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ARTIFACTS AND FEATURES
PETROGLYPH DATING

This article is one of an occasional series discussing matters archaeological, especially with reference to the Maturango Museum. In previous articles we have talked about why chronologies are important in archaeology, and about qualitative and quantitative techniques for establishing dates or sequences. Today we will briefly cover methods of dating petroglyphs, a matter of local interest because of the outstanding Coso petroglyph field and the perennial question from visitors of "How old are they"?

Petroglyphs are created by scratching, pecking, or abrading away the dark layer of so-called desert varnish which forms on the exposed surface of rocks, thereby exposing the lighter rock beneath. (Incised or cut petroglyphs are found in the Southwest, but Coso basalt is too hard for this technique). Desert varnish is created by bacteria over long periods of time, and as soon as a petroglyph is created the varnish starts to reform on the exposed rock. Petroglyphs were created on many types of rock – basalt (as at Coso), sandstone (frequent in the Southwest), volcanic tuff (as in the Bishop Tablelands), and others as well.

There are basically two categories of methods of petroglyph dating, qualitative and quantitative. Qualitative dating is based on observed qualities such as subject matter, relative darkness of the image, superposition, and observation of associated features or artifacts. Of these, subject matter is probably the powerful tool; an image of a bow and arrow must be less than about 1600 years old, because that is when the bow and arrow was introduced, replacing or supplementing the atlatl and dart. Unfortunately an image of an atlatl does not necessarily predate1600 years ago, because the atlatl may have persisted in use or memory past that time; it is known to have done so in the Northern Great Basin. An image of a cowboy on a horse is probably post-AD 1850 in this area. The $E = mc^2$ image in Little Petroglyph canyon probably dates from the period when the Atomic Energy Commission operated the Salt Wells facility at China Lake, prior to 1950. An image has been reported from the Echerren Valley area which may be a mammoth; if so, it would push the date back beyond 10,000 years ago. This technique requires recognizable images whose subject matter can be dated, so it is limited in applicability.

Because desert varnish does not form at a consistent rate in all conditions, image darkness (or contrast) and superposition are not especially helpful for dating, although they can help establish a sequence. Some types of image, the so-called scratched style, generally overlie pecked style figures, for example, and are hence generally inferred to be later.

Association with other artifacts can give a clue to age. For example, if petroglyphs are found in association with lithic scatters containing obsidian, where people were preparing or repairing obsidians tools, the obsidian can be dated and the age of the images inferred. A similar argument can be made for charcoal from associated campfires. This must be done cautiously, of course, but is reasonably valid if a trend can be observed: for example, a series of petroglyph sites might be found, all with similar motifs and all with similar obsidian or radiocarbon ages. Similarly, if a petroglyph is partially or fully covered with soil, the soil can be dated to estimate a "must-be-earlier-than" age.

Direct measurement techniques include radiocarbon dating, varnish microlamination, cation-ratio (CR) dating, and X-ray fluorescence dating. Radiocarbon dating is performed using Accelerator Mass Spectrometry (AMS) on microscopic carbon particles embedded in the desert varnish. It was believed to hold great promise at one point, but is seldom used today, primarily because the minute samples (milligram size) are extremely sensitive to contamination, either in the field or in the laboratory. It can still be a useful technique for pictographs, especially if the pigments employed contained an organic binder.

Cation-ratio dating is based on the observation that chemicals in the surface layer of the rock are leached out by exposure to water, and that some elements leach more rapidly than others. In this technique, the ratio of calcium plus potassium to titanium is measured using a variety of techniques (such as particle-induced X-ray emission) and compared to a calibration curve. Results of CR dating have been inconsistent – some researchers have been successful, others not. It seems to depend on the exact structure of the desert varnish, and hence requires great care and microscopic study of the varnish. Its primary drawbacks are that it requires removal of a sample from the glyph, and it is relatively expensive to conduct. Since varnish formation depends on many variables, a valid calibration curve is difficult to construct.

Microlamination dating is based on the build-up of identifiable colored layers in the desert varnish, reflecting wet and dry climatic cycles. A small sample is cut from the glyph and a thin section prepared, perpendicular to the rock surface. When examined under a high-powered microscope, colored layers are visible which correlate with wet and dry episodes known from the geological record. The technique gives valid results, but is tedious and expensive to apply. It works best for very old glyphs.

A new technique currently being explored is X-ray fluorescence. This can be done in the field with hand-held units, and is relatively rapid and cheap and is non-destructive to the glyph. The principle is to measure the concentrations of lead, manganese, and iron in the glyph and the surrounding varnish, calculate the ratio, and again apply a calibration curve. The calibration curve is developed from geologically-dated rocks, and arriving at a valid curve has the same issues as CR calibration. The technique is promising, but is still experimental, and currently seems to work better on soft rock than on basalt.

In summary, there is no single technique that works well for dating all petroglyphs, so any assessment of age must employ multiple arguments and look for a convergence of evidence, similar to forensic analysis. For our local case, estimating the age of the Coso petroglyphs requires examining multiple strands of evidence. Starting with the early Holocene, a CR age of 11,000 years has been reported, plus there is the possible mammoth image in Echerren Valley; another CR age around 6,000 years has also been reported. For later periods, correlation of obsidian readings with single-component rock art sites on the Coso Military Targets Range shows a scattering of ages from before 5,500 to about 2,800 years ago; it then shows an upsurge in site numbers from 2,300 to 650 years ago, with virtually none since then. From a subject matter standpoint, the obviously large number of sites in Little Petroglyph Canyon showing bows and arrows suggests a great deal of activity post-1,600 years ago. And then there are historic period images, of horses, cowboys, jeeps, and physics equations. Obviously the Cosos have been used for a very long time!