The Sun Dagger

Teaching Guide

by Don Reid

THE SUN DAGGER

Discovery of a prehistoric Pueblo Indian
calendar system in Chaco Canyon, New Mexico

Writer/Producer:	ANNA SOFAER
Director/Editor:	ALBERT IHDE
Photography:	ROBERT KAYLOR KARL KERNBERGER
Narration:	ROBERT REDFORD
Music:	MIKE IHDE

Distributed by: Bullfrog Films, Oley, PA 19547 (215) 779-8226
Available in two versions: 58 minutes and 29 minutes
Formats Available: 16mm film, ¾" U-Matic and ½" VHS or Beta videocassette
Transcript available for 58-minute version - $5.
Teachers guide - additional copies - $2 each.

Contents

* Please make as many copies of the *
centerfold **Student Handout** as you need.

Introduction & Curriculum

THE SUN DAGGER is a general audience film, introduced and narrated by Robert Redford, which tells the story of Washington artist Anna Sofaer's exciting discovery and subsequent investigation of a prehistoric American Indian solar/lunar calendar located atop a high butte in Chaco Canyon, New Mexico. The calendar marks the seasonal solstices and equinoxes in vivid symbolic images of light and shadow on stone, a subtle integration with nature that is typical of North American Indian cultures. Filmed on location in the Chaco Culture National Historic Park, THE SUN DAGGER also examines the life and culture of the Anasazi (ancient Pueblo) Indians who built the calendar and thrived in the arid canyon environment a thousand years ago. Educators particularly interested in mythological and religious aspects of American Indian culture are recommended to use the longer 58-minute version of this film. For grades 7 through 12, the following applications are suggested:

social studies (history, civilization, geography & archaeology):
- a unique cultural achievement of a sophisticated group of prehistoric American Pueblo Indians
- a cultural artifact that reveals information about its builders, and their integration of art, science, and religion
- an example of cultural and physical adaptation to an arid environment
- one early method of calculating the passage of time
- early use of an astronomical calendar for ceremonial and agricultural purposes
- comparison of Sun Dagger calendar to Stonehenge & other prehistoric sites
- importance of preserving this national historic site
- description of a high desert plateau region (6000 feet)

earth sciences (astronomy, geometry, geology, environment):
- observation of the sun and moon to mark passage of time
- introduction to solstice and equinox events
- introduction to archaeoastronomy
- an early development in astronomical observation & calendar making
- geometry & alignments of a prehistoric solar/lunar calendar
- use of objects & events from the natural environment for calendar making
- steps in the procedure of scientific inquiry

Lesson Plan & Learning Objectives

LESSON PLAN [29-minute film: grades 7 - 12]

These suggestions are offered independently of any specific curriculum

LEARNING OBJECTIVES: Students should be able to:

1) Locate Chaco Canyon and the Four Corners area on a map.
2) State the circumstances of the Sun Dagger discovery: who, where, when, and how.
3) Identify the culture which built the Sun Dagger, including name, approximate time period, and geographic region.
4) List the special interests that led Anna Sofaer to her discovery.
5) Describe what the Sun Dagger marks are and how it differs from other prehistoric calendars.
6) Explain the concepts of solstice and equinox.
7) Define archaeoastronomy as it relates to the Sun Dagger.
8) State the contributions of the other researchers to Anna Sofaer's investigation of the Sun Dagger.

TEACHER PREPARATION:

1) Obtain or prepare a MAP of the Four Corners area. (See page 6)
2) Select KEY CONCEPTS applicable to your curriculum.
3) Select VOCABULARY terms requiring discussion or study.
4) Prepare comments on PARTICIPANTS appropriate to your class. [See Review Questions #05.] Consider your opportunity to discuss the relevant careers.
5) Select REVIEW QUESTIONS appropriate to your curriculum.
6) Evaluate the MARKINGS and IMAGES exercises for class use.

PREVIEWING ORIENTATION:

1) Read or paraphrase the FILM SUMMARY.
2) Locate Chaco Canyon on the MAP in relation to other places of significance in the Four Corners region.
3) Announce LEARNING OBJECTIVES, or what you expect students to learn from the film.
4) Introduce the film PARTICIPANTS.
5) Define any VOCABULARY terms needing introduction.

POSTVIEWING REVIEW & FOLLOW-UP:

1) Insure solstice and equinox are understood; these are the events which the Sun Dagger marks [MARKINGS exercise].
2) Review additional VOCABULARY terms if necessary.
3) Review CONTRIBUTIONS of the film participants [Review Question #05].
4) Reinforce learning objectives using REVIEW QUESTIONS.

Film Summary

Near midday in late June of 1977, while on a field trip to record Indian rock art atop a high butte in Chaco Canyon, New Mexico, artist Anna Sofaer was amazed to see a thin shaft of sunlight slowly streaming across an ancient spiral rock carving, and immediately suspected that she had found something extraordinary. Already a student in the astronomy of ancient cultures, she wondered, "Why does this vertical form of light move downward when the sun is obviously passing horizontally overhead?" To help her analyze this phenomenon, she enlisted the help of specialists in archaeoastronomy, architectural design, geology and anthropology. After months of thorough investigation, the researchers learned that the site precisely marks the seasonal solstices and equinoxes, and the extreme positions of the moon's nineteen year cycle. They now believe this to be the first ancient calendar found in the New World that marks –at one site–the extreme positions of both the sun and the moon.

Because such knowledge is far beyond what scientists previously believed possible for these early people, Anna re-examines the Anasazi Indian culture that built this remarkable calendar and thrived in the harsh Chaco Canyon environment a thousand years ago. Ultimately, she asks us to recognize our responsibility for preserving the Sun Dagger, and to realize that as we gobble up the coal and uranium that lie beneath their exquisite ruins, the "Ancient Ones" still challenge us to emulate their example of harmonious living on Planet Earth.

Key Concepts

01. Anna Sofaer's interest in photography, rock art, and archaeoastronomy led her to discover the Anasazi Sun Dagger and to recognize its significance.
02. Sofaer's investigation of the Sun Dagger follows the basic process of scientific inquiry: discovery, theory, model, experiment, and proof.
03. Anna sought the cooperation and support of other professionals to help her research the facts about the Sun Dagger.
04. The Sun Dagger is uniquely different from other New World prehistoric calendars.
05. The Anasazi observed and marked the seasonal solstices and equinoxes and may have used them to regulate their agricultural and ceremonial calendars.
06. Studying how the Anasazi used their calendar to relate to the sun and moon falls within a newly defined science called archaeoastronomy.
07. A knowledge of astronomy, as evidenced by the Sun Dagger, is consistent with other Anasazi cultural achievements in art, architecture, agriculture, trade, and communication.
08. Their use of natural materials and setting for the Sun Dagger suggests the Anasazi lived in harmony with their environment.
09. Intensive coal and uranium mining pose a new threat to preservation of the Chaco Canyon environment and the Sun Dagger site. *

* Long version only

Participants & Contributions

ANNA SOFAER [artist]

With her multi-media background in painting, sculpture, photography (sculptural photo-montage), rock art and archaeoastronomy, Washington artist Anna Sofaer was uniquely prepared to respond to the "dagger of light" and to recognize its significance. She wrote and produced the Sun Dagger film to tell its story and is founder and director of the Solstice Project to protect the calendar site, and continues research of Southwestern archaeoastronomy.

ROLF SINCLAIR [physicist]

Dr. Sinclair is director of the Atomic, Molecular and Plasma Science Program, Physics Division, National Science Foundation in Washington, DC. An experimental research physicist with specialties in instrumentation design and use, and laboratory planning and administration, he has extensive knowledge of archaeoastronomy. "In his analysis of the geometry and alignments of the site, he has provided an invaluable objective, scientific approach – an honest and creative skeptic!" (Sofaer)

VOLKER ZINSER [architect]

A Washington design architect whose studies have included special investigation into the nature of light and shadow formation, "Volker was instrumental in our analysis of the slab geometry and its control of light across the spiral. With his great capability to conceptualize the three dimensions of the site – and the fourth, of time and moving light – he was able to conceive a laboratory model of the slabs which gave us an explicit hypothesis to test at the site." (Sofaer)

ALFONSO ORTIZ [anthropologist]

Dr. Ortiz was among the first to support Anna Sofaer's belief in the possibility of lunar alignments in the Sun Dagger calendar. Born and raised a Tewa Indian of the San Juan Pueblo, he is professor of Anthropology, University of New Mexico at Albuquerque. An educator and author with unique understanding of traditional Pueblo culture, art, religion and social organization, he is an active participant in contemporary Indian affairs.

JOSEPH CAMPBELL * [mythologist]

A prolific New York author, educator, lecturer and scholar of mythology, symbolism and mysticism in both Eastern and Western primitive cultures, Joseph Campbell examines the Pueblo worship of sun and moon as expressed in the Sun Dagger calendar and suggests parallels in other ancient cultures worldwide.

HAROLD LITTLEBIRD [poet/songwriter]

Currently living near Taos, Littlebird is a native New Mexican Pueblo Indian potter, poet and songwriter of the Santo Domingo and Laguna Pueblos. Although deeply concerned about exploitation of ancestral sacred sites by outsiders, he was the first Pueblo Indian to discuss with Anna the cultural, artistic and religious implications of her discovery, based on his knowledge of traditional stories, songs, and legends.

* Long version only

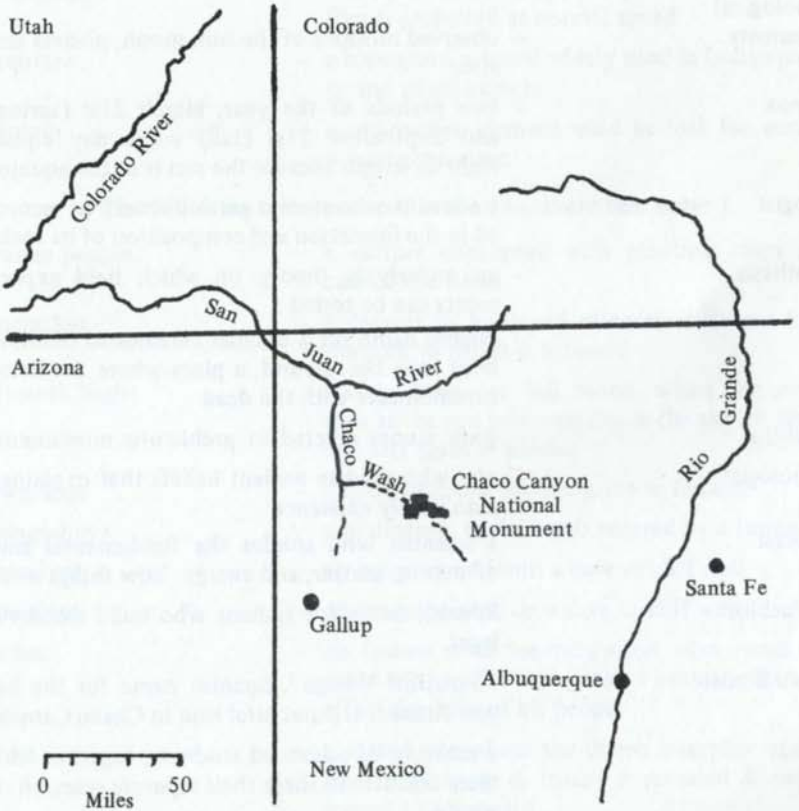
JANE McGRATH [expedition leader]

A professional expedition leader and organizer for several years with the Outward Bound organization in Santa Fe, Jane McGrath is a multi-faceted personality of great versatility and flexibility. Her logistical support was crucial to the success of the filming project and Anna's on-site research. Jane is now a pre-med student.

ROBERT REDFORD [actor]

Award winning actor, writer, director and producer for stage, screen and television, Redford is perhaps less recognized for his significant contributions to many envirnomental, conservation, political and social issues. An ardent supporter of Anna Sofaer's project, he assisted in the preparation of the narration which he so eloquently reads.

Map



Vocabulary

Anasazi	– Navajo name for the prehistoric Pueblo Indians (anatsazi, "the ancient enemy")
anthroplogist	– one who studies the nature of man as revealed by his art, history, language, culture, environment and social relationships
archaeologist	– one who studies artifacts and remains of ancient people
archaeoastronomy	– a newly defined science which studies how ancient people used special sites (like Sun Dagger) to relate to orderly movements of the sun, moon, planets & stars
bisect	– to divide (the spiral) into two equal halves
butte	– a small flat-top hill or mountain usually isolated
cosmos	– Greek word for systematic order of the universe
cosmological movements	– observed motions of the sun, moon, planets and stars
equinox	– two periods of the year, March 21st (spring) and September 21st (fall) when day equals night in length because the sun is at the equator
geologist	– a scientist who studies earth's history as recorded in the formation and composition of its rocks
hypothesis	– an underlying theory on which field experiments can be tested
kiva	– Pueblo name for a circular ceremonial chamber built into the ground, a place where the living communicate with the dead
megaliths	– giant stones erected in prehistoric monuments
mythologist	– one who studies ancient beliefs that explained man's early existence
physicist	– a scientist who studies the fundamental laws of nature, matter, and energy: how things work
the Pueblos	– Spanish name for Indians who build stone villages
Pueblo Bonito	– "Beautiful Village", Spanish name for the largest Anasazi architectural ruin in Chaco Canyon
seminar	– a meeting of advanced students, together with their teacher, to share their separate research or studies
symposium	– a meeting at which experts read papers on the same or related topics

Stonehenge – a prehistoric circle of stones aligned to summer solstice sunrise in England

solstice – the time when the sun "stands still" at its greatest distance from the equator and begins to turn back to the equator

NOTE: The solstice and equinox events result from the tilt of earth's axis relative to earth's orbit around the sun, not from independent movements of the sun itself.

summer solstice – June 21st, the longest day of the year, when the sun sets farthest to the north

winter solstice – December 21st, the shortest day of the year, when the sun sets farthest to the south

tangent – touching (the spiral) at a single point along an edge

time-lapse photography – filming events at slower than normal time intervals such that they appear speeded-up when the film is projected at normal speed

turquoise – a blue-green mineral widely used in Indian jewelry and ritual objects

uranium – a radioactive element used as fuel for nuclear power generation

[The following terms are used in the 58-minute film only:]

agrarian people – a culture concerned with planting crops and care of the fields

concretion – a deposit of hardened minerals different from the rock in which it is found

Fifteenth Night – Navajo term for full moon, when the moon rises as the sun sets, remains in the sky all night, and sets again at sunrise

Newgrange – a 6000-year-old passage-grave in Ireland

passage-grave – a prehistoric burial tomb entered by a tunnel

petroglyph – an image carved into a cave or cliff wall

pictograph – an image painted on a cave or cliff wall

shaman – an Indian medicine-man/priest who communicates with spirits and gods to heal or otherwise affect the lives of his people

shrine – a sacred site where the divine interplay of cosmic movements & forces is revealed & experienced [Campbell]

ziggurat – an ancient Babylonian pyramidal tower with a shrine at the top

Review Questions (Answer Key)

[see Review Questions Handout page 11]

references to KEY CONCEPTS

01. The dagger of light is visible for only eighteen minutes at midday. [Concepts 01, 04]

02. The Sun Dagger was built by prehistoric Pueblo Indians known as Anasazi in approximately A.D. 1000 in Chaco Canyon, N.M.

03. From the Navajo word anatsazi which means "the ancient enemies." [The Navajo moved into the Four Corners region long after the Anasazi Pueblos had left. They are not related tribes.]

04. Photography, Indian rock art, and archaeoastronomy.

05. Physicist: analyzed geometry and alignments of the site.

Architect: conceived a model and hypothesis to demonstrate how the slabs form the daggers of light across the spirals.

Anthropologist: recommended research for lunar alignments at the site.

Mythologist*: examined parallels to the Sun Dagger calendar found in other prehistoric cultures.

Expedition leader: organized logistic support for research and filming in Chaco Canyon, an undeveloped historic park.

Geologist: analyzed fracture patterns in the rock slabs and found a concretion which offers evidence that the Anasazi purposely moved the slabs.

Poet/Songwriter: first Pueblo Indian to assist Anna Sofaer with cultural interpretation of the Sun Dagger site.

06. She questioned why the dagger of light could be moving vertically downward when the sun is moving horizontally across the sky. [Concepts 01, 04]

07. a) It utilizes the changing height of the sun at midday. (Other calendars mark positions of the sun or moon at the horizon.) [Concept 04]

* Long version only

b) It changes horizontal movement of the sun's path across the sky into vertical motion of the daggers across the spirals.

c) It marks the extreme positions of both the sun and moon at one site.

d) It is made from natural materials on the butte: it does not appear to be a man-made structure.

08. a) In winter the sun is low in the sky, but in summer it is very high, thus the sunlight falls on the calendar at different angles. [Concept 05]

b) Summer solstice is June 21st, the longest day of the year, when the sun moves farthest to the north and summer begins.

c) Winter solstice is December 21st, the shortest day of the year, when the sun moves farthest to the south and winter begins.

d) The solstice and equinox events result from the tilt of earth's axis relative to earth's orbit around the sun, not from movements of the sun itself.

09. a) Equinox marks the time when the sun passes above the equator, which is the same point in the sky in either spring or fall, thus the equinox sunlight always falls on the calendar at the same angle. [Concept 05]

b) There are two equinoxes each year: March 21st (spring) and September 21st (fall) when day equals night in length because the sun is above the equator.

10. a) the dart of light passing across the shaman's eyes (cave pictograph) [Concept 05]

b) light passing through windows onto specially marked opposite walls

c) movements of shadows cast by large rock formations

11. The geologist, by matching a concretion deposit in the slabs to the same occurrence in the cliff face, showed their original positions were too low and far to the left of where they now rest: they had to have been moved. [Concepts 02, 03, 04, 08]

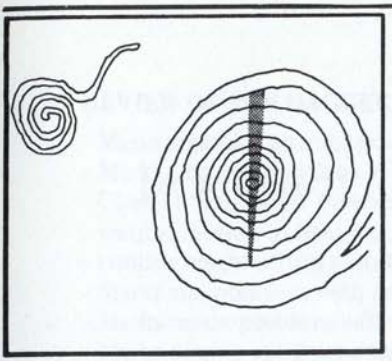
(Continued on page 13)

Review Questions Handout

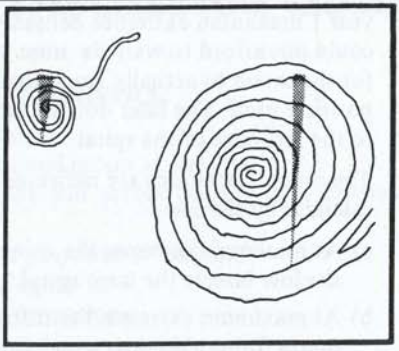
01. Why did no one recognize the Sun Dagger before 1977?
02. Who built the Sun Dagger? Approximately when did they build it and where is it located?
03. What is the origin and meaning of the name Anasazi?
04. What special interests and abilities led Anna Sofaer to her discovery of the Sun Dagger?
05. Who were the professionals who helped Anna Sofaer investigate the Sun Dagger site, and what were their special contributions?
06. What observation led Anna Sofaer to suspect the moving dagger of light was something more than just a noon marker?
07. Name four ways the Sun Dagger differs from other prehistoric calendars in the New World.
08. How does the Sun Dagger mark the winter solstice differently from summer solstice? Explain when and why these events occur.
09. Why does the Sun Dagger mark the two equinoxes the same way? When do the equinoxes occur and why?
10. What other methods does the film suggest the Indians used to mark the passage of time in Chaco Canyon?*
11. What convinced the researchers that the Anasazi purposely moved the two-ton slabs into position, that they hadn't merely fallen there naturally?*
12. What was demonstrated with the laser and why was it necessary for the researchers to use it?
13. How does the Sun Dagger calendar mark the minimum and maximum extremes of the moon's nineteen year cycle?
14. What is archaeoastronomy?
15. What evidence are we shown that the Anasazi were concerned with things other than just getting food into their stomachs?
16. What is the Pueblo Indian kiva?
17. What does Pueblo Indian poet/songwriter Harold Littlebird mean when he warns Anna, "You have a big responsibility now"?
18. What new danger threatens the existence of the Sun Dagger?

* Long version only

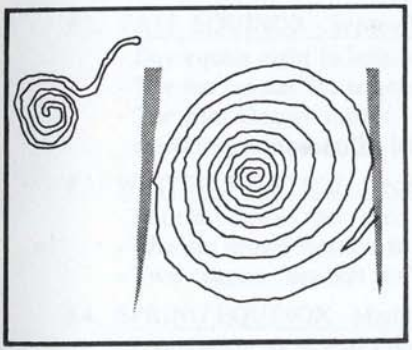
Markings Illustrations Handout



#1. SUMMER SOLSTICE - June 21st
- Longest day of the year.
- The sun moves farthest to the north.
- The Sun Dagger bisects the large spiral at midday.



#2. FALL EQUINOX - September 21st
- Day equals night in length, because
- The sun crosses the equator.
- The Sun Dagger moves to the middle of the large spiral's right side; the small dagger bisects the left spiral.

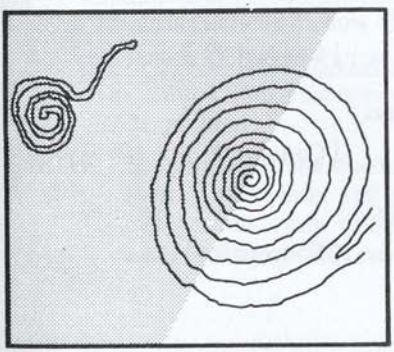


#3. WINTER SOLSTICE - December 21st
- Shortest day of the year.
- The sun moves farthest to the south.
- Two daggers "bracket the spiral, holding it empty of light" [Sofaer]

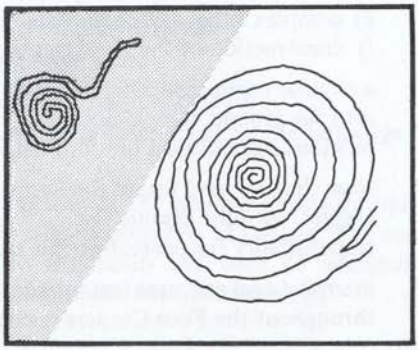
#4. SPRING EQUINOX - March 21st
(same marking as Fall Equinox, #2)

#5. MOON'S MINIMUM EXTREME
- The rising moon's shadow bisects the large spiral. [in nineteen year cycle]

#6. MOON'S MAXIMUM EXTREME
- The rising moon's shadow falls tangent (at laser dot) to the left edge of the large spiral. [in nineteen year cycle]



#5



#6

12. After calculating the correct angle, the researchers used the laser to simulate the light of the rising moon at its [nineteen year] maximum extremee because they could not afford to wait six more years for the moon to actually reach that position itself. The laser dot fell tangent to the left edge of the spiral. [Concepts 02, 03, 04]

13. The moon's positions are indicated on the calendar by shadows: [Concepts 04, 06]

    a) At minimum extreme, the rising moon's shadow bisects the large spiral.

    b) At maximum extreme, the rising moon forms a shadow which lies tangent to the left edge of the large spiral.

    c) The minimum and maximum extremes of the moon's nineteen year cycle are roughly equivalent to the winter and summer solstice positions of the sun.

    d) It takes nineteen years for the moon to move from minimum to maximum and back to minimum again, thus the spiral has nineteen rings.

14. Archaeoastrony is a newly defined science, combing archaeology and astronomy, which studies how ancient people used special sites like the Sun Dagger to relate to the sun, moon, and stars. [Concept 06]

15. a) elaborate stone architecture (built without writing or math)
    b) complex road network (to allow import and trade goods) [Concept 07]
    c) artistic jewelry, ceramics, and weaving
    d) run-off water irrigation systems
    e) complex ritual and ceremonial life
    f) construction of the Sun Dagger calendar

16. a circular ceremonial chamber built into the ground, a focal point of religious and political life for Pueblo Indians. [Concept 07]

17. Now that we have found the Sun Dagger, we must assume the responsibility for protecting this sacred site. [Concept 09]

18. intensive coal and uranium mining throughout the Four Corners region. [Concept 09]

Sun Dagger Markings - Discussion Guide

REVIEW OF SUN DAGGER CHARACTERISTICS:

- Marks solstices, equinoxes and seasons.
- Marks extreme positions of both sun and moon at one site.
- Changes horizontal movement of the sun across the sky into downward vertical motion of light-daggers.
- Utilizes height of sun at midday, not positions at horizon.
- Marks sun positions with daggers of light.
- Marks moon positions with shadow formations.
- Marks cosmic events at a sacred site.
- Relates cosmic events to everyday life on earth.

#1. SUMMER SOLSTICE - June 21st

- Longest day of the year.
- The sun moves farthest to the north.
- The Sun Dagger bisects the large spiral at midday.

#2. FALL EQUINOX - September 21st

- Day equals night in length, because
- The sun crosses the equator.
- The Sun Dagger moves to the middle of the large spiral's right side; the small dagger bisects the left spiral.

#3. WINTER SOLSTICE - December 21st

- Shortest day of the year.
- The sun moves farthest to the south.
- Two daggers "bracket the spiral, holding it empty of light" [Sofaer]

#4. SPRING EQUINOX - March 21st

(same marking as Fall Equinox, #2)

NOTE: Solstice and equinox events result from the tilt of earth's axis relative to earth's orbit around the sun, not from independent movements of the sun itself.

#5. MOON'S MINIMUM EXTREME [in nineteen year cycle]

- The rising moon's shadow bisects the large spiral.

#6. MOON'S MAXIMUM EXTREME [in nineteen year cycle]

- The rising moon's shadow falls tangent (at laser dot) to the left edge of the large spiral.

NOTE: The minimum and maximum extremes of the moon are roughly equivalent to the winter and summer solstice positions of the sun. The complete moon cycle (minimum to maximum and back to minimum) takes nineteen (18.6) years. The large spiral has nineteen rings.

Images Exercises

Deriving Key Concepts By Recalling Images And Statements From The Film

As you read each image description to your class, ask students to volunteer their associations or memories from the film. There are no right or wrong answers but students should offer reasons for their interpretations. You might preface each image with the question, "Do you remember . . .".

A. THE THREE ANCIENT SPIRALS CARVED ON A GIANT GRAY STONE*
"That triple spiral carved on the walls of the inner chamber of the tomb [Newgrange] is lit by light just at winter solstice sunrise as a kind of symbol of rebirth." [Sofaer]

"Spirals are the most common design in Chaco Canyon rock art, and to find a site of rock art, even today, gives me a feeling of joining, in a way, the ancient people who linked themselves to earth and sky." [Sofaer]

CONCEPT 01: Anna Sofaer's interest in photography, rock art, and archaeoastronomy led her to discover the Sun Dagger and to recognize its significance.

B. THE COILED RATTLESNAKE WAITING IN THE ROCKS
"The Pueblo Indians believe the rattlesnake is a protector and guardian of sacred sites." [Narrator]

"In Pueblo origin traditions, all life, including human life, ultimately results from happenings within the earth. The idea is that of emerging from a prior world beneath this one." [Ortiz]

CONCEPT 08: Their use of natural materials and setting for the Sun Dagger suggests the Anasazi lived in harmony with their environment.

C. THE NATURAL APPEARANCE OF THE THREE ROCK SLABS LEANING AGAINST THE CLIFF (i.e. they do not look like a man-made structure)
"It's very Indian somehow that something as casual as the placement of these slabs should yield such a precise, exact astronomical observation post. It all melts right into the natural environment." [Campbell]

"One of our greatest difficulties in determining whether or not the slabs were moved was their subtle appearance resting here on the cliff face. In fact, archaeologists and geologists have come up the trail right by the slabs but wouldn't necessarily look in and see the spiral or notice the slabs to be anything but more rocks." [Sofaer]

CONCEPT 04: The Sun Dagger is uniquely different from other prehistoric calendars [Compare Review Question #07.]

CONCEPT 08: Their use of natural materials and setting for the Sun Dagger suggests the Anasazi lived in harmony with their environment.

* Long version only

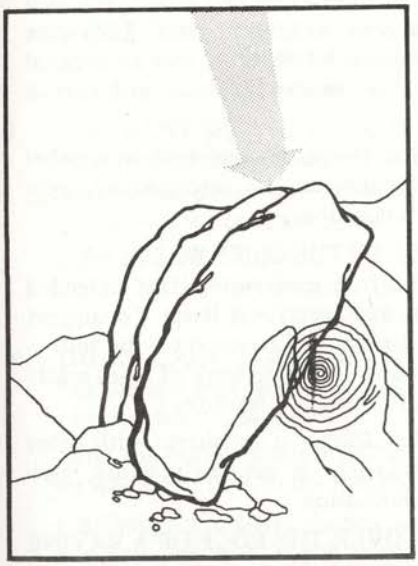
D. ARCHITECT VOLKER ZINSER MAKING CLAY MODELS OF THE SLABS

The architect made clay models of the slabs in order to demonstrate his theory that the slabs had to be curved to make the sunlight move vertically downward across the spirals. Anna questioned him, "How is it possible?" and he said, "Well, you'll need some kind of curved surfaces."

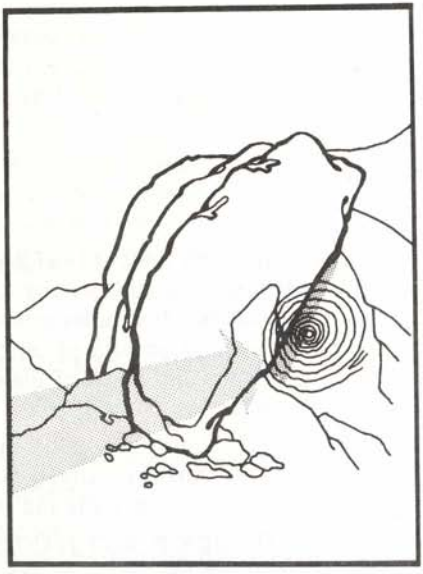
"I thought, 'Had we imagined this entire theory?' until the next morning when we came back to see, as the light went down through the spirals, that the edges forming the light were indeed curved." [Sofaer]

CONCEPT 02: Sofaer's investigation of the Sun Dagger follows the basic procedure of scientific inquiry: the researchers built a model to demonstrate their theory.

CONCEPT 03: Anna sought the cooperation and support of other professionals to help her research the facts about the Sun Dagger.



Solar markings
at Midday



Solar/lunar markings
at rising

E. HOW THE SUN FORMS AN ARC ACROSS THE SKY AS IT PASSES FROM SUNRISE TO SUNSET

"The Sun Dagger on Fajada uses the height of the sun at midday, whereas almost all the [other] known solstice marking sites in the New World use the position of the rising or setting sun on the horizon." [Narrator]

"How they worked that thing out so the winter solstice has two spears coming down, the summer only one – just the way of capturing the light and translating its horizontal movement into a vertical one – it's a mechanical feat, really, that is itself worthy of great, great respect." [Campbell]

CONCEPT 04: The Sun Dagger is uniquely different from other prehistoric calendars. [Compare Review Question #07.]

CONCEPT 06: Studying how the Anasazi used their calendar to relate to the sun and moon falls within a newly defined science called archaeoastronomy.

F. THE LARGE CIRCULAR ROOMS LYING EMPTY IN THE GROUND

"The structure predominant in Chacoan architecture is the kiva, a ceremonial chamber built into the ground . . ." [Narrator]

"The kiva has always been, so far as we know, the place where the living communicate with the dead. Pueblo peoples have always been known to have very complex cycles, dances, ritual observances and schedules which are based upon very accurate observations of the sun and moon. They were preoccupied with their place in the cosmos where there was an ordered scheme of things governing their lives from season to season and year to year." [Ortiz]

CONCEPT 07: Construction of the Sun Dagger is consistent with other Anasazi cultural achievements in art, architecture, agriculture, trade and communication.

G. THE STAIRSTEPS CARVED STRAIGHT UP THE CLIFF WALL

"The cliff stairsteps connect the canyon to a road system that extended more than one hundred miles across the San Juan River Basin. To support themselves in such an arid place, the Anasazi had to import – by foot – lumber, ceramics and much of their food over this network of roads reaching south to Mexico and west to the Pacific coast." [Narrator]

CONCEPT 07: Construction of the Sun Dagger is consistent with other Anasazi cultural achievements in art, architecture, agriculture, trade and communication.

H. THE DEAD CORN PLANT HANGING OVER THE EDGE OF A RAVINE

The canyon growing season is very short, but the corn plant needs more than three months to mature, so perhaps the Pueblos developed a planting calendar by observing the sun on the horizon and in shadow and light patterns. [from Narration]

CONCEPT 05: The Anasazi observed and marked the seasonal solstices and equinoxes and may have used them to regulate their agriculture.

I. PHYSICIST ROLF SINCLAIR FIRING THE LASER AT THE SPIRAL
The researchers began to wonder whether the slabs which were set to mark the sun's movement might also have been set to mark the moon's movement. Because the moon's nineteen year cycle is so much more complicated than the sun's twelve month cycle, scientists seriously doubted this possibility, but Anna and her colleagues pursued this speculation knowing that the moon is of equal importance with the sun to the Pueblo people for the setting of their planting and ceremonial calendar. Anna had been encouraged in this idea by Dr. Ortiz. [from Narration]

To test their hypothesis, Anna and Rolf calculated the correct angles and set the laser to simulate the light of the rising moon at its [nineteen year] maximum extreme because they could not afford to wait six more years for the moon to actually reach that position itself. The laser's dot fell tangent to the left edge of the spiral. [from Narration]

"Fajada Butte is presently the only known site in the New World where the maximum positions of both the sun and the moon are marked [together]". [Narrator]

CONCEPT 03: Anna sought the cooperation and support of other professionals to help her research the facts about the Sun Dagger.

CONCEPT 06: Studying how the Anasazi used their calendar to relate to the sun and moon falls within a newly defined science called archaeoastronomy. [Compare Review Question #13.]

J. THE GIANT SHOVELS SCRAPING COAL FROM A LARGE OPEN PIT*
"The land of the Anasazi is rich in huge deposits of coal and uranium. We demand the power sleeping in this land but we yearn for harmony. We do not know if we can have both." [Narrator]

CONCEPT 09: Intensive coal and uranium mining pose a new threat to preservation of the Chaco Canyon environment and the Sun Dagger site.

K. THE SHADOW SLOWLY MOVING AROUND FAJADA BUTTE
"As the sun goes over each day, the butte casts a shadow around itself like a big sundial." [McGrath]

"And the butte's shadow shifting through the seasons from summer to winter would tell time to the Indians." [Sofaer]

[Although the butte shadow image does not specifically illustrate one of our Key Concepts, it was important enough that the film makers chose it for the opening and closing image of the film. - Editor]

* Long version only

Interpretive Questions & Projects

01. Carefully study a large map or atlas of the Four Corners area for place names whose actual meanings are unknown to you. Why are so many of these names of Spanish and Indian origin? Use dictionaries, gazetteers, encyclopedias, foreign language dictionaries, and find other sources to explore the meanings and derivations of these names. Display your completed chart of Four Corners Place Names to your class.

02. How do we know when the Anasazi sites were built? Investigate and compare the major archaeological time-dating techniques: stratigraphy, dendrochronology, radiocarbon analysis, and archaeomagnetism. [Suggested source: C.W. Ceram, THE FIRST AMERICAN, "Book Two."]

03. When was Pueblo Bonito first discovered in Chaco Canyon and what was its condition at that time? Prepare for your class a temporary display of early photographs (in books) which show how Chaco Canyon and other Anasazi sites in the Four Corners region (Mesa Verde, Aztec, Bandelier, Betatakin, and Wupatki) looked in 1860 when southwestern archeologists first began to explore the prehistoric Pueblo cultures. Compare architecture, artifacts, and chronology of these sites as part of your display. [Suggestion: look for books about early western photographers such as E. S. Curtis, T.H. O' Sullivan, A.C. Vroman, and early archeologists such as Richard Wetherill, Adolph Bandelier, Earl Morris and Neil Judd. "Suggested Reading" opposite is a good start.]

04. Research the Sun Dagger as: a) scientific knowledge, b) artistic expression and c) religious and spiritual expression. Which cultural perspective seems most applicable to the Anasazi life experience? Consider the following statement in your analysis:

> "Most commentaries on Indian cultures have been recorded by those who were natural enemies. The white man cannot ignore the fact that he is evaluating a culture that he has successfully suppressed. This inevitably introduces emotional and psychological elements that result in tremendous distortions." ["Arts of American Indian Peoples", 1982: ENCYCLOPEDIA BRITANNICA, Micropaedia–I, p. 658.]

05. Research and build a model of the Pueblo kiva and explain its social, political, and religious role–both historic and contemporary–in Pueblo Indian life.

06. Why did so many "primitive" cultures–not related–find it important to build astronomical calendars? Research other prehistoric calendar sites to include their locations, what is known about them, how they functioned, whey they are believed to have been built, and their similarities to, or differences from, the Sun Dagger.

07. Compare the life of the Anasazi Indians to the life of our society today. Why were the Anasazi compelled to build the Sun Dagger? Why do we need to build computers? Consider the length of time and degree of precision required, the presence of previous models of thought, and motivations and values other than science.

08. Diagram and explain the sequence of the moon's phases to your class.
09. Evaluate how our society makes decisions, political and social, between our need for energy resources and our desire to protect the environment. As a model for your research, use the situation in the Four Corners: our need for its coal, uranium, and water vs. our desire to preserve Chaco Canyon and sites like the Sun Dagger.
10. Anna Sofaer initially met with skepticism from the scientific community concerning her theories about the Sun Dagger because she was not a professional scientist. How did she deal with this problem? What should be the appropriate response of society to new ideas from relatively inexpert, obscure, or amateur sources?

Suggested Reading

THE SUN DAGGER

"The Anasazi Sun Dagger", Kendrick Frazier
SCIENCE-80, Nov/Dec 1979, pp. 56-67.

SKY WATCHERS OF AGES PAST, Malcolm Weiss
Boston: Houghton Mifflin Co., 1982.

"A Unique Solar Marking Construct", Anna Sofaer, V. Zinser & R. Sinclair
SCIENCE, 19 Oct 1979, pp. 283-291. [Technical Paper]

"The Anasazi: Riddles in the Ruins", Thomas Y. Canby
NATIONAL GEOGRAPHIC, Nov. 1982, pp. 554-592

ARCHAEOASTONOMY

COSMOS: "The Harmony Of Worlds", Carl Sagan
New York: Random House, 1980.

EARLY MAN AND THE COSMOS, Evan Hadingham
New York: Walker & Co., 1984.

ECHOES OF THE ANCIENT SKIES, Edwin C. Krupp
New York: Harper & Row, 1983.

IN SEARCH OF ANCIENT ANSTRONOMIES, Edwin C. Krupp
Garden City: Doubleday & Co., 1977.

SKY WATCHERS, Weiss (see above)

CHACO CANYON

CHACO CANYON: ARCHAEOLOGY AND ARCHAEOLOGISTS, Robert & Florence Lister
Albuquerque: University of New Mexico Press, 1981.

CHACO CANYON: CENTER OF A CULTURE, Douglas & Barbara Anderson
Tucson: Southwest Parks & Monuments Association, 1981.

GREAT PUEBLO ARCHITECTURE, Stephen Lekson
Albuquerque: National Park Service, 1984.

RICHARD WETHERILL: ANASAZI, Frank McNitt
Albuquerque: University of New Mexico Press, 1966.

THOSE WHO CAME BEFORE, Robert H. and Florence C. Lister
Tucson: Southwest Parks & Monuments Association, 1983.

ANASAZI HISTORY & CULTURE

ANASAZI: PREHISTORIC PEOPLE OF THE FOUR CORNERS, R. Ambler & M. Gaede
Flagstaff: Museum of Northern Arizona, 1977.

ANASAZI: ANCIENT PEOPLE OF THE ROCK, David Muench & Donald Pike
Palo Alto: American West Publishing Co. 1974.

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Flagstaff: Northland Press, 1981.

"The First Southwesterners", Carle Hodge
ARIZONA HIGHWAYS, Oct 1981.

PREHISTORIC INDIANS OF THE SOUTHWEST, H.M. Wormington
Denver Museum of Natural History, 1978.

RICHARD WETHERILL, McNitt (see above)

THOSE WHO CAME BEFORE, Lister (see above)

SOUTHWESTERN ARCHAEOLOGY

ANCIENT RUINS OF THE SOUTHWEST, Noble (see above)

DIGGING IN THE SOUTHWEST, Ann Axtell Morris
Santa Barbara: Peregrine Smith, Inc., 1978.

EARL MORRIS AND SOUTHWESTERN ARCHAEOLOGY, Florence & Robert Lister
Albuquerque: University of New Mexico Press, 1968.

THE FIRST AMERICAN, C.W. Ceram
New York: Harcourt Brace Janovich, 1971.

PREHISTORIC INDIANS OF THE SOUTHWEST, Wormington (see above)

RICHARD WETHERILL, McNitt (see above)

SOUTHWESTERN ARCHAEOLOGY, Alfred Kidder
New Haven: Yale University Press, 1962.

SOUTHWESTERN ARCHAEOLOGY, John C. McGregor
Urbana: University of Illinois Press, 1965. [Textbook]

THOSE WHO CAME BEFORE, Lister (see above)

PUEBLO INDIAN LIFE

THE PUEBLO INDIANS OF NORTH AMERICA, Edward P. Dozier
New York: Holt, Rinehard & Winston, 1970.

THE MAN WHO KILLED THE DEER, Frank Waters
Chicago: Sage Books/Swallow Press, 1942. [Fiction]
New York: Pocket Books/Washington Square Press, 1971 (paperback)

ZUNI – SELECTED WRITINGS OF FRANK HAMILTON CUSHING
Lincoln, NE., and London: University of Nebraska Press

ROCK ART

INDIAN ROCK ART OF THE SOUTHWEST, Polly Schaafsma
Albuquerque: University of New Mexico Press, 1980.

ROCK ART OF THE AMERICAN INDIAN, Campbell Grant
New York: Thomas Crowell, 1967.

SUNS AND SERPENTS: SYMBOLISM OF INDIAN ROCK ART, Gar & Maggy Packard
Albuquerque: Packard Publishing, 1974.
[Packard Publishing, 11521 Snow Heights-NE, Albuquerque, NM 87112]

KIVA & ANASAZI ARCHITECTURE

AZTEC RUINS, John M. Corbett [Historical Handbook Series No. 36]
Albuquerque: National Park Service, 1962.
GREAT KIVAS OF CHACO CANYON, Gordon Vivian & Paul Raiter
Albuquerque: University of New Mexico Press, 1965.
GREAT PUEBLO ARCHITECTURE, Lekson (see above)

Who to Contact:
Questions, Assistance & Information

the Sun Dagger:

THE SOLSTICE PROJECT
P.O. Box 9619
Friendship Station
Washington, D.C. 20016

Chaco Canyon & Anasazi Culture:

CHACO CULTURE RESOURCES CENTER
National Park Service
P.O. Box 26176
Albuquerque, NM 87125
[505] 766-3780

MUSEUM OF NEW MEXICO
Laboratory of Anthropology
Attn: Stewart Peckham
Box 2087
Santa Fe, NM 87504
[505] 827-8941

CHACO CULTURE NATIONAL HISTORIC PARK
Star Route 4
Box 6500
Bloomfield, NM 87413
[505] 786-5384

Publications, guides, maps & information on the Southwest:

SOUTHWEST PARKS & MONUMENTS ASSOCIATION
221 North Court
Tucson, AZ 85701
[602] 622-1999

Related Bullfrog Films:

THE FOUR CORNERS: A National Sacrifice Area? 58 min.
(Available on 2 reels
for classroom showings)
1983

The first comprehensive, balanced critique of current plans for major expansion of Western energy development in the four corners area – home of the Mormon, Hopi, and Navajo cultures and the Golden Circle of National Parks.

IN OUR OWN BACKYARDS: Uranium Mining in the United States 29 min.
1982

Explores the impact of uranium mining on the environment, and on the health of workers and nearby residents, particularly Navajo Indians who have been heavily employed by the uranium industry in the four corners area.

CHILDREN OF THE LONG-BEAKED BIRD 29 min.
1976

For grades 3 to 6, a portrait of a modern Indian family that erases the stereotype made infamous by Westerns. Shows the daily life of 12-year-old Dominic Old Elk, who is proud of his Indian heritage, but is part of young America too.

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