate of deterioration and loss of this remarkable record of human passage by monitoring and treating threatened inscriptions. Inscriptions are monitored by comparing old photos with present appearances for lichen growth, clay deposition, cracking or detaching and erosion of the sandstone.

The following treatments have been developed through testing and trial applications, and may be implemented by conservators when the loss of an inscription is imminent:

- use of cement-based grouts to fill voids (keeping water out) and to reattach fragments
- consolidation of loose rock with ethyl silicate and epoxide around eroded inscriptions
- securing inscription panels with drilled in pins
- treatment with calcium hypochloride (swimming pool bleach) to stop the growth of lichens

While these treatments may be effective in the short-term, the inscriptions and petroglyphs on the face of El Morro pose the ultimate challenge to the National Park Service mission of preserving them in perpetuity while allowing natural processes to operate.

We must ask ourselves what treatments are acceptable and how far we will go to delay the inevitable. Cover the rock wall with glass? Remove the inscriptions and place them in a museum? Or should we allow nature to take its course?

