

astronomical petroglyphs



Searching for Rock Art Evidence for an Ancient Super Aurora

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FOR TENS OF THOUSANDS of years, humans have expressed themselves artistically on their surroundings—painting, etching, carving, and molding designs, decorations, and imagery on surfaces ranging from portable, often hand-held objects (such as animal bone and stone) to more stationary features of the landscape, such as scattered rocks, caves, and cliffs. The most famous early examples of this so-called rock art are the fabulous Paleolithic cave paintings from southwestern France and northern Spain, which date to about 15,000 years ago (see *Expedition* 47(3):20-24). Less well known, but far more common, are the petroglyphs (drawings or etchings carved on stone) that have been identified around the world. Besides a general human fascination with visual representation in different media, these rock art images can tell us not only about the people who made them—a broadly anthropological question—but also about environmental conditions of the past.

To understand this, one must first appreciate the nature and variability of the subject matter. Rock art images are quite diverse, seemingly depicting everything from simple geometric shapes (lines, circles, triangles, squares) to more or less recognizable representations of creatures or elements from the local environment (such as humans, animals, plants, or tools). Less obvious representations of real or imagined phenomena (such as the sun, geographic features, natural forces like wind or running water or creatures of fantasy) can also be identified as well as things that no two people would agree upon without having the artist there to explain what is being depicted. Identifying and understanding the meaning of particular petroglyphs, in fact, can be likened to a game of Pictionary—with some sketches being fairly straightforward and others a visual conundrum—albeit without the artist on hand to say who has guessed right!



From left, geometric shapes such as concentric circles, a dotted square (both from Rinconada Canyon, Petroglyph National Monument, New Mexico, USA), and a “wheel” with spokes (from Foppe di Nadro and Campanine, Valcamonica, Italy) are represented in rock art.



Left and below, these petroglyphs show recognizable representations of creatures such as a snake and a quadruped, and a bird enclosed in a circle (both from Rinconada Canyon, Petroglyph National Monument, New Mexico, USA).



Above, petroglyphs may also illustrate what may be natural phenomena such as a sun with rays (from Parco Nazionale delle Incisioni Rupestri, Naquane, Valcamonica, Italy).

Hallucinations Depicted in Stone?

For archaeologists and anthropologists, researching rock art typically involves the detailed recording of images in their primary context and an attempt to determine their age (date of origin) and likely cultural affiliation (which group created them) through a variety of means ranging from stylistic comparisons to radiocarbon dating of materials found in association with the rock art. With these contextual clues, archaeologists and anthropologists are better able to determine the likely identity or function of certain depictions because they can interpret what they see on a rock face in light of what they already know about the inhabitants of that particular location at a particular date.

For example, consider a rock art image hypothetically found in Scandinavia showing a human figure holding a large cross-like implement. Knowing that this image dated to 1,000 BCE during the Bronze Age would rule out any potential Christian interpretation, suggesting that the cross-like item might actually be a battle axe. In contrast, a determination that the hypothetical image dated to 1,000 CE—when Christianity was sweeping through Scandinavia—would mean that the figure might as likely be holding a Christian cross as a battle axe. Needless to say, this would probably make the identification of the person holding the cross-like implement more difficult to determine, let alone provide a full understanding of the meaning that the artist was trying to convey. Was the battle axe meant to indicate a war-like person? Would a cross signal a peacemaker? Or would the similarity of a cross to a battle axe symbolize the spread of Christianity by force?

For archaeologists and anthropologists, context is everything, allowing them the best possible opportunity to find and piece together the clues needed in order to understand the past and the people who lived there. However, even with good contextual analyses, rock art often leaves researchers at a loss to say what certain glyphs were meant to represent. For example, although we might all agree that a shape can be classified as a circle, how do we determine whether that circle was meant to represent the sun or the moon or a wheel or an island or the mouth of a cave, or something more abstract like an emotion, or even nothing at all? Similarly, what does a line represent? What about a square or a triangle or a cross? Is a

A popular explanation today for rock art imagery is that it was inspired by artists' hallucinations. Pioneered by David Lewis-Williams of the Rock Art Research Institute at the University of the Witwatersrand (South Africa), this interpretation does not necessarily contradict our auroral hypothesis since the types of images claimed to represent hallucinations often do not overlap with the categories of images we have identified as representing auroras. Furthermore, Wilder Penfield discovered in 1958 that hallucinations can be triggered by electrical fields applied directly to people's brains. Is it possible that massive auroral storms and their increased electromagnetic activity could have induced hallucinations? If so, this would suggest that the images we argue represent auroral activity may be a combination of direct visual recordings and some hallucinatory ones produced by artists under the influence of the auroras.



Rock art sometimes includes images on the meaning of which no two people would agree without having the artist there to explain what is being depicted. From left, a fourfold star (from Piedras Marcadas Canyon, Petroglyph National Monument, New Mexico, USA); and a spiraling “snake” and joined sets of vertical “filaments” that may represent mammals (from Rinconada Canyon, Petroglyph National Monument, New Mexico, USA).



Above, is this a “snake,” a meandering river, or an image from the artist’s imagination? (from Rinconada Canyon, Petroglyph National Monument, New Mexico, USA).



Below, ladder-like designs, such as those shown here, may represent paths that need to be followed to enter the spirit world after death—stairways to heaven (from Parco Nazionale delle Incisioni Rupestri, Naquane, Valcamonica, Italy).



Above, petroglyphs are open to interpretation. This hypothetical rock art image shows a human figure holding a large cross-like implement. But is it a battle axe or a Christian cross or a hybrid of the two?





A wavy line may represent water, a river, a snake, or something else (from Sugok-ri, Imdong-Myeon, Andong-si, South Korea).

spiral used to represent the funneling of water down a hole or the drilling of bone to make a tool or the disorientation one feels when spinning quickly in place or even the intoxication one feels when having drunk too much alcohol?

Rock art specialists encounter such enigmatic designs, symbols, patterns, and images all the time. In some instances, they are able to suggest what these glyphs represent based on their understanding of the artistic and cultural tradition of the particular people who produced them. For example, a ladder-like design may represent a path that needs to be followed to enter the spirit world after death—a stairway to heaven. Alternatively, wavy lines side by side might represent a body of water that needs to be crossed to enter the Underworld—like the River Styx.

In many instances, however, rock art specialists cannot even come up with an informed guess. This has led to a plethora of explanations. Some have argued that the non-figurative designs, symbols, patterns, and images are not actual or accurate representations of anything—merely what we might call doodles in the margins. Others thought that these glyphs are so abstract that there is no direct connection between a particular design (e.g. a circle) and what was meant to be conveyed (e.g. death, life, dreaming, seeing, sadness, etc.). Or they could have represented what the artist saw during a dream or a trance, perhaps even one induced by the consumption of hallucinogenic plants or mushrooms.

But might there be another way to look at such enigmatic designs?

Astronomical Inspiration

Since 2000, the authors, a comparative linguist and a plasma physicist, both with a fascination for rock art and astronomical phenomena, have been collecting data about petroglyphs, geoglyphs (man-made formations inscribed on the ground), and other archaeological structures and objects from around the world. With the help of teams stationed in different countries, we have compiled a database of images from 139 countries—perhaps the largest rock art dataset ever collected.

The base assumption has been that, throughout time and space, humans around the world have been exposed to *shared experiences* that probably found common expression in their art. The simplest example of this would be the general experience of the human body. No one would be surprised to find drawings of humans that depicted hands and feet with five fingers and toes anywhere in the world. This common human feature would be sufficient inspiration to explain the appearance of similar petroglyphs worldwide. Likewise, one would expect to find other human body parts depicted in rock art in many different places and at many different times simply on the basis that all humans share these basic physical similarities. Other aspects of human experience that we might expect to see depicted by all humans in all places and at all times are celestial objects that are constant the world over—the sun, the moon, the planets, and the stars. No matter where one lived, no matter how long ago, it is reasonable to expect that all humans were familiar with these celestial bodies visible in the sky. From this celestial assumption, one might deduce that petroglyphs around

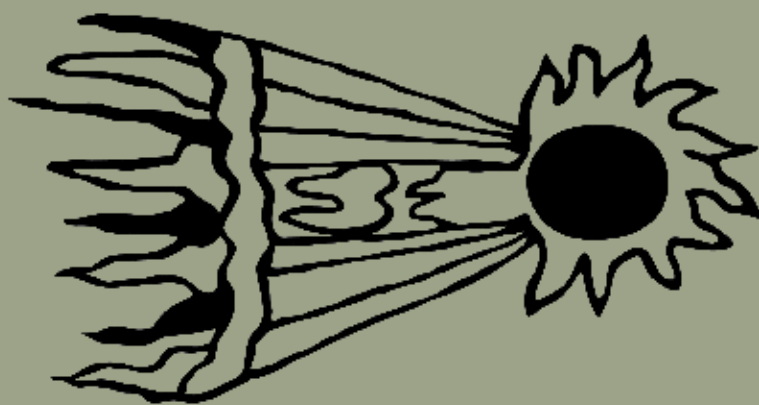
the world might represent these heavenly bodies in some form that would be generally recognizable to even the uninitiated. Maybe a circular disk with or without rays would depict the sun. How about a circle or a sliver to indicate the moon? Maybe some sort of pointy-shaped symbol represented a bright planet or star. You get the picture.

Reality is not that simple, however. For one thing, this expectation of “naturalistic” images is rarely met in the perplexing world of rock art, where humans are frequently depicted with three, four, or another number of digits on their hands and feet, with a strangely elongated trapezoid or circle for a body, with a bird instead of a head, and so on. Or where “suns” stand on pillars or consist of a number of concentric rings. There has to be a reason why “strange” people are far more common in rock art than anatomically correct people, just as weird animals and incorrect astronomical objects outnumber accurate ones. Also, as carving a petroglyph requires a considerable amount of work, often in difficult locations and under harsh weather conditions, it is not clear why anyone would go to the trouble of depicting an ordinary human being or a simple planet. Faced with this impression, our base assumption of a global source of inspiration is modified to the effect that trivial subjects rarely formed the subject of rock art; apparently, petroglyph carvers were often more interested in depicting *unusual or extraordinary phenomena*. These could be of a psychological nature, such as curious hybrid forms of animals and human beings seen during hallucinations, which were interpreted as “spirits” or “mythical people.” Or they could represent rare and striking aspects of the natural environment. Both repositories, psychological and celestial anomalies or curiosities, can be described in terms of globally recurrent factors, setting them apart from the local determinants considered by anthropologists and archaeologists.

What sort of unusual astronomical phenomena might have been sources of inspiration for rock art? Historical documents indicate that eclipses and comets such as Halley’s have caught the attention of ancient peoples for thousands of years, albeit only at certain points in time. Similarly, the auroras (or the Northern and Southern Lights) have been regularly commented upon, although more commonly in those places from which they are normally visible. In general, it seems likely that other astronomical phenomena, especially rarities like far off supernovae, might have attracted the attention of stargazers the world over. We know such transient events have been recorded worldwide in oral traditions and literature. It is reasonable to suppose that they were also recorded in rock art. This hypothesis inspired us to scour the world for petroglyphs that might depict astronomical phenomena.

A Record of Past Astronomy

Our approach is significantly different from that of archaeologists and anthropologists who study rock art within the context of a cultural system. As noted above, they are trying to answer broadly anthropological questions about the past that will shed light on the people who made the rock art and the world in which they lived. For archaeologists and anthropologists, petroglyphs are not simply representations of the visual world of people in the past, they are depictions of things that had meaning for the artists who made them and the audiences by whom they were viewed. Their decipherment by archaeologists and anthropologists, therefore, is akin to attempting to read a foreign language to gain an understanding of the speakers of that language. As a “dictionary” is not available in most cases, this often leads to an ill-defined circular method, where information about a local culture colors the interpretation of the rock art in some cases, and the rock art feeds back into the understanding of that cul-



Infrequent eclipses and comets have caught the attention of ancient peoples for thousands of years. This reproduction of an image of Halley’s Comet, which was seen in the sky in 1066, was embroidered on the Bayeux Tapestry, completed in about 1077.

ture in other cases. For example, a petroglyph that looks like a wheel can be interpreted as a chariot wheel if the local culture is known to have had chariots. Conversely, a petroglyph that looks like a sheep can be interpreted as evidence that the local culture tended sheep even if such is not otherwise known. In either case, the interpretation rests on simple and untestable speculation, and there is no systematic method to interpret larger sets of petroglyphs.

In contrast, we approach petroglyphs as the possible man-made evidence generated after the occurrence of a few major environmental events. Just like a meteorite striking the Earth might leave a crater and a spray of debris that could be sampled thousands of years later by geologists looking for evidence of an impact, we consider petroglyphs as possible evidence for a series of major atmospheric events that may have occurred in the past and that were witnessed worldwide provoking artists to depict these astronomical phenomena in their rock art. Rather than study the rock art for what it might tell us about past peoples, we study rock art for what it might tell us about past astronomical events. There is no absolute contradiction between these different approaches, as information about local cultural settings remains important: people will always have *interpreted* environmental and astronomical events from their own local perspective and based on their own cultural background. While archaeologists and anthropologists quite rightly point out that our interpretation of petroglyphs should be refined for each individual cultural context based on local information, their studies will benefit from our practice to consider the orientation to the sky of each rock art site individually—something that has simply never been considered in the rock art literature (though it has been in archaeoastronomy).

Why rock art? In contrast to geologists or other environmental scientists, who study the physical effects of astronomical phenomena such as meteorites (e.g. craters and debris layers) or increased radiation from space (e.g. higher ozone levels captured in glacial ice deposits), we are interested in identifying astronomical phenomena that may not have left any physical primary evidence on the Earth's surface, but only the secondary recorded impressions of those who witnessed them visually. After all, we only know about Halley's Comet and its flyby every 76 years because we have seen it and recorded it. There is no physical evidence on the Earth's surface to indicate that this has occurred, unless, of course, you count the depictions and descriptions of this comet—the

secondary evidence—as recorded by people through the ages. Just so, we are looking for the eyewitness accounts of similar astronomical phenomena that would have been visually noteworthy but left no physical trace.

The Rock Art Evidence

Our survey of rock art images over the past decade has taken us to 139 countries, where we have recorded over 4 million individual rock art images—bearing in mind that one location with rock art imagery can include thousands of individual rock art images. For each location we visited, we recorded the site's latitude, longitude, and altitude, and determined the inclination to the horizon and the direction the artist was most likely looking. Besides providing a detailed geographic location that can be mapped globally, these data allowed us to determine which parts of the sky were visible from the location where the rock art was created.

A tentative analysis of the data suggests that all of the mapped locations provided at least one field-of-view toward the sky over the rotational/geographic South Pole. This is not to say that all the sites were south-facing or that all the images were on south-facing surfaces, but just that all the sites allowed for the rock artist to look to the South Pole of the sky (as well as any other parts of the sky that might have been visible from that particular place). If rock artists worldwide were interested in places where they could observe this part of the sky while producing their art, at what sort of astronomical phenomena may they have been looking?

If we exclude from consideration those petroglyphs which seem clearly to represent recognizable phenomena (animals, plants, etc.) and focus exclusively on those enigmatic abstract shapes that few comfortably interpret, we find ourselves presented with 84 types of abstract images. Assuming that these images were indeed meant to depict phenomena seen in the skies, we propose, based on our experience of auroras seen at polar latitudes and plasmas (ionized gases) modeled and photographed in laboratory settings, that these “abstractions” may actually be visual representations of intense auroral storms. Auroras are centered on the poles. In this case, our observations suggest that an auroral storm of unprecedented proportions may have occurred over the South Pole. The light associated with such storms is unbearably bright and is called *synchrotron radiation light*. We have found that people carved the images exclusively from locations where the



Solar Plasma

When, perhaps every 4,000 years, intense solar plasma currents occurred in the Solar System, the profile was the same as that measured in high-energy-density experiments in the laboratory. The intense current cross-section is 56 currents (two pairs of 56 currents to be exact, or 112). These numbers dominate “rayed” circular petroglyphs as well as stone circles or megaliths. In time, through a process called Ampère’s Law, the currents merge to lesser numbers, eventually to four. Seen end on, these appear as white dots in the upper frames. Magnetic field lines (green) around these currents (called a quadrupole in magnetic fusion) trapped interplanetary plasma (violet), compressing it to thermonuclear temperatures. This geometry is called a *quincunx* when found on ancient or modern objects and occurs as a glyph in the Maya script. Quincunx petroglyphs are known worldwide. In the top frames above, the four currents are shown along with four more that are generated in the densest part of the plasma. Time increases left to right, and the carvers may have documented this evolution on stone. (Image on bottom left from Yucatan, Mexico; Image on bottom right from Foppe di Nadro and Campanine, Valcamonica, Italy). [Overlay of white dots added by A. Peratt]



brightest parts of the formations were hidden from view by local features such as rocks and distant mountains that may have served as *shields*.

What would such storms look like? Auroras usually appear as brooding red to green clouds, conspicuous luminous rays, or dancing curtains of light. On occasion the corona of the Sun ejects clouds of plasma or ionized gas into the solar wind, which causes severe perturbations in the magnetic field of the Earth, which, in turn, results in enhanced auroras around the Earth’s poles.

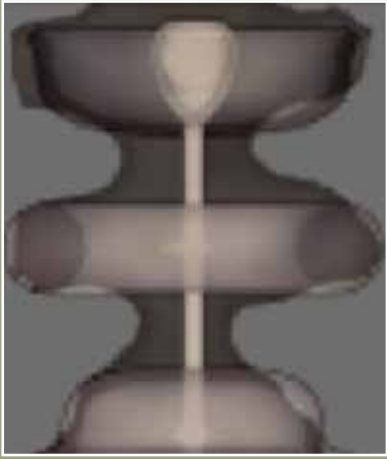
On very rare occasions, extreme auroral storms can even be seen in areas closer to the equator. The most famous example is the so-called Carrington Event of 1859. A feature article posted May 6, 2008 on the SCIENCE@NASA website describes how on the morning of September 1, 1859, the English astronomer Richard Carrington witnessed a massive solar flare during his normal recording of sunspots.

Just before dawn the next day, skies all over planet Earth erupted in red, green, and purple auroras so brilliant that newspapers could be read as easily as in daylight. Indeed, stunning auroras pulsed even at near tropical latitudes over Cuba, the Bahamas, Jamaica, El Salvador, and Hawaii. Even more disconcerting, telegraph systems worldwide went haywire. Spark discharges shocked telegraph operators and set the telegraph paper on fire. Even when telegraphers disconnected the batteries powering the lines, aurora-induced electric currents in the wires still allowed messages to be transmitted.

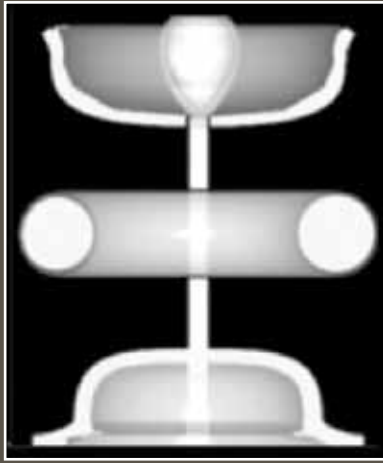
We now know that large solar flares cause geomagnetic storms that not only increase auroral activity near the Earth’s poles, but also disrupt communication and electrical power transmissions. A number of these events have been recorded in the past few decades, knocking out long-distance telephone communication, power stations, and satellite transmissions. However, none have come close to the massive scale of the Carrington Event.

What would the sky look like if the solar wind was further increased by one to two orders of magnitude? Although we have no scientific proof that this has ever happened, the American astronomer, Thomas Gold (1920–2004), proposed that such an event did happen within the past 12,000 years. Unfortunately, we have no visual depictions of what such an event would have looked like, but thanks to the affiliation of one of the

EXPERIMENT-CONCEPTUAL
OVERLAY



CONCEPTUAL



GUYANA



NEW MEXICO



ARIZONA



VALCAMONICA



Stickman

The so-called "Stickman" is the world's most prevalent petroglyph. Found everywhere, the stickman can be carved as a stick-like figure with a head, two arms stretched out and up, and two legs stretched out and down. The figure is distinguished by a male anatomy. The stickman has several variations: with a belly, "an inner tube" around the belly, and variations in the arms (such as one or two, up or down). The head is usually bulbous but can also be a cup, a bird, or two horns. A rarer variety of stickman has two dots on either side of the belly. All of these varieties have been produced in a single plasma column, a result of a time-evolving nonlinear evolution of toroids pinched in the column. For example, shown to the right, the Kurchatov Institute, Moscow also produced an intense plasma column.



HOPI



ARMENIA



SPAIN



UNITED ARAB
EMIRATES



TYROL



CHINA



authors with the Los Alamos National Laboratory, it was possible to use the world's fastest computer, *Roadrunner*, to simulate the evolution of an aurora under the influence of such a massive solar wind. Apparently, the aurora would assume different shapes than the familiar frivolous waves, rays, and ripples and take on a less scattered, more concentrated form. As its height profile is altered, a column forms that joins the magnetosphere of the earth to the solar wind. Expected structures include pinched ropes of a "sausage" type, helices, concentric circles, filamentary "rays" that intertwine and merge, and the emergence of "plasmoids" shaped like orbs or eggs. As such a configuration achieves a degree of semi-stability, moreover, the event would last considerably longer than ordinary auroral outbursts, allowing petroglyph carvers to depict aspects, depending on their own point of view on earth. The snapshot results of the different stages of the simulated aurora appear to match closely many of the so-called abstract petroglyphs seen around the world. Some of these are juxtaposed here for direct comparison.

So, could these enigmatic petroglyphs be evidence that humans witnessed intense auroral storms in the past? We believe this is the case and have reason to postulate three episodes of auroral activity of this type, accompanied by rock art carving, which occurred between roughly 10,000 and 3,000 BCE. Although it is wise to keep one's feet on the ground at all times, it is also clear that archaeologists could benefit much from lifting their gaze up to the heavens. The sky was as much a part of the ancients' environment as the earth. 🏠

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tude equal to that of an intense aurora, and the computer facilities necessary to model such an event.

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Marinus Anthony van der Sluijs with a petroglyph showing an anthropomorphic creature with two "antennae" (from Chichictara, Palpa Province, Peru).

Anthony L. Peratt at Machu Picchu, Peru.

