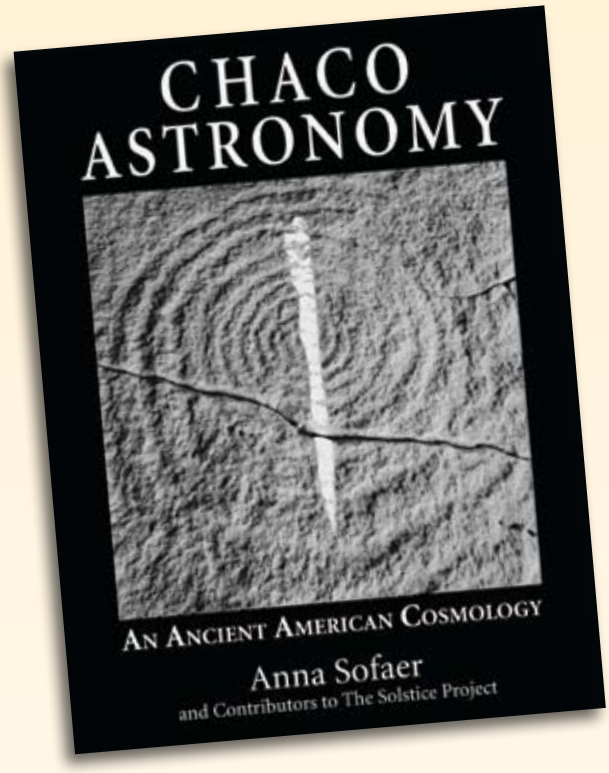


We have underestimated **people's knowledge** of geography and culture **beyond their supposed boundaries.**

Anna Sofaer

With Robert Wilder

Photography by Adriel Heisey

While working on a field project atop Fajada Butte in Chaco Culture National Historical Park in midsummer of 1977, Anna Sofaer witnessed a remarkable phenomenon: a single shaft of light perfectly bisecting a spiral petroglyph carved there centuries ago by the ancestors of today's Pueblo people. Recognizing the significance of this "Sun Dagger" began for Sofaer a three-decade odyssey of intense investigation to recover the astronomical expressions throughout the architecture and rock art of the Chaco culture. Sofaer is the author of the newly published *Chaco Astronomy: An Ancient American Cosmology*, and she produced, directed, and co-wrote two documentaries narrated by Robert Redford: *The Sun Dagger* (1982) and *The Mystery of Chaco* (2000). She is the founder of The Solstice Project and has been its director since 1978.

Wilder: What initially led you to Chaco and your discovery of the Sun Dagger?

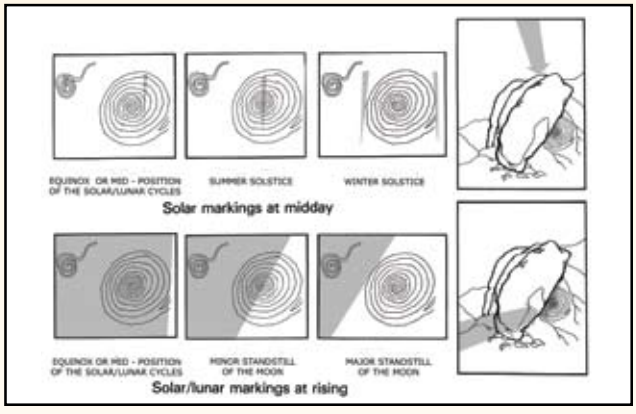
Sofaer: I went to Chaco in June of 1977 because I was fascinated with rock art. I had taken a course in Mayan astronomy that included some images of rock art from the Southwest. I was an artist at the time and was completely spellbound by these images. I subscribed to *La Pintura*, the American Rock Art Research Association newsletter, and replied to a notice that you could be a volunteer in Chaco and record rock art. This was a group run by James Bains, a rock-art scholar and retired colonel from Albuquerque. It was the second day in my life in the desert, and we all woke up and assembled to do our work. The colonel said, "Someone needs to do Fajada Butte," and there it was in the distance. There was an experienced climber—Jay Crotty—who was ready to go and looked as if he had all the right equipment. I said, "I'll go," and we climbed the butte and recorded about twenty-two sites, not quite to the top but near.

We decided to climb to the top that first afternoon and see what was there. We saw a beautiful carved, spiral in the shadow of three leaning large rock slabs, but it was too late in the afternoon to photograph, so we decided to return the next day. We happened to get there near noon, a week from solstice, and a dagger of light was bisecting the spiral. It was formed by one of the openings of the three rock slabs in front

The summit of **Fajada Butte** in Chaco Canyon glows at sunrise, with the three large rock slabs of the Sun Dagger site visible at right on the slope below the highest level of the butte. ©Adriel Heisey. (Inset: close-up ground view of slabs ©The Solstice Project.)

of the spiral. I felt certain it was marking the summer solstice because the sharply pointed light shaft centered on the spiral created such a strong image.

Some earlier experiences in observing shadow and light markings at ancient sites helped me know what I was viewing. Three months before at spring equinox I had been at the Mayan site Chichén Itzá and saw just at sunset a marvelous serpent shadow take shape on the side of the large pyramid El Castillo. The stone serpent head at the base is connected to the top of the pyramid by a rippling shadow that forms its body. Only a month before, Ken Hedges, an anthropologist from San Diego, had presented at a rock-art conference a series of slides that showed a light dagger crossing the eyes of a shaman figure in a cave in Baja. This occurred just as the sun rose at winter solstice. These images came back to me as I saw the dagger descend through the spiral on Fajada on a day close to summer solstice.



Wilder: What did you do after a discovery as important as the Sun Dagger?

Sofaer: I went back to my artwork and worked in my studio, but I kept thinking that I needed to do something with this discovery. So after a while I developed the photos, enlarged the images, and saw that they were more amazing than I had remembered in the searing heat on Fajada. Then I took the photos to my teacher of Mayan astronomy, but he was rather skeptical that this was any more than a daily noon marking.

At this point I knew that I had to work with colleagues who had strong backgrounds in astronomy, archaeology, and other disciplines. I was extremely fortunate in very soon meeting Rolf Sinclair, a physicist at the National Science Foundation, who had a great interest in ancient astronomy. He thought it was an intriguing discovery, and so we started then working in what became a fourteen-year collaboration—at that time first setting out to analyze how the site of the three slabs and the light dagger functioned. We went back to Chaco Canyon in May of 1978 with another key person, Volker Zinser, an architect who had been trained in Germany in the play of shadow and light.

Volker helped us to solve the puzzle of how the light pattern that I originally recorded could move down in a vertical course and at the same time, if the sun were lower, appear farther right on the spiral. We were trying to understand if the dagger was discreetly showing solstice and if other vertical forms would then show other months and weeks by being positioned rightward on the spiral. This was key since I had been told by my former teacher that a vertical band of light appearing on a spiral near noon must be formed by a vertical opening of the slabs, and therefore it wouldn't distinguish where the sun was in its seasonal path.

It was a daunting challenge to prove our theory, but at the same time something in our minds—perhaps from my work as an artist and Volker's as an architect—persuaded us the light dagger was distinctly solstitial; it wasn't simply a band of light every day at noon. By going back to the site five weeks before solstice, we could test our theory. We did find the light dagger an inch and a quarter off the spiral's center, which conveyed that it registered the sun right at the center only at the summer solstice, the highest point of the sun in the year. That affirmed for us that this was an important and unique site. Later in 1978 we found the site marked with other light daggers for the equinox and the winter solstice.

The full moon rises from behind the San Juan Mountains in southern Colorado. **Chimney Rock** Pueblo, a Chacoan ruin, can be seen at lower center frame. The moon rises between the pinnacles of Chimney Rock as seen from the Pueblo only at the major standstill in its 18.6-year cycle. ©Adriel Heisey.

Wilder: How did you then make the connection that there might be a correlation with the moon as well as the sun?

Sofaer: We began to observe that the light of the moon formed patterns on the spiral just as the sun does. I began to study the lunar standstill cycle with help from LeRoy Doggett, an astronomer at the US Naval Observatory, who had profound knowledge of "celestial mechanics." LeRoy was initially both intrigued and skeptical about claims of lunar markings at the site, but as the evidence developed, he became convinced of its lunar significance. In 1979 we recorded how at one extreme in the moon's eighteen- to nineteen-year cycle (the minor standstill), the eastern slab forms a shadow that bisects the spiral just as the moon rises; and at its other extreme, nine- and-half years later (the major standstill), the shadow of the rising moon falls on the left edge of the spiral. In each case these shadows align with pecked grooves. These findings were very strong for LeRoy as well as for Rolf and me. We presented together our paper on the lunar markings at the first International Conference on Archaeoastronomy at Oxford University.

Soon after that Phillip Tuwaletstiwa, a Hopi man who was deputy director of the National Geodetic Survey, suggested that with their help we develop a survey of the major buildings of Chaco. We soon learned from the NGS survey that many of the major buildings are aligned to the extreme and mid-positions of the solar and lunar cycles.

This was quite astounding to us, and we then worked with Joey Donahue, a physicist at Los Alamos Laboratory, to conduct chance analysis to see whether these alignments could be random. We found that twelve out of the fourteen buildings are oriented to the extremes or the mid-positions of the solar and lunar cycles, the same solar and lunar positions that are marked on Fajada. It was not chance.

Through these studies two people gave important cultural context for our findings. When Alfonso Ortiz, a brilliant anthropologist of San Juan Pueblo, saw our slides of just the sun markings on Fajada, he said emphatically, "Where the sun is so marked, so would be the moon." He explained that the sun and moon are held in complementary relationships in the myths and ceremonies of the Pueblo cultures. And when Joseph Campbell saw our slides of the solar markings—and the new lunar markings that we had just found at the site—he spoke of how cultures universally seek to unite the symbolic powers of the sun and the moon. He described them as two concepts of time: the sun as absolute eternal time and the moon as cyclical time related to birth, life and death, and return.

South wall of **Pueblo Bonito** at sunset. The equinox setting sun aligns with the south wall of Pueblo Bonito in Chaco Canyon. ©Adriel Heisey.

This low aerial view of **Pueblo Bonito** shows the alignment of the south wall with the equinox setting sun. ©Adriel Heisey.

In the late 1980s, J. McKim Malville, an astronomer at the University of Colorado, made a remarkable finding that helped to affirm—with totally independent evidence—the Chacoans' widespread interest in the moon. He documented how Chimney Rock, a Chaco building set high on a precipice ninety miles northeast of Chaco, is aligned to the major standstill moon. As viewed from the building, at only this time in its eighteen- to nineteen-year cycle, the moon rises in the center of a window formed by two nearby rock towers. We were able to photograph this magnificent view from the air at the midwinter full moon of 2006.

Wilder: Through your discoveries comes speculation that perhaps Chaco was not a residential area, as previously thought, but more of a religious pilgrimage center.

Sofaer: My research corresponds with this theory, but really the people responsible for that new understanding are archaeologists—most Chaco archaeologists have now moved in that direction. When I first came to Chaco, the prevailing belief was that about 10,000 people had lived there, an estimate based on the great number of rooms in the large buildings. Recent archaeological findings, however, demonstrate that the buildings were not lived in or perhaps only minimally occupied. Most rooms had no ventilation, no hearths, many were sealed, and most are far, far larger than the rooms of domiciles of that time. Few corncobs and *metates* were found in the buildings. The mounds near the buildings, which were thought to be middens, have been found to have no organic material. Fewer than 500 burials had been found in the canyon; all the conditions you think of as related to residential living are absent in the great houses of Chaco. Now archaeologists believe fewer than 1,500 people lived in Chaco at any one time.

Wilder: What about the idea of Chaco as a commercial center?

Sofaer: Not much evidence of commerce either. The Chaco Research Center excavated Pueblo Alto in the late 1970s—a big project—thinking they'd find the marketplace of Chaco. It made sense because many roads connect there; it was a great idea, but again they found very few hearths, very few signs of people living there, very little activity that could explain a marketplace. There is a broad network of roads in Chaco and extending out of it, which had supported the hypothesis of Chaco as a trade center—the thinking was that the roads must have been for transporting goods and people. That belief has also changed.

In the mid-1980s I learned from archaeologists who were studying the roads that they weren't finding evidence of encampments along them and that the roads' engineered construction was far more elaborate than people would need for trade and transportation. The roads are thirty feet wide, stretching straight across the desert up to thirty-five miles—

sometimes in parallel courses. They often do not connect resources or communities to the center of Chaco.

We began our own study of the thirty-five-mile Great North Road, suspecting that its direction was astronomically important. I was privileged to work with Mike Marshall, a very insightful archaeologist who had in-depth experience studying Chaco sites. We found that the road took a course directly north to the steepest edge of a badlands canyon, Kutz Canyon, and a large promontory. We discovered a staircase descending the slope and strewn with numerous broken pots. In Pueblo culture breaking pots is ceremonial. It appeared that the road had been constructed for the purpose of commemorating the direction north and a significant topographic feature. We wrote that it was built as a "cosmographic expression" and presented our paper to the Second Oxford International Conference on Archaeoastronomy.

We shared our findings with several Pueblo people. Paul Pino, a war chief of Laguna Pueblo, spoke of the great spiritual significance that roads and the direction north hold for his people. The late Edmund Ladd, an archaeologist of Zuni, said that for the Chaco people the Great North Road might have been the place of their emergence and of the return of their spirits of the dead.

As you mentioned, Chaco is now understood to have been a pilgrimage center serving a vast area of perhaps up to 70,000 square miles. Perhaps the pilgrimages to Chaco were timed to the cycles of the sun and the moon. The people may have come there at key times to witness events of the sun and the moon, such as solstices and lunar standstills. The many great kivas and the hundreds of smaller ones were used by thousands of people conducting ceremonies, in part honoring the sun and the moon. Paul Pino speaks eloquently in our film *The Mystery of Chaco Canyon* of the people of Chaco having "great spiritual power and power over other people." It may have been a power imbued with exquisite knowledge of the cycles of sun and moon.

Wilder: What are you and The Solstice Project currently working on?

Sofaer: This summer I will continue working with Ben Luce, a theoretical physicist, who is conducting research with our new interactive computer graphics model of the Sun Dagger site. He asked how complex and planned was the work to develop the site. His experiments with the model suggest that the people tightly coordinated several variables to create the light markings, such as shaping the slabs and the cliff face and adjusting the slabs, to cast the shadows that create the light markings.

I also have a book under way with Adriel Heisey, an extraordinary aerial photographer. The book will show from the air and in graphics how the buildings are aligned at the actual times of the rising and setting suns and moons. Adriel has completed most of these photos [some appear here], and the images are stunning. They allow the viewers to witness themselves what the Chacoans embedded in their buildings and held in their mind's eye. In this book we will also explore new areas such as the question of the Chacoans' awareness of geography.

In addition, The Solstice Project has proposed a seminar, "Latitude and Parallels," with colleagues in Mesoamerican studies who have made similar findings of sun and moon markings and building orientations in Mayan and other ruins. There is evidence at these sites, as there is in Chaco, that ancient Americans had concepts of latitude and geography that may have influenced their choice of locations for their large ceremonial complexes.

It's exciting for me to work with Mesoamerican scholars because they so appreciate culture, symbolism, and cosmology. They're not afraid to explore and articulate those aspects of the sites they study. There's a tendency to oversimplify Chaco by North American scholars because the Chacoans did not leave written records, as did the Mesoamericans.

I don't want to suggest that similar expressions in the constructions in Chaco and Mesoamerica developed from direct contact with astronomers from the south or from the influence of a great astronomer priest who came from Mexico City or Palenque to Chaco—we don't know that—but I'm fascinated that complex expressions of cosmology were so much the norm in ancient America. The people of Chaco developed one orderly pattern reflecting the universe, while their neighbors expressed variations in their understanding of the cosmos. It would have been of great interest to the Chacoans to know what calendrical systems were used to the south, north, east, and west of them. We have underestimated people's knowledge of geography and culture beyond their supposed boundaries. Shared astronomies may have created binding relationships. Our seminar will explore these questions.

Wilder: How would you sum up your work?

Sofaer: I think I spent most of my energy on judgment. It isn't the actual writing; it isn't the field trips or the measurements or all those calculations that go into it. It's trying to find the most appropriate presentation of the material so that it honors the traditions of the Pueblo people and the science of Chaco but, at the same time, does not exploit or sensationalize. I don't interpret Chaco symbolically or spiritually. My policy—and it feels right—from the beginning is simply to share what we have found. When you share, people appreciate it. In the end, it's just the right thing to do, especially with something this important. ■

Robert Wilder's essays have appeared in *Newsweek*, *Details*, *Salon*, and *Creative Nonfiction*. His column "Daddy Needs a Drink" appears monthly in the *Santa Fe Reporter*, and he is the author of two books, *Daddy Needs a Drink* and *Tales from the Teachers' Lounge*.