THE MAKING OF AMERICA: THE SOUTHWEST

VOL. 162, NO. 5 NOVEMBER 1982

NATIONAL GEOGRAPHIC

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D.C.

BOTH friends and total strangers have said to me, "The Geographic must be a great place to work." It is. But what always comes out eventually is that they mean "to travel on assignments must be great."

It often isn't. As I write this, photographer Loren McIntyre has just spent two weeks in a seven-by-nine-foot jail cell in a remote Venezuelan town, as have five other Americans, because of an innocent difference with local officials—perhaps complicated by cool relations rising from the United States' pro-British stand on the Falkland Islands. The U. S. Embassy was never notified. After ten days Loren smuggled out a note, and word reached the embassy. The travelers were soon released.

All our field staff lives with the common travel maladies—plus some exotic ones that internists and tropical-medicine experts have yet to identify. It's not unusual for a writer or photographer to return home 15 to 20 pounds lighter. I once diverted my route home across the Pacific to see if I could help a photographer who had been bitten by a shark. He survived with a bit of surgery.

While photographing Jerusalem, Jodi Cobb was caught in a fusillade of bullets at the Dome of the Rock after an American-born Jew began shooting at Muslim worshipers. As a souvenir, she collected a spent cartridge that fell nearby.

Just shepherding a dozen or so cases of equipment through airport police and customs requires patience, ingenuity, and—in some countries—an experienced sense of when and how much bribe may be required.

But despite all aggravations, resignations occur with less frequency than solar eclipses. I like to think it's because of pride in the product. The staff knows from letters and a member-renewal loyalty unmatched in publishing that their work is appreciated. An unprecedented number of awards this year has made us all even prouder—especially the coveted public-service award of Sigma Delta Chi, the professional journalists' society, for our Energy issue and Acid Rain article.

Though neither a fine product, readership loyalty, nor distinguished awards will get you out of jail or cure a fever, they do inspire a lot of people to say, "That must be a great place to work."

Wilbur E. Garrett

EDITOR

NATIONAL GEOGRAPHIC

THE NATIONAL GEOGRAPHIC MAGAZINE VOL. 162, NO. 5

November 1982

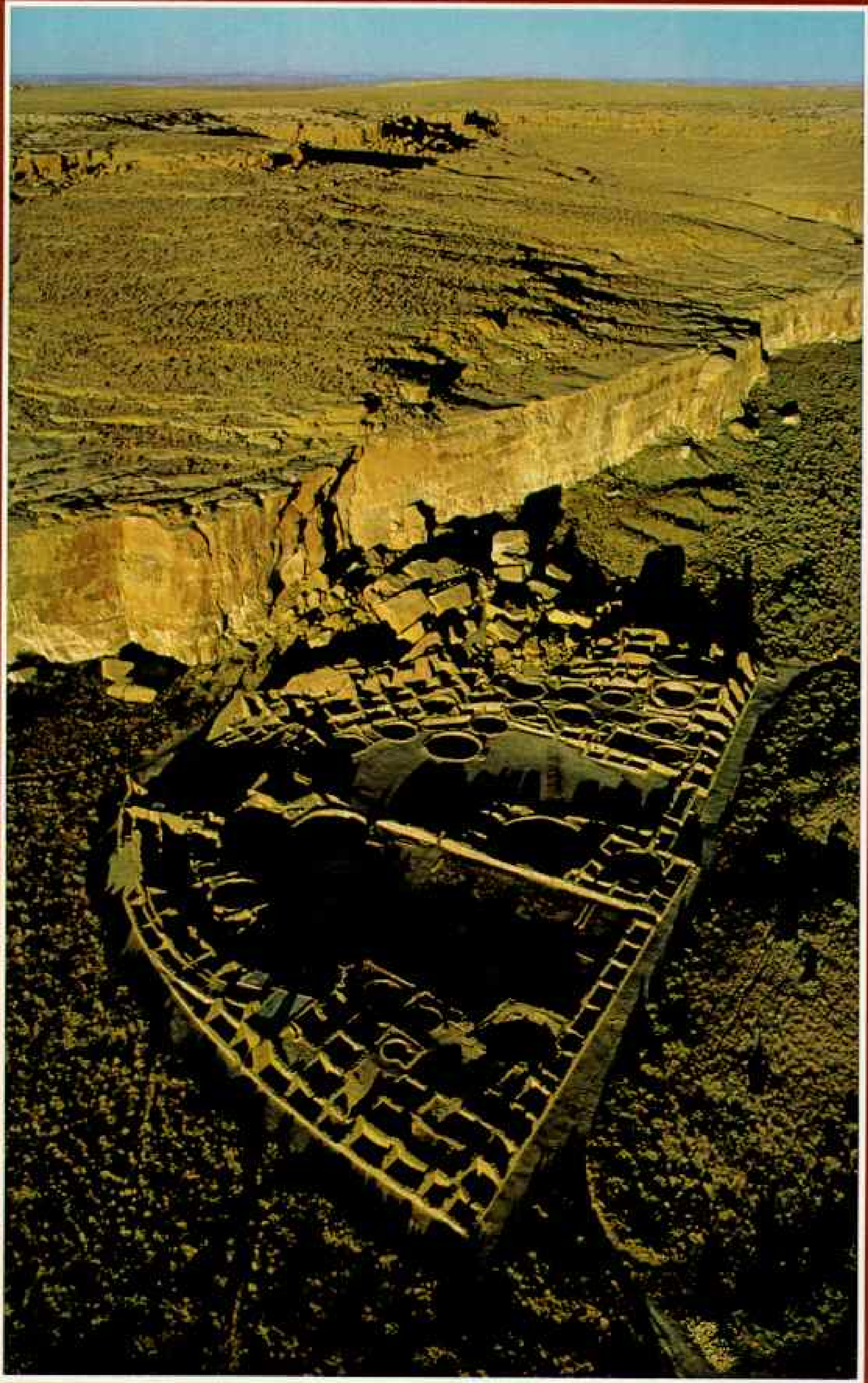
COVER: *Children cling to a ceramic "Storyteller" figure fashioned by Helen Cordero of New Mexico's Cochiti Pueblo. Photograph by Jerry D. Jacka.*

Magnificent ruins of 1,000-year-old Pueblo Bonito parch in the New Mexico sun as a painted maiden dances to bring rain. Coping with a harsh environment was a life and death struggle for

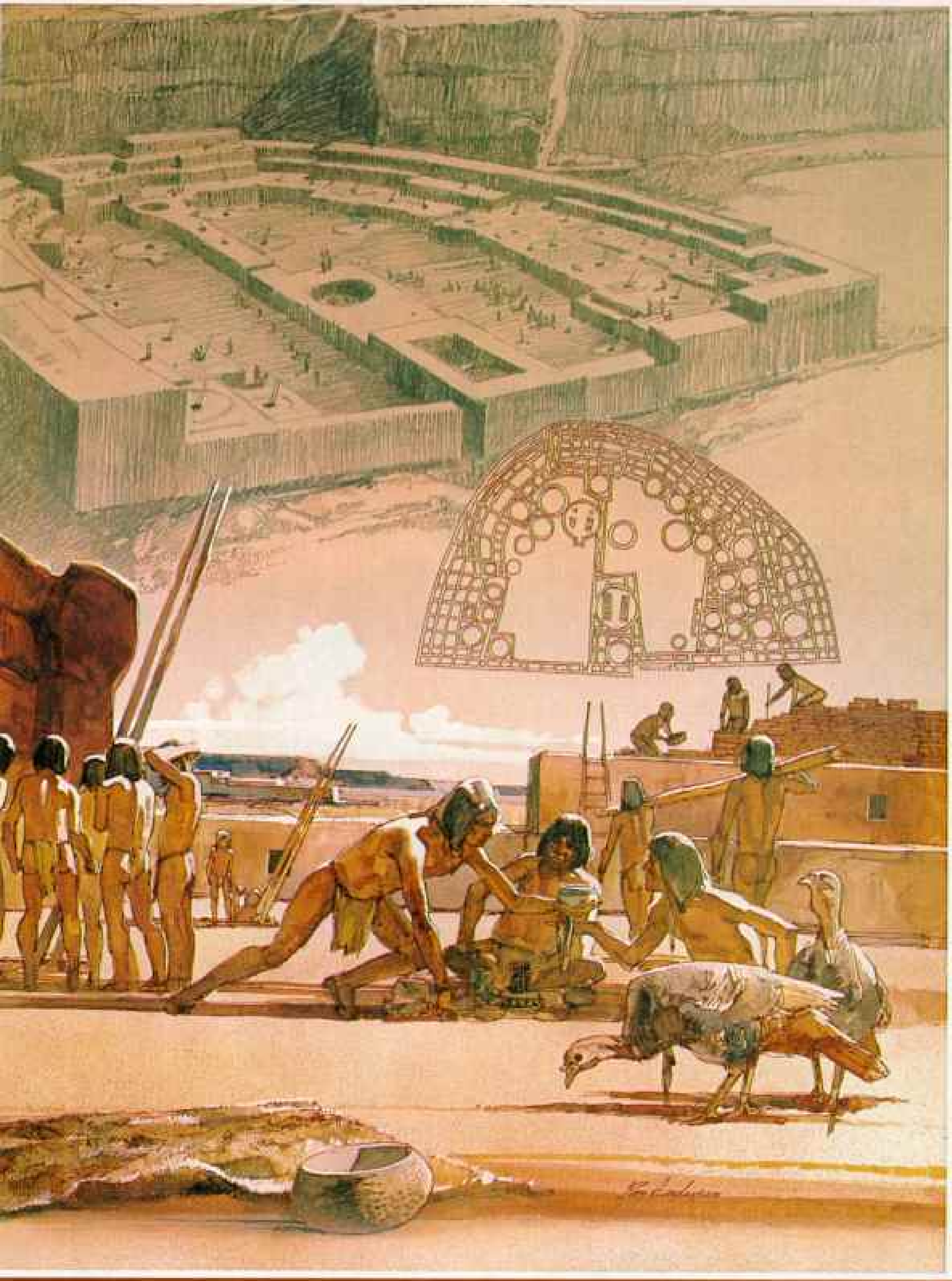
The Anasazi

KIVA MURAL, CA 1400, AT POTTERY MOUND, NEW MEXICO

FRANK C. HIBBEN (ABOVE); DAVID MALL

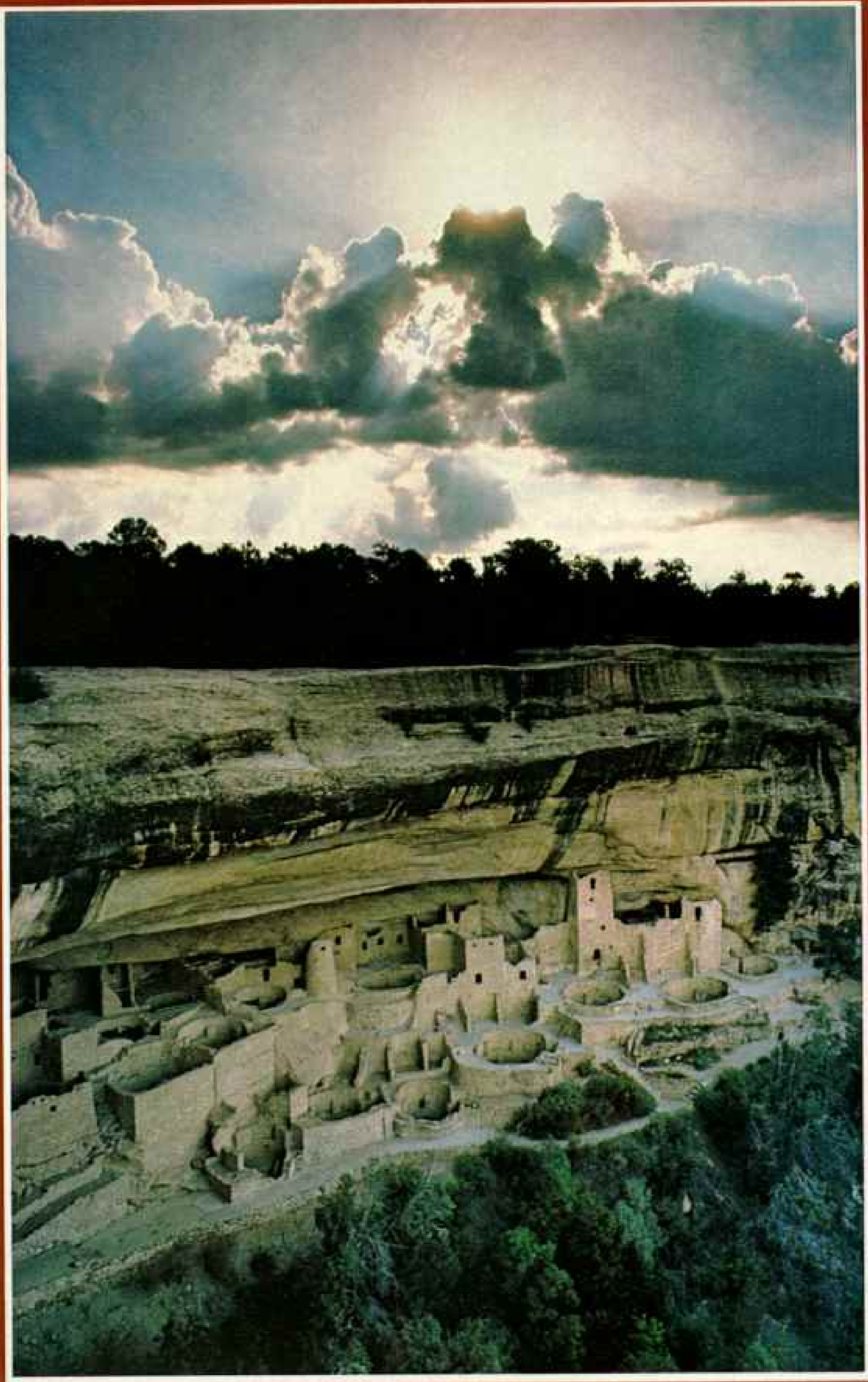


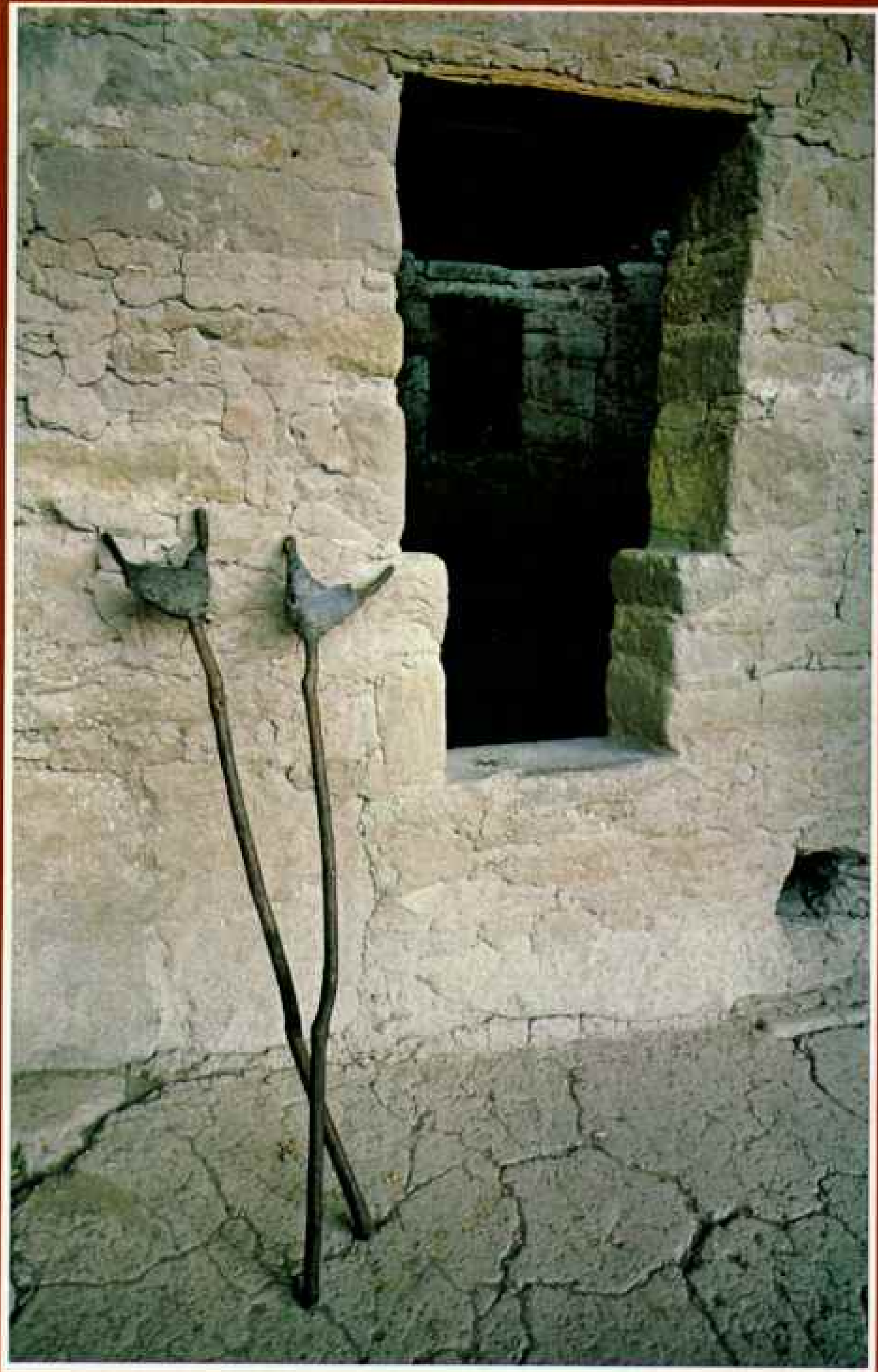
Turquoise pendants, shell bracelets, and pottery are the grist for trading in the vast marketplace of Pueblo



PAINTING BY ROY ANDERSEN

Bonito — beautiful village — centerpiece of the great Anasazi pueblos scattered through Chaco Canyon.





BOTH BY DEWITT JONES

The Anasazi legacy leaves questions: Why did the Mesa Verdeans of Colorado tuck their pueblos in lofty cliffs? Why the T-shaped doorways? Yet for a people plagued with arthritis, crutches provide their own answer.

Epilogue of destruction in the book of the Anasazi,
Homolovi II and companion sites near Winslow, Arizona,

DEWITT JONES

abandoned 500 years ago, have been ravaged by pothunters with shovels, backhoes, and even bulldozers.

THE ANASAZI Riddles in

RIDING into Chaco Canyon in 1877, photographer William Henry Jackson reined his mule and gazed ahead. From the parched canyon floor rose ruins of once magnificent buildings—desiccated husks of a long-vanished culture. Yet this northwest corner of New Mexico Territory was bleak desert, home only to a handful of impoverished Navajo herdsmen.

By
THOMAS Y. CANBY
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by
DEWITT JONES and
DAVID BRILL

Paintings by
ROY ANDERSEN

Jackson carefully examined the time-gnawed masonry walls, perhaps the finest north of Mexico. Pacing off one of the largest structures, he did some mental arithmetic. This single building, he calculated, required hauling, shaping, and placing 30 million stones. With ten of these colossal structures visible, that would be. . . .

Before leaving, the celebrated "picture maker of the Old West" shot some photographs. Disaster! Defective film spoiled every exposure.

An earlier trip had also taken Jackson west, to Colorado. Word came that miners had discovered stone dwellings tucked in cliffs rising from the Mancos River to a great green tableland. Struggling upward, Jackson and a companion reveled in being the first white men to enter this haunting human aerie. This time his film was good, recording the first dramatic photographs of Mesa Verde's famous cliff houses.

On Jackson went, to Hovenweep, remote ruins with many stone towers straddling the Colorado-Utah line. He visited Canyon de Chelly in Arizona, a breathtaking gallery of cliff houses and rock art. Finally he reached the mesa-top homes of the Hopis, living descendants of the mysterious ancients of the ruins (see article, pages 606-629).

In his pilgrimages through the Four Corners area, Jackson traversed the heartland of the Anasazi. Their domain, larger than California, stretched from east of the Rio Grande west into Nevada, and from central New Mexico and Arizona north into Colorado and Utah (map, pages 566-7).

Here, at about the time of Christ, hunter-gatherers were making the transition from nomadic life to a sedentary existence based primarily on growing corn. In their struggle to nurture this crop in a dry, unyielding land, the Anasazi lifted themselves to a cultural level unsurpassed by any other prehistoric Americans north of Mexico.

Compulsive builders, the Anasazi raised multifamily dwellings not equaled in size in the United States until the 1870s. Though lacking the wheel and beasts of burden, they laced their land with hundreds of miles of broad roads. To subsist by farming, they evolved ingenious water-control devices that fed larger populations than inhabit many of the same areas today.

Then they abandoned most of what they had built, leaving behind still another enigma to tantalize archaeologists.

For centuries their silent towns slept, until wandering Navajos occupied a large part of the Anasazi's land. Contemplating the brooding remains, the Navajos believed they were built by "alien ancient ones"—Anasazi in their Athapaskan tongue.

Because of the ruins' immense size and often excellent preservation, the Southwest has received as much archaeological attention as any other prehistoric place of comparable size on earth. A leader in this research has been the National Geographic Society, whose support of Anasazi archaeology traces back to the landmark excavations of Neil M. Judd in Chaco Canyon in the 1920s.

the Ruins

Yet such work only scratches the surface. More than 25,000 Anasazi sites have been identified in New Mexico alone. At least this many are known in Arizona, and thousands more in Colorado and Utah. Tens of thousands of sites doubtless await discovery. (See **The Southwest**, a double map supplement to this issue.)

Today, however, these ancient ruins face perils more dire than the eroding toll of time. Pothunters, seeking relics worth thousands of dollars on the black market, have plundered half the known remains, although stiff new laws reduce this vandalism. Immense deposits of natural gas, uranium, and strip-minable coal underlie the region. Many small but exquisite ruins that I visited soon will crumble before draglines gouging out coal for industries here and abroad.

Ironically this same economic force that threatens the remains provides the greatest impetus for their study. Archaeological conservation laws require surveys of jeopardized sites and excavation of those considered important. Further, some concerned energy companies carry their archaeological exploration far beyond the laws' requirements. As a result, research has burgeoned in energy regions of the West.

THE EARLY ANASAZI trod lightly on the land.

"Only a handful of sites tell us about their first settled villages," said Dr. W. James Judge, director of the Chaco Center, a National Park Service research facility at the University of New Mexico. "They made homesteads by clearing a shallow depression and roofing it with a canopy of brush and mud. Storage pits stood behind, and nearby they scattered trash. Among remains of game animals and wild plants, charred corn shows that these Anasazi had become part-time farmers."

Excavating these pit houses, archaeologists discovered that the occupants lacked pottery and instead used vessels of fine basketry, some woven so tightly that they may even have held water. Acknowledging their skills, scholars named these early Anasazi the Basketmakers.

After A.D. 500 the Basketmakers made three fateful acquisitions. Pottery arrived, probably from a southern people of the Mogollon culture, and it attained a cherished beauty (pages 593-605).

From a source still unknown they obtained the bow and arrow, and they developed the hafted ax. Simultaneously, agriculture grew in importance, based on corn, pumpkin-like squash, and the bean, which brought much needed protein to their diet.

With their lives thus enriched, the Basketmakers saw their population soar. Pit houses expanded into most niches of the southern Colorado Plateau, even into precipitous walls of the Grand Canyon, in the land of the western Kayenta Anasazi.

"One of their greatest enemies was fire," I learned from Al Lancaster, whose 50 years as a Southwest field excavator give him unique insights into the Anasazi. "A dwelling's fire pit was only about six feet beneath the pit-house ceiling, which bristled with logs and brush—real tinder. A large number of houses I dug had burned."

This bane of the Basketmakers has proved a boon to archaeologists. Flames that turned timbers and foodstuffs to charcoal also left them resistant to the bacteria of decay, and thus ideal for dating by the radiocarbon method. The fires also permanently fixed the magnetic alignment of iron in the heated clay, permitting scientists to date the events through archaeomagnetism.

Fire-damaged Anasazi roofs also spurred archaeological use of tree-ring dating, a

technology that gives the Southwest a unique chronological record. By identifying distinctive patterns of a tree's growth as preserved in its rings, dendrochronologists can determine when the tree lived, and even the year it was cut for a roof beam.

These dating devices show that soon after A.D. 700 the Anasazi had scaled a new plateau in their cultural climb.

"Across their domain," said Dr. Judge, "the Basketmakers began living in enlarged versions of surface storage rooms behind the circular pit houses, which in turn became kivas, focal points of ceremonial life. This transition to aboveground, community living marks the end of the Basketmaker era and the start of the Pueblo period, which carries down to today's Pueblo Indians."

At this point the Anasazi acquired another distinctive trait: They began strapping their babies to hard wooden cradleboards, causing the back of the head to flatten.

"These characteristics—distinctive pottery, pueblo homes, community living, shared religious practices—give the Anasazi their identity as a people," observed archaeologist Florence Hawley Ellis. "Never a nation or even a single tribe or language group, they nevertheless successfully maintained their traditions across vast expanses of distance and time."

FOR THE NEXT four centuries the Anasazi—with the notable exception of those living in Chaco Canyon—keyed their lives to the rhythm of an unkind climate.

"Much of the southern Colorado Plateau was unfit for growing corn," observed Dr. Kenneth L. Petersen of the Dolores Archaeological Program in Colorado. "Even the best areas were marginal. Land lying below 5,500 feet was too dry, and land above 7,500 feet was too cold. Even within the narrow belt suitable for corn, local droughts and frosts struck frequently. As a result, the Anasazi constantly were moving, looking for areas of favorable rainfall and temperature.

"Our excavations show that 2,000 to 3,000 people lived in the Dolores River valley in the 800s, and in the next century almost all were gone. We think the cause was a slight drop in summer temperatures. The cooler air would have settled in the valley, shortening the growing season until corn became too great a gamble." This tactic of abandonment and rebuilding has given the Anasazi the name "urbanized nomads."

Formerly slaves to a fickle environment, by the 900s the Anasazi began to assert control. They did it by manipulating water.

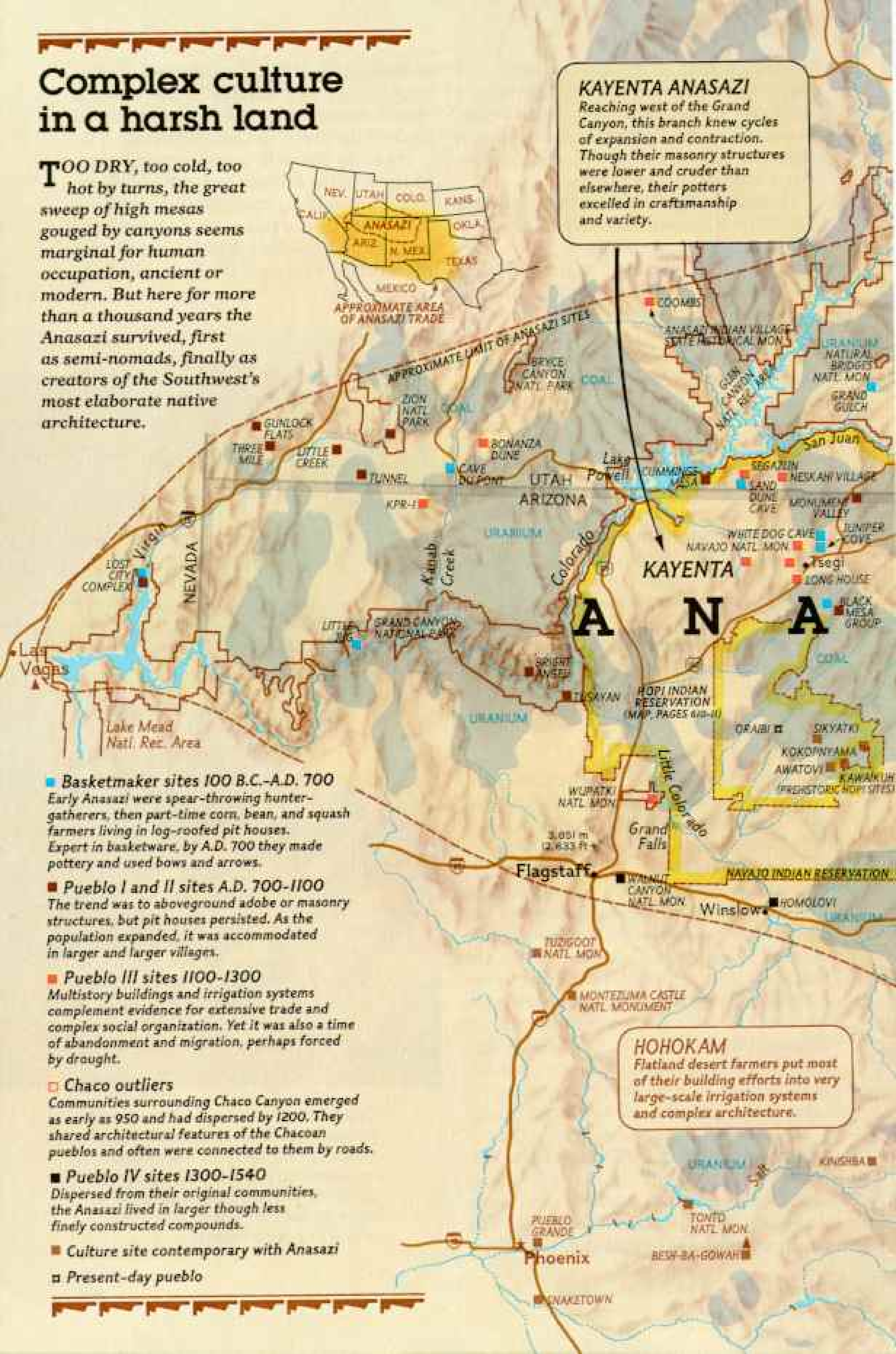
"Most of their water-control devices were shallow channels that diverted runoff onto small fields," explained Dr. Arthur H. Rohn

BOTH BY DAVID BRILL

Cradle of culture *for one branch of the Anasazi, New Mexico's Chaco Canyon* ***(facing page)*** *contains their finest architectural accomplishments, from giant pueblos to a workmanlike set of steps pecked into a canyon wall for access to a mesa* ***(above)***.

Complex culture in a harsh land

TOO DRY, too cold, too hot by turns, the great sweep of high mesas gouged by canyons seems marginal for human occupation, ancient or modern. But here for more than a thousand years the Anasazi survived, first as semi-nomads, finally as creators of the Southwest's most elaborate native architecture.


KAYENTA ANASAZI
Reaching west of the Grand Canyon, this branch knew cycles of expansion and contraction. Though their masonry structures were lower and cruder than elsewhere, their potters excelled in craftsmanship and variety.
HOHOKAM
Flatland desert farmers put most of their building efforts into very large-scale irrigation systems and complex architecture.
NEV.
UTAH
COLO.
KANS.
CALIF.
ANASAZI
OKLA.
ARIZ.
N. MEX.
TEXAS
MEXICO
APPROXIMATE AREA OF ANASAZI TRADE
APPROXIMATE LIMIT OF ANASAZI SITES
COOMBS
ANASAZI INDIAN VILLAGE STATE HISTORICAL MON.
BRYCE CANYON NATL. PARK
COAL
URANIUM
NATURAL BRIDGES NATL. MON.
GRAND GULCH
ZION NATL. PARK
GUNLOCK FLATS
THREE MILE
LITTLE CREEK
TUNNEL
BONANZA DUNE
CAVE DU PONT
UTAH
ARIZONA
Lake Powell
CUMMINGS MESA
San Juan
NESKAHI VILLAGE
SAND DUNE CAVE
MONUMENT VALLEY
KPR-1
WHITE DOG CAVE
JUNIPER COVE
NAVAJO NATL. MON.
Tsegi
LONG HOUSE
KAYENTA
BLACK MESA GROUP
A N A
Colorado
Kanab Creek
Virgin
LOST CITY COMPLEX
NEVADA
GRAND CANYON NATIONAL PARK
Las Vegas
Lake Mead Natl. Rec. Area
TUSAYAN
HOPI INDIAN RESERVATION
ORAIBI
SIKYATKI
KOKOPNYAMA
AWATOVI
WUPATKI NATL. MON.
Little Colorado
Grand Falls
3,851 m (12,633 ft)
Flagstaff
WALNUT CANYON NATL. MON.
NAVAJO INDIAN RESERVATION
Winslow
HOMOLOVI
TUZIGOOT NATL. MON.
MONTEZUMA CASTLE NATL. MONUMENT
KINISHBA
TONTO NATL. MON.
PUEBLO GRANDE
Phoenix
BESH-BA-GOWAH
SNAKETOWN

■ *Basketmaker sites 100 B.C.–A.D. 700*
Early Anasazi were spear-throwing hunter-gatherers, then part-time corn, bean, and squash farmers living in log-roofed pit houses. Expert in basketware, by A.D. 700 they made pottery and used bows and arrows.

■ *Pueblo I and II sites A.D. 700–1100*
The trend was to aboveground adobe or masonry structures, but pit houses persisted. As the population expanded, it was accommodated in larger and larger villages.

■ *Pueblo III sites 1100–1300*
Multistory buildings and irrigation systems complement evidence for extensive trade and complex social organization. Yet it was also a time of abandonment and migration, perhaps forced by drought.

□ *Chaco outliers*
Communities surrounding Chaco Canyon emerged as early as 950 and had dispersed by 1200. They shared architectural features of the Chacoan pueblos and often were connected to them by roads.

■ *Pueblo IV sites 1300–1540*
Dispersed from their original communities, the Anasazi lived in larger though less finely constructed compounds.

■ *Culture site contemporary with Anasazi*

▫ *Present-day pueblo*

Within the gray-tinted areas lie 10 percent of the Western world's uranium reserves, substantial oil and gas reserves, and large amounts of the nation's coal suitable for strip mining. Leased federal, state, and Indian lands are surveyed for archaeological sites prior to exploitation.

Anasazi road ▲ Turquoise mine

MESA VERDEANS

Last of the Anasazi to build complex masonry structures within their traditional homeland, the people of Mesa Verde tended to cluster in high-density sites. Their cliff dwellings are among the most spectacular remnants of Anasazi culture.

CHACOANS

Enormous pueblos, irrigation systems, trade goods from Mexico, a complex road system, satellite communities called outliers—all characterize the finest flowering of the Chacoans. By about A.D. 1200 they had left the area and all their works.

MOGOLLON

At first influencing the Anasazi, and then influenced by them, this group was centered in the region's higher mountains.

RIO GRANDE ANASAZI

Although early sites have been found in the region, population density here began to increase about the time other Anasazi were abandoning their territories. Some migrated to the Rio Grande, where the threads of Anasazi tradition are part of contemporary Pueblo culture.

of Wichita State University in Kansas. "They also built check dams that collected eroding soil and held the water that carried it. Though individually small, these devices sometimes numbered in the hundreds in a single community."

PROBING and pondering the Anasazi's most minute remains, including their highly informative skeletons, experts have captured many insights into their daily lives.

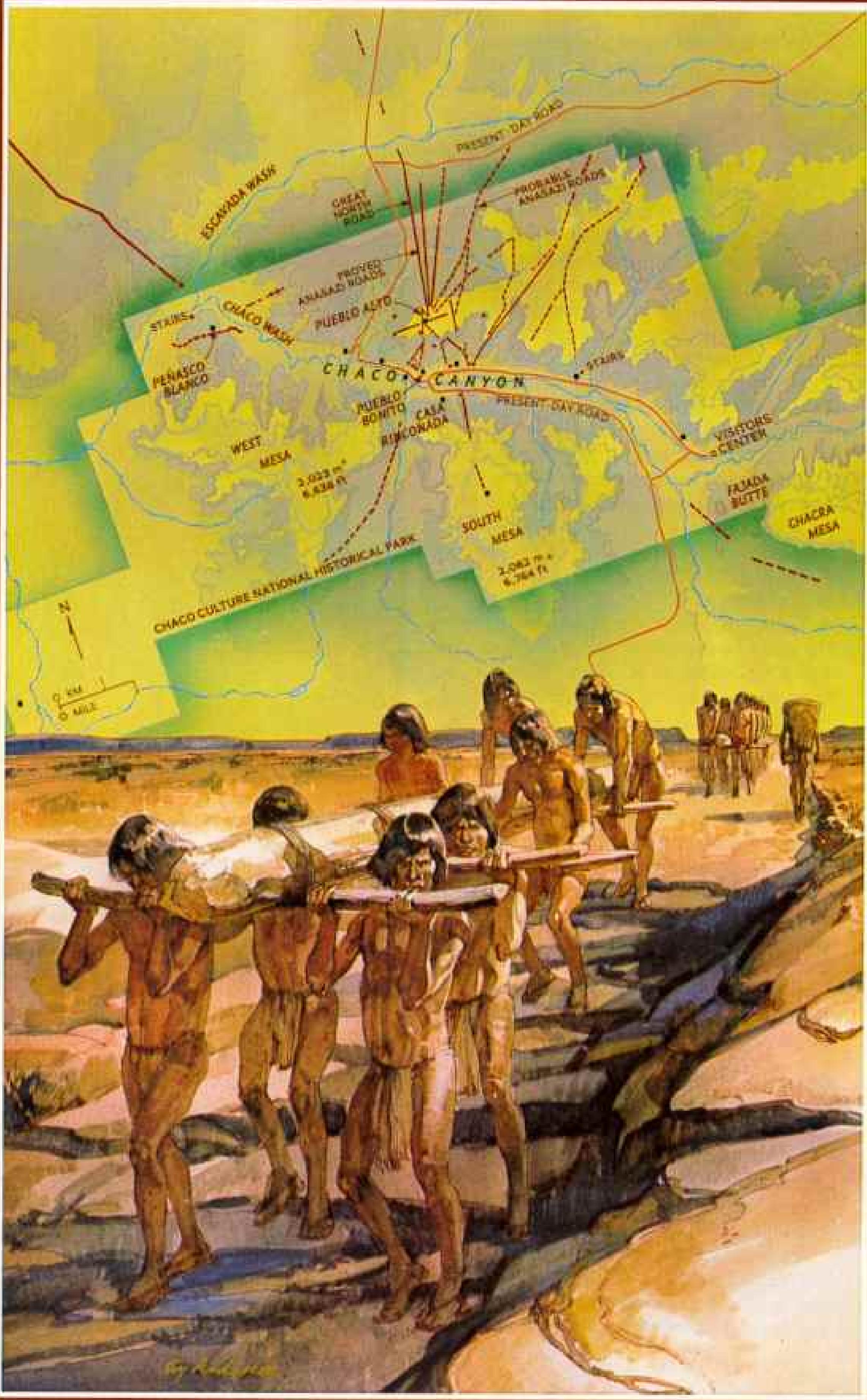
Allow yourself to be carried back to the tenth century, to the pueblo occupied by your extended family in Chaco Canyon. The fact that you are alive means you are beating the odds: A third of your brothers and sisters died before age five. As a youth you shepherd the village turkeys as they feed on nuts and insects. The only domesticated animals except dogs, they provide feathers for warmth and for finery.

Your clothes are made of hides and of cotton cloth, traded from Anasazi cotton farmers along the Little Colorado River. For stitching, your mother used the sharp tip and attached fiber of a yucca leaf—nature's needle and thread. The generous wild yucca offers banana-like fruit, fibers for sandals and baskets, roots to pulverize into soap, and a sweet stalk for chewing (archaeologists will find your quids by the thousands).

If you are a woman, you probably own all the family's personal property. One of your possessions is a metate, a large troughed stone used for mealing corn and other seeds. You are its slave. Day after day you bend over it, grinding, grinding, grinding.

PAUL LOGSDON

Barely visible furrows, *remnants of Anasazi roads cut by deeper modern roadways, converge on the ruins of Pueblo Alto near Chaco Canyon (***above***). Archaeologists have identified a network of roads (***right***) that connected the canyon pueblos with satellite communities. Here Anasazi work teams carry logs from forests as distant as 30 miles to serve as roofing timbers.*


ESCAVADA WASH
GREAT NORTH ROAD
PRESENT DAY ROAD
PROBABLE ANASAZI ROADS
PROVED ANASAZI ROADS
PUEBLO ALTO
CHACO WASH
STAIRS
PEÑASCO BLANCO
CHACO
CANYON
PUEBLO BONITO
CASA RINCONADA
PRESENT DAY ROAD
VISITORS CENTER
WEST MESA
3,933 ft
1,438 ft
SOUTH MESA
2,083 ft
1,764 ft
FAJADA BUTTE
CHACRA MESA
CHACO CULTURE NATIONAL HISTORICAL PARK
N
1 KM
½ MILE

If you are a man, you run the ceremonial side of life, with its focus in the kiva. This role means much more than possessing property, for religion dominates all—the planting, the hunt, the design of the pueblo and the kiva, the rites to bring rain.

Outside the sanctuary of the kiva a man's life also is hard. You and a few others carried the sandstone for the pueblo—hundreds of tons of it—block by block from a local outcrop. The search for firewood lengthens as stands of piñon and juniper dwindle.

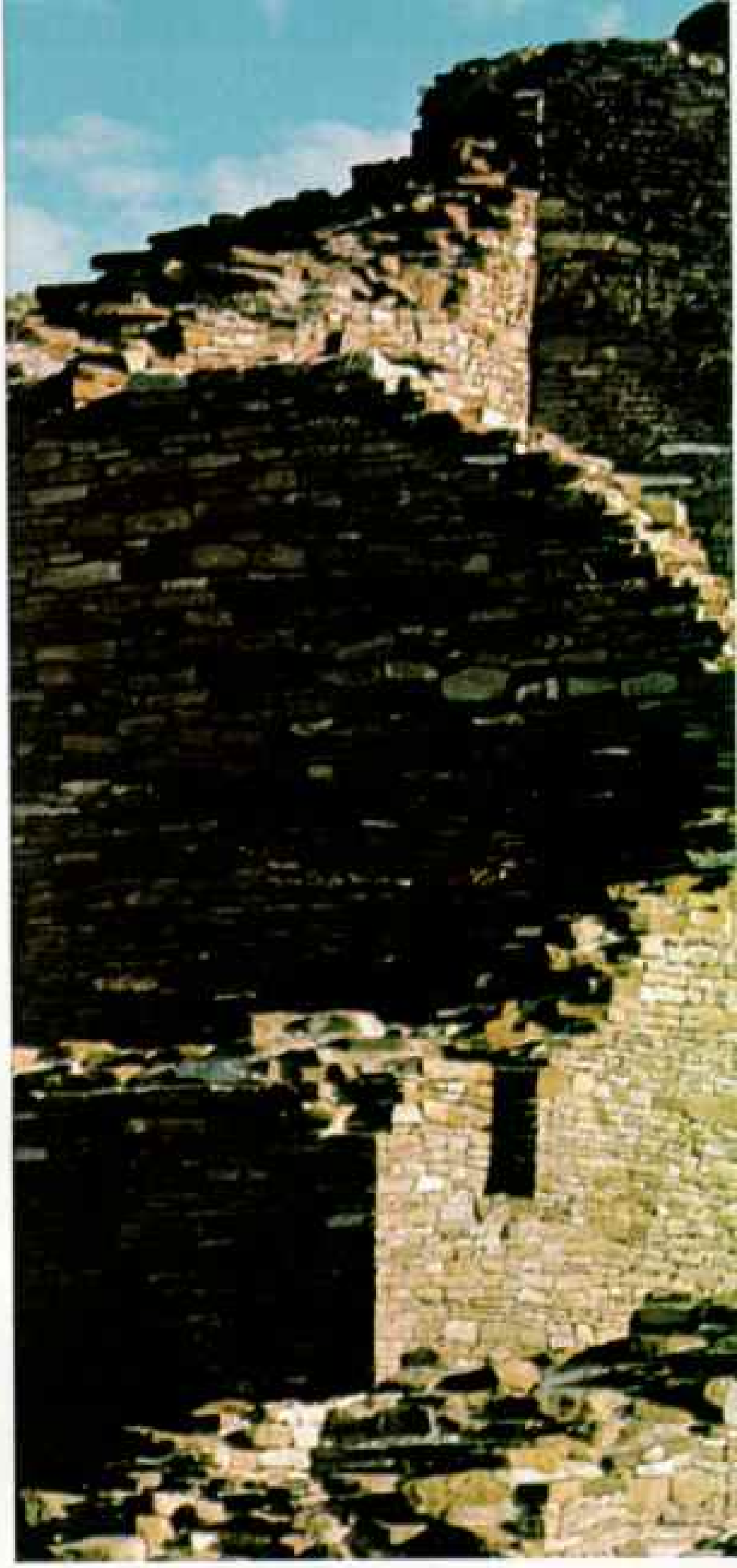
At times the hunting groups fail, sometimes for weeks. Then your diet consists largely of protein-shy corn, and hunger saps your vitality. Hint of famine brings dread; stories tell of starving neighbors who resorted to cannibalism in their despair.

You admire the community artists. One, a priest, occasionally goes forth with a hard stone in hand to peck designs on cliff faces. Another, a musician, entertains in evenings by playing a flute made from the wing bone of a golden eagle.

You reach your 40s, and you groan under the accelerating disrepairs of old age. Arthritis torments your joints. Your teeth, worn to the gums by grit from the metate, pain intolerably from abscesses that are eating deep into your jawbones.

The dreadful winters—surely they are growing colder. You stoke the fire until smoke disturbs the rest of the family; at night you wedge your stiff body between theirs to draw on their warmth.

Deep into that harsh winter you sink into a final sleep. Relatives place your body in an empty storage room or dig a grave in the loose soil of the village trash mound. They fold your body into a fetal position, and place beside it a few possessions to serve you on your journey to the spirit world.



IN A.D. 919, according to the tree rings, workmen from Chaco Canyon cut roof beams for a new pueblo, situated beneath the north rim where a side canyon channeled runoff during storms. Known as Pueblo Bonito, it would be the finest expression of North American Indian architecture.

Two other large structures also began taking shape, both situated near mouths of side canyons. Their locations support other archaeological evidence that Chacoans had begun to capture runoff from the canyon rim to water crops on the canyon floor.

Within a few years the buildings were immense. Pueblo Bonito rose three stories and embraced more than a hundred rooms; no other Anasazi building rivaled it. Then, for almost a century, construction halted.

The lull was perhaps a strength-gathering time, a period when Chacoans were drawing back a cultural bow that would catapult their society to its heights. As they entered the 11th century, the people of the canyon cast off the bonds of the past and launched

BOTH BY DEWITT JONES

Time-gnawed walls *of Pueblo Bonito* ***(above)*** *testify to prodigious labor that fitted sandstone blocks into towering five-story walls. Wooden beams nestled into the masonry reveal the builders' attention to detail. A layer of mud plaster, long since eroded, smoothed the walls. Probably afflicted by drought, these Anasazi abandoned Chaco Canyon around A.D. 1200.*

CHACO CENTER, ALBUQUERQUE, NEW MEXICO

HERITAGE CENTER COLLECTION, BUREAU OF LAND MANAGEMENT, DOLORES, COLORADO

SMITHSONIAN INSTITUTION

CHACO CENTER

The Mexican connection

PUEBLO riddle: Did the great Chaco edifices and complex road system originate with the Anasazi, or were they the result of outside influence?

*Scholars debate the question, but a macaw-feather skirt (**right**) found in a Utah cave in 1954 by guide Kent Frost, here seen on a return to the site, confirms ties of trade with Mexico.*

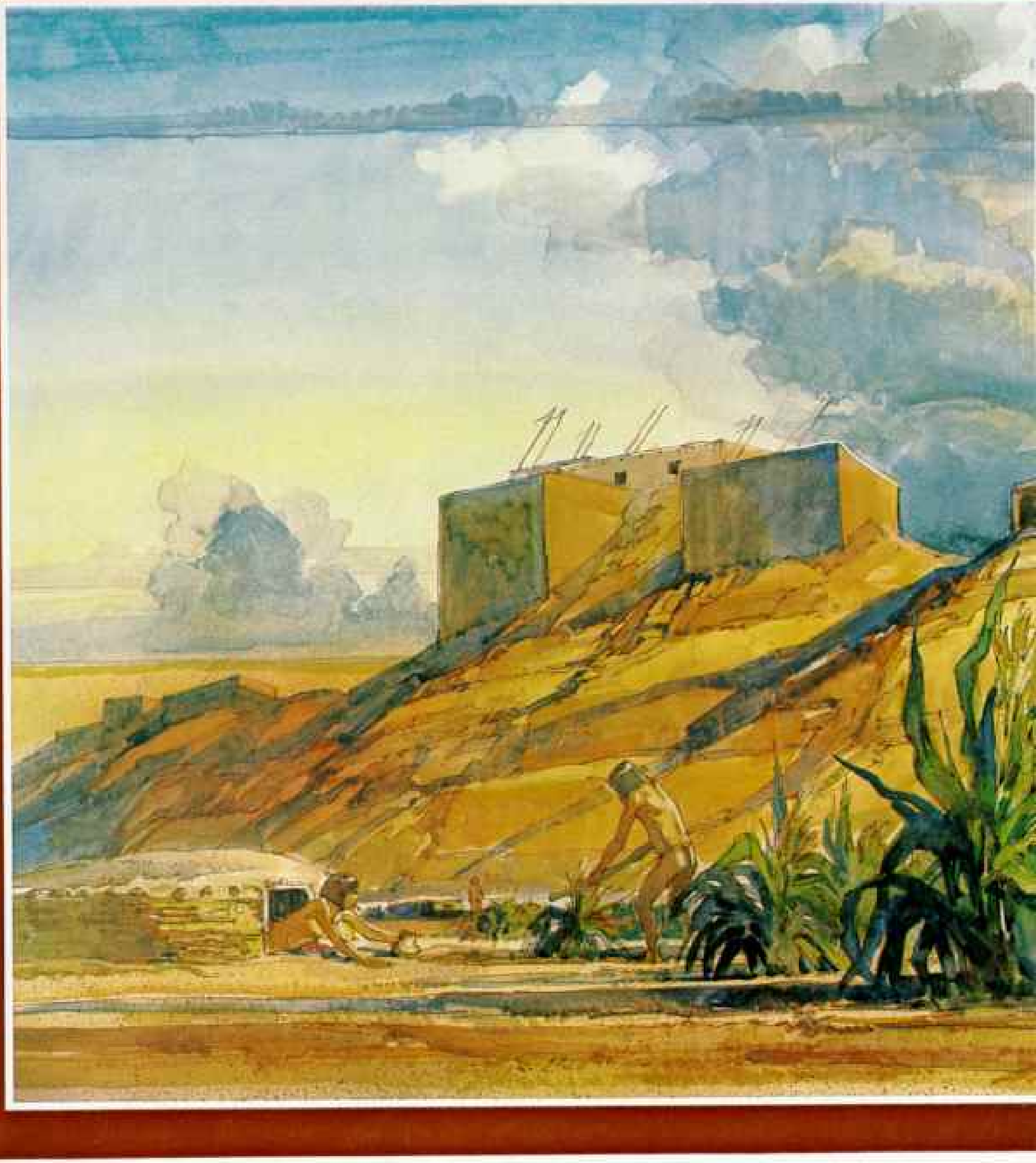
Examining the artifact, archaeologist Lyndon L. Hargrave concluded that it was "probably made by a 'Mexican' Indian in the 12th century . . . and reached Utah through various trade routes."

*An abalone-shell frog (**center** at left), found in a 12th-century Colorado site, evidences trade with the Pacific coast.*

*Of the Anasazi ritual life, only fragments remain. A wooden headdress (**top**) probably had a ceremonial function; a stone cache of turquoise (**bottom**) may have been a shrine.*

*Decorative inlays in a deer-bone scraper (**center**) hint at an owner's high status.*

DAVID BRILL (CENTER RIGHT AND BOTTOM); JEWITT JONES

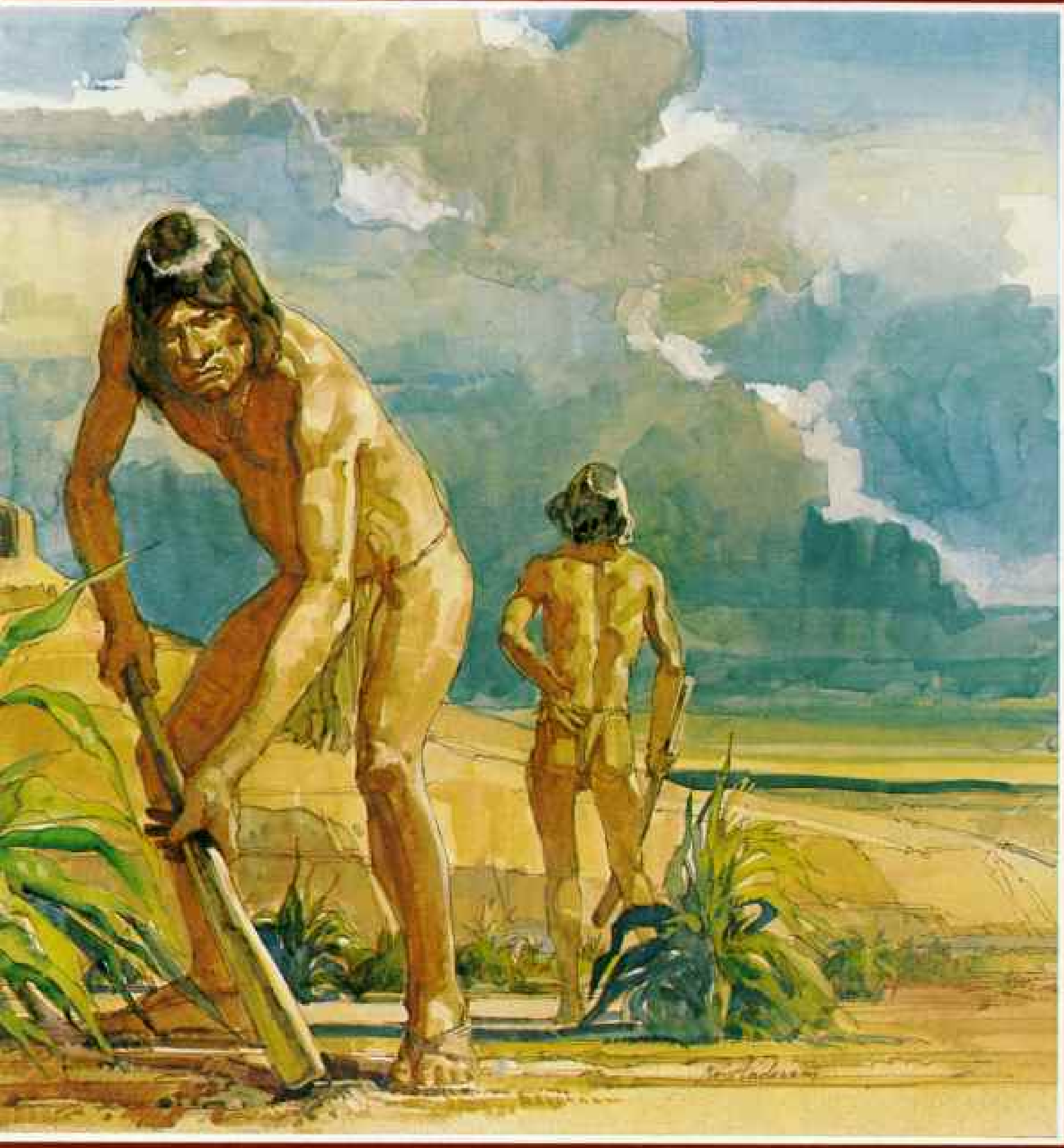


an epoch of transcendent grandeur known as the "Chaco phenomenon."

Construction boomed, and workmen swarmed over Pueblo Bonito and its two sister structures, tearing out old walls, building larger ones. Seven other great pueblos rose, some little more than a bowshot apart, several situated near side canyons.

"There was an astonishing similarity between the buildings as they grew during the next 130 years," said Dr. Judge as we surveyed the enormous ruins. "Despite the long construction period, each building's growth suggests careful planning from the start to achieve uniformity of design."

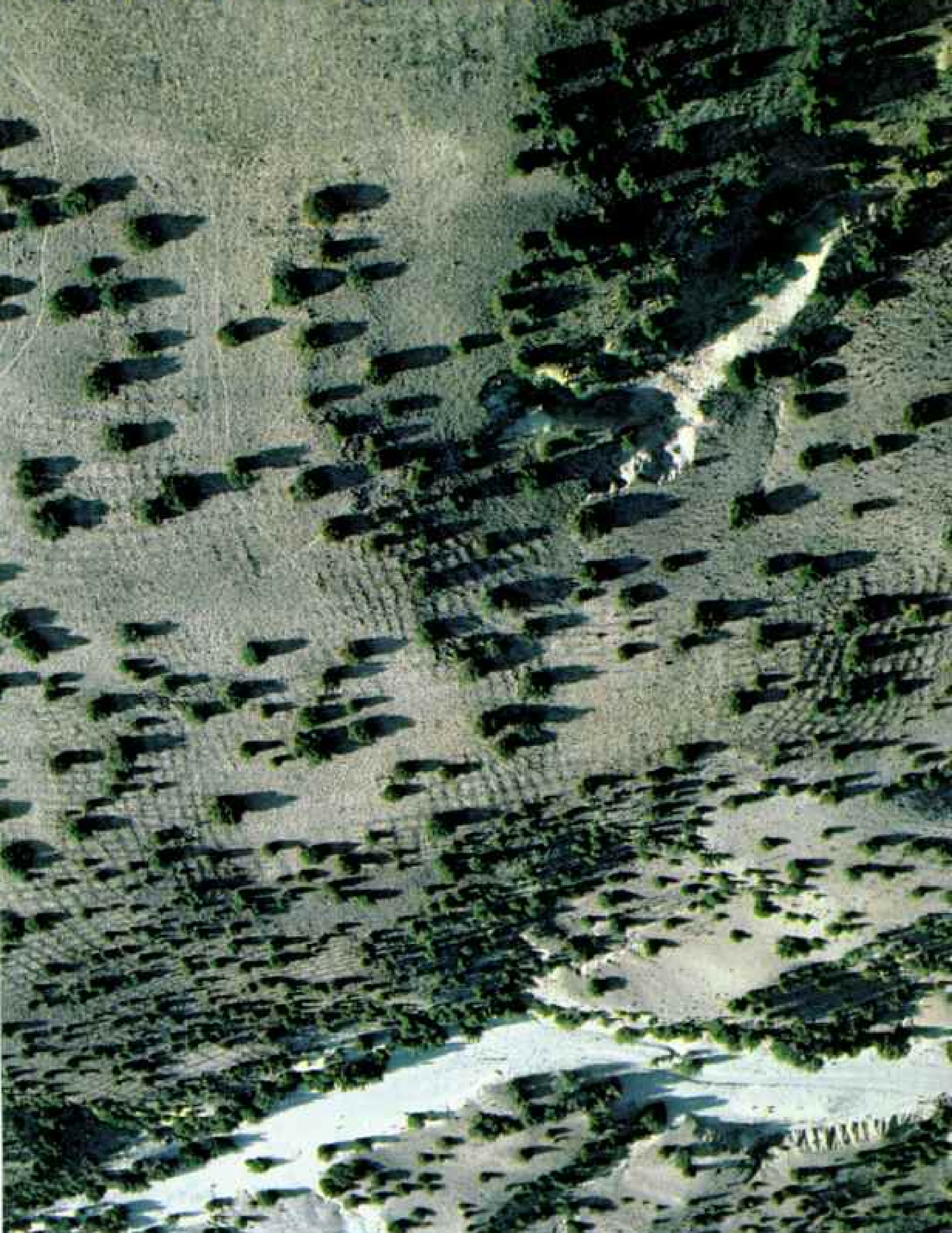
We paused at the base of Pueblo Bonito, its rear wall towering five stories. "Where heights such as this were needed," Dr. Judge explained, "lower walls were built more than three feet thick, tapering as they rose to



Coaxing corn *from the desert soil, a Chaco Indian cultivates plants with a dibble stick at Bis sa'ani Pueblo, one of some 70 satellite communities, or outliers, of Chaco Canyon. Harvested ears go into ground-level bins for storage. The Anasazi diet also included squash and beans, game, and wild plants such as squawberries and piñon nuts.*

support each higher level. For extra strength the builders devised a distinctive wall structure. Earth-and-stone rubble, forming the wall's center, was carefully worked into outside layers of sandstone blocks—a design we call core-and-veneer.

"Timbers for roofing the first rooms may have come from sparse stands of pine and fir in the canyon. But soon the Anasazi were seeking beams in mountain forests as much



PAUL LOKKEDOR (LEFT); DEWITT JONES

Like waffle irons, *the remnants of Anasazi farms stipple the land near the Ojo Caliente River in New Mexico* ***(left)****. Here rock and cobble borders created miniature catchments about a yard wide to retain water, most likely for nurturing corn, the principal crop.*

Some Anasazi corn may have been larger than people think, argues botanist Paul Knight of Corrales. Taking two ears about seven inches long ***(above)*** *of a variety once grown by Pueblo Indians, he burned them in his fireplace. The resulting cobs in the dish at left are virtually indistinguishable from burned cobs, at right, that Knight recovered from a dig dated at A.D. 1300. A cornstalk pecked out on a rock face near the ruins of San Cristobal shows two ears—one large, one small* ***(top)****.*

as 30 miles distant, and dragging or carrying them back to the canyon. We estimate they manhandled as many as 100,000 timbers to roof the great pueblos."

The roof beams demanded as much craftsmanship as the stonework. "The Chacoans weren't content with rough, axed-off rafters," said Dr. William J. Robinson of the University of Arizona Laboratory of Tree-Ring Research. "Using slabs of sandstone, they sanded the beams until the ends of each were smooth."

When finished, Pueblo Bonito held some 650 rooms and was the largest, most complex building of its kind in the Anasazi world. The front plaza held two large circular chambers known as great kivas, used for community functions. Eleven other great pueblos in or near the canyon embraced another 2,000 rooms. Here, in what is now a wasteland, stood housing for thousands.

Artifacts from the great pueblos suggest their occupants' activities. Thousands of turquoise beads, found among galaxies of flakes, tell of craftsmen working this stone, possibly for trade with Mexican civilizations. Unversed in metallurgy, the Chacoans imported small copper bells along with brilliant macaws, prized for plumage.

Grinding rooms held ranks of stone metates, and other chambers yielded personal effects that indicate dwelling areas. Many held nothing, suggesting that they were used for storing food and other perishables.

As they built the great pueblos, the Chacoans also were installing a vast array of water-control devices.

"The north side of the canyon was probably covered with irrigated fields," explained Dr. Gwinn Vivian of the Arizona State Museum in Tucson. "The source of the moisture was runoff from the rim that normally cascaded uselessly down side canyons into Chaco Wash. With a system of ditches and

Etched by moonlight, *a ladder and its shadow point the way to a cave carved from volcanic tuff at the base of Frijoles Canyon in Bandelier National Monument* ***(left)****. Candles light the cave's interior, as well as that of another to the right.*

Most archaeologists feel that the caves were living and storage rooms contiguous to main dwellings built of blocks of tuff; the remnants of walls stand beside the ladder. But Charlie R. Steen, an archaeologist formerly with Los Alamos National Laboratory, believes that such cave rooms had a religious purpose.

"They were small, poorly ventilated, and intentionally blackened by a fire from resinous woods," he says. Some, like a cave in Sandia Canyon ***(right)****, contained rock art such as this animal figure surrounded by human ones.*

"The caves were places where a man could go to pray," Steen concludes.

diversion dams the Anasazi managed to control and distribute this flow—an ingenious means of irrigating without a river."

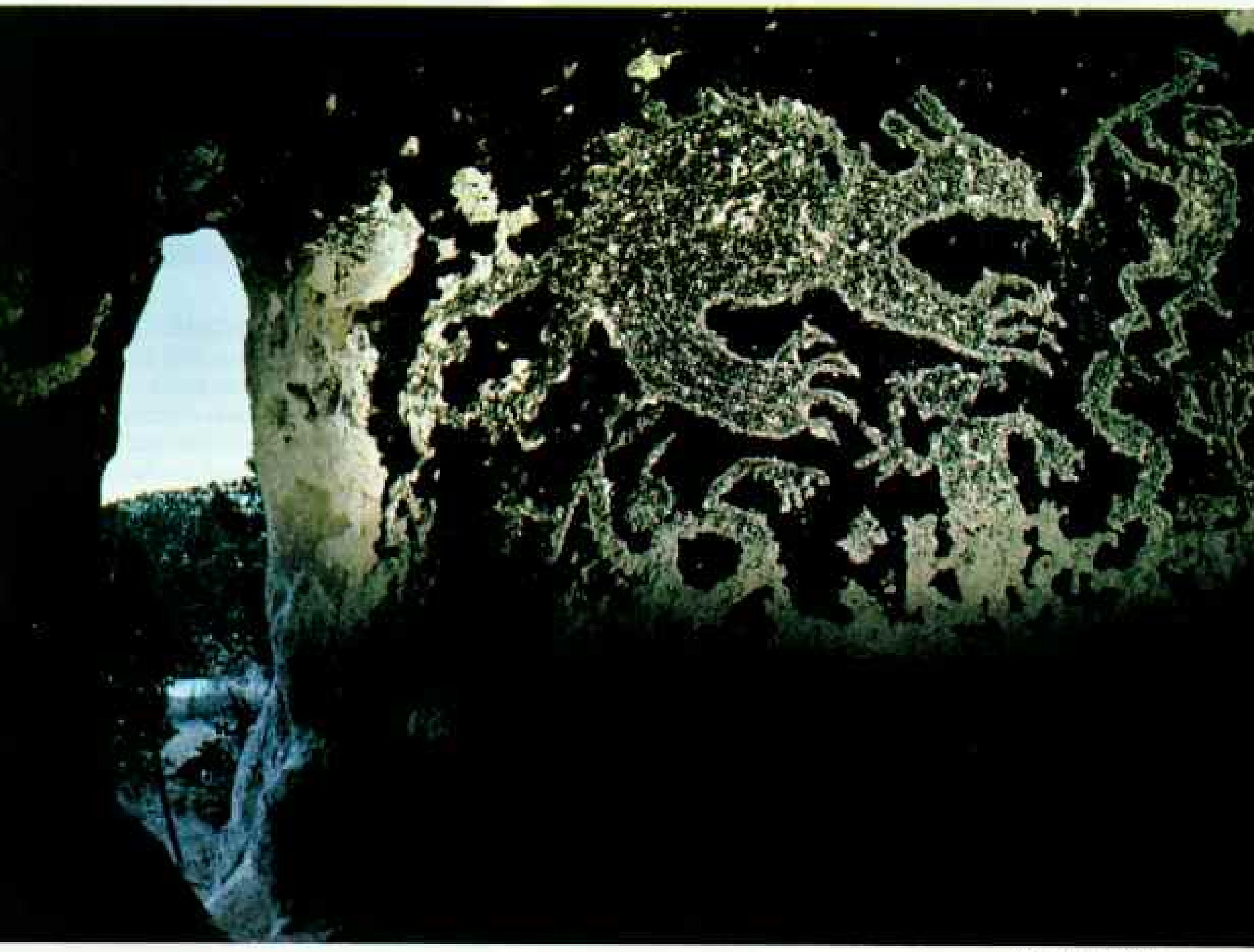
AS LABORERS constructed the great pueblos, at least 70 communities, similar in design but generally smaller in scale, were rising outside the canyon. As close as a few miles, as distant as 100, these outliers often included a great kiva and a multistory central house, built with core-and-veneer masonry. Most obviously were preplanned, and many appear to have been built from a single, standardized design.

Few outliers have been excavated by archaeologists. But many have yielded to the shovels and bulldozers of pothunters.

In 1967 this appeared to be the fate of a mammoth outlier known as the Salmon ruins, 40 miles north of Chaco on the banks of the San Juan River. A developer was buying the mound to subdivide into ten-foot "digging rights" for sale to pothunters. Seventy-two hours before the deal closed, nearby residents hastily organized a door-to-door campaign and scraped up funds to make the down payment.

Excavating the massive ruin, however, would require a multimillion-dollar archaeological effort. The local residents enlisted the help of Dr. Cynthia Irwin-Williams, an archaeologist then at Eastern New Mexico University in Portales. After intensive fund raising and lobbying, one of the nation's largest digs began pouring forth information about the Chacoan outlier.

"The entire complex of nearly 300 rooms was built according to a preconceived plan," said Dr. Irwin-Williams. "Begun in 1088, it was virtually complete only six years later. Loggers journeyed to Colorado's La Plata Mountains, more than 75 miles away, to cut huge beams. The stonework was



BOTH BY DEWITT JONES

The seasons strike on a clock of stone

PAUL LOGSDON

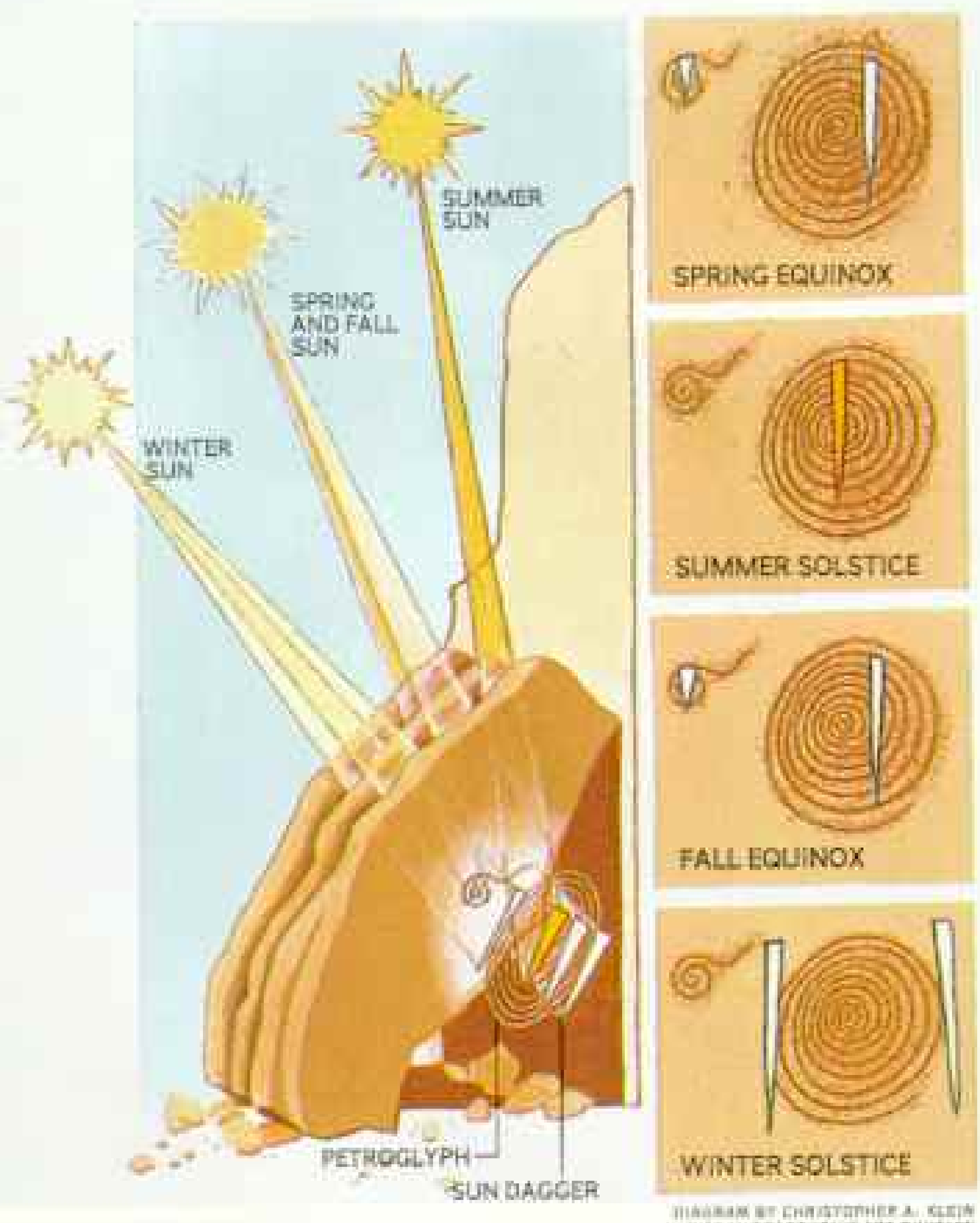


DIAGRAM BY CHRISTOPHER A. KLEIN
NATIONAL GEOGRAPHIC ART DIVISION

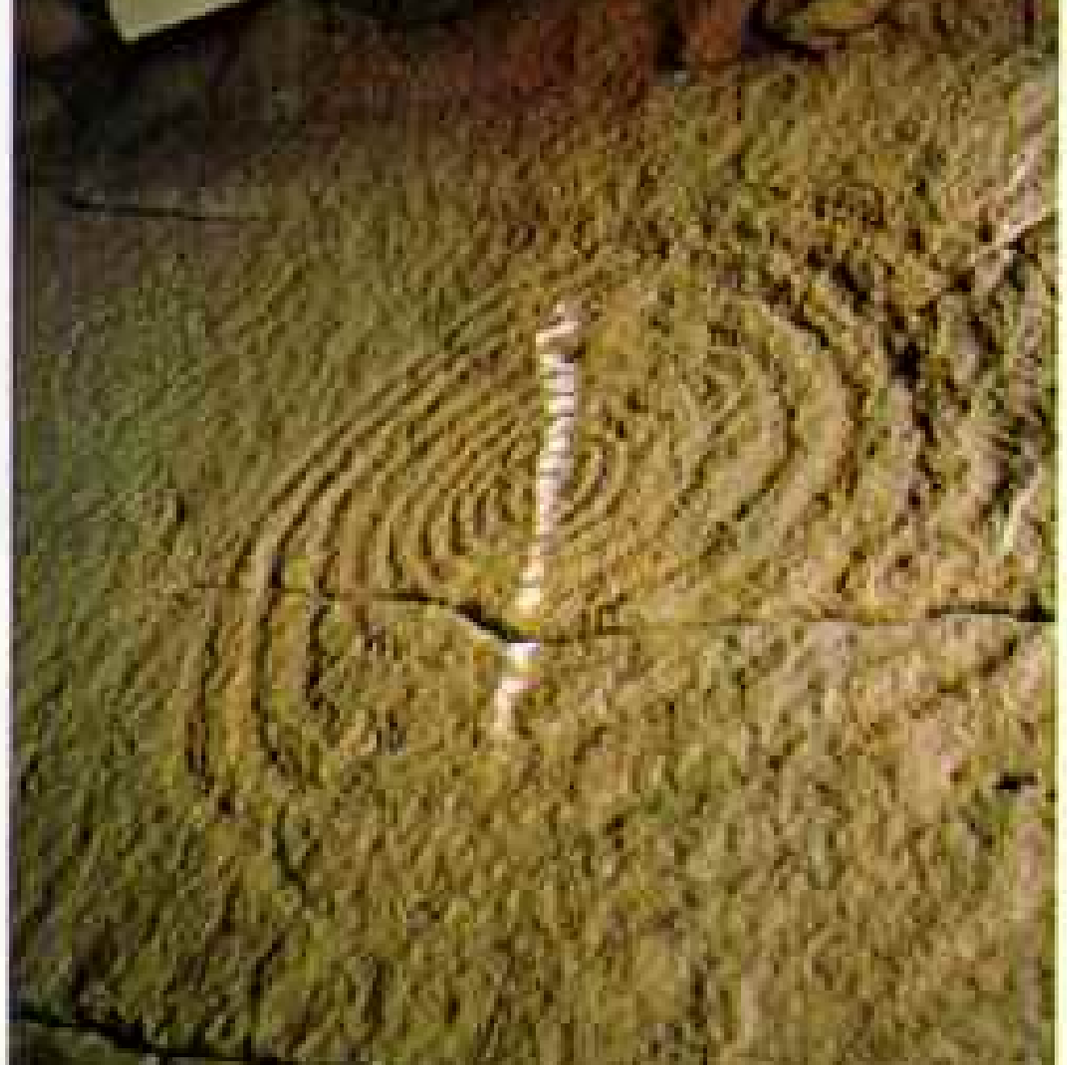
"SUN DAGGER" PHENOMENON: *Winter's first day is marked by rays of sunlight guided between stone slabs; they bracket* **(above)** *a spiral petroglyph on 443-foot Fajada Butte* **(top left,** *inset) at the south entrance to*

DAVID BRILL / ABOVE AND BELOW

Chaco Canyon.

*A single shaft of light, moving downward to bisect the petroglyph (**below,** left to right), signals the start of summer. Spring and fall are announced with an additional light on a smaller petroglyph (**diagram**).*

Discovered by artist Anna Sofaer, the device reflects the intellectual capacity and achievement of the prehistoric Anasazi, who utilized the midday sun to record time's passage.



phenomenal. After the masons shaped and placed each block, they smoothed it further by pecking with a hard stone, then gave it a final sheen by sanding."

Salmon held a great kiva, but its centerpiece was a commanding structure known as the Tower Kiva. Rising from the second story of the town, the tower's six-foot-thick walls were supported by solid buttresses similar in principle to those of Europe's cathedrals.

Two centuries after it was built, the Tower Kiva became a theater for tragedy. Fire started nearby, and two matrons herded a group of 50 children onto the sanctuary roof. But the fire spread. Soon the roof crashed down with the screaming crowd, the heat so great it melted sand on the floor. When archaeologists uncovered the scene, scorched skeletons showed that many children had died in each others' arms.

THE SURGE that built the Chacoan outliers produced other works. In a 1970 report on the water system, Gwinn Vivian included mention of Anasazi "roads." Though known to local Navajos and mentioned in earlier reports, the alleged network had left archaeologists skeptical: Why would a people lacking vehicles have built elaborate highways?

To study the system, the Chaco Center examined aerial photographs, some taken by Charles Lindbergh soon after his solo flight across the Atlantic in 1927. Faint lines hinted of a web of roads, most of them radiating out from Chaco Canyon. The threat of energy development recently generated an intensive surface study under the direction of the Bureau of Land Management (BLM), custodian of the largest part of the system lying on public lands.

"The roads usually ran arrow straight regardless of the terrain," explained BLM archaeologist John Stein as we walked the sandy soil north of the canyon. "Usually they were 30 feet wide, with the beds scooped down to bedrock or clay hardpan.

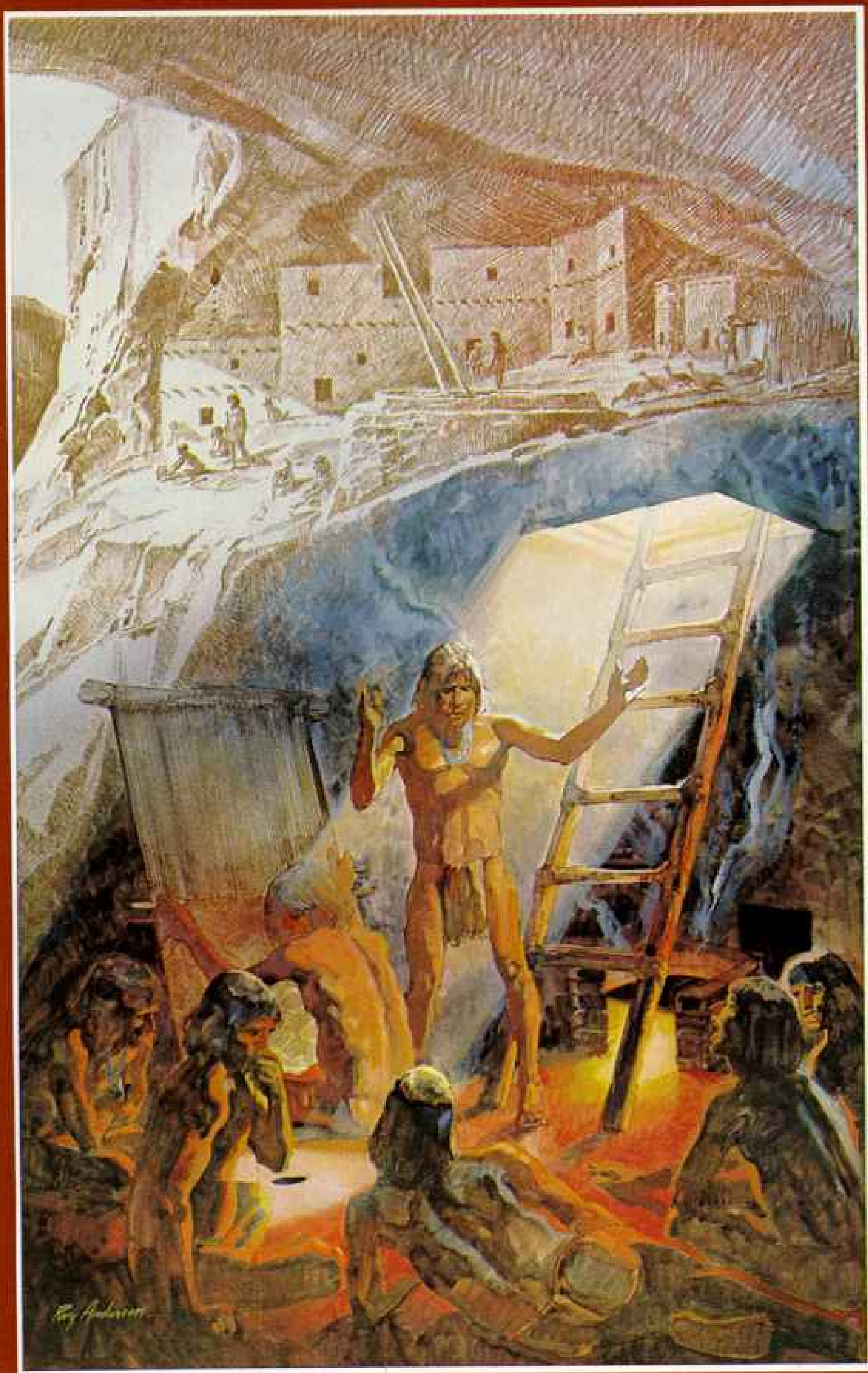
"A few segments are easy to detect at eye level, such as where the Chacoans cut paths through high dunes, built low stone curbs, or carved steps to scale cliff faces.

"But most of the roads in the aerials are invisible on the ground. To find them, we

A brooding thunderstorm *unleashes a cascade of rain near Puyé, a Rio Grande*

DEWITT JONES

ruin northwest of Santa Fe. Principal source of water for Anasazi farms, the capricious storms would drench one locale while leaving another dry.



looked for pottery sherds—remains of the many pots that probably broke during transport. Like here at our feet."

I looked down. Hundreds of sherds paved a path about 30 feet wide, stretching far ahead. We followed it, among the first pedestrians in almost a millennium.

"We call this the Great North Road," Mr. Stein continued. "It runs past several outliers almost to the Salmon ruins, then vanishes in present-day development along the San Juan River. Most of the roads connect outliers."

Exhaustively analyzing the aerial photographs, Gretchen Senter Obenauf, now of the BLM, has identified nearly 500 miles of possible roads, and speculates that many more await discovery. Five major roads converge at Pueblo Alto, a hundred-room ruin on the canyon rim that could have served as a trade center. At times two roads run parallel. At one point the Great North Road swells to four separate lanes, wider than many of today's interstates.

To complement the road system, the Chacoans appear to have devised a communication network, operated from high mesa tops scattered throughout the region. Some experts are skeptical, but one school of thought holds that these sites were located so that fires, or sunlight reflected by mica mirrors, could have been seen for great distances between outliers, and between outliers and the canyon.

Like other agrarians, the Chacoans set their ceremonial and planting calendar by close observation of solar cycles. To monitor the sun's seasonal progressions, they devised a solar observatory atop Fajada Butte, a 443-foot stump-shaped promontory rearing abruptly from the canyon floor. Spiral patterns, carved into native rock, caught shafts of light between other rocks precisely at the solstices and equinoxes. Discovered in 1977 by artist Anna Sofaer, this Chacoan "sun dagger" is widely regarded as the prehistoric Southwest's most sophisticated astronomical device.

SUNDAGGER, long-distance communications, mysterious roads, mammoth buildings, outliers. . . . What social system created these sophisticated ingredients of the Chaco phenomenon? Answers to this great riddle of archaeology run the gamut of speculation.

Chaco's undoubted contact with Mexico, combined with architectural features common to the two areas, leads many scholars to embrace a hypothesis often referred to as the "Mexican connection."

"The two cultures had many common economic goals as well," asserted Dr. Charles C. Di Peso, director of the Amerind Foundation. Excavator of the colossal Casas Grandes ruin in nearby northern Mexico, Dr. Di Peso believes that a merchant class in that city designed a Chacoan-like exchange system that operated trading outposts for dealing in turquoise and other exotics, with a road network that led north into the land of the Anasazi.

Support for the Mexican connection came from Alden Hayes, a respected former Park Service archaeologist. "Too much happened too fast to have been a local happening," said Mr. Hayes. "The jump from one- to five-story buildings, the roads and astronomical observatory, the complex social organization they imply—it's too much to accept without outside influence."

Another camp explains Chaco in terms of events that occurred within the area itself—a school of thought Dr. Judge labels "local boys make good."

"A key lies in the Chacoans' water-control system," said Dr. Vivian, a leading spokesman for this view. "To manage the water-diversion gates and canals and prevent washouts during violent downpours required a vast labor pool. The workmen would have lived in the great pueblos, which also stored the crops. When not involved with agriculture, people built the roads and great pueblos, both of which were partly make-work. Excess population was siphoned off to the outliers."

Relating a tale, *a Rio Grande Anasazi entertains his fellows in a kiva, an underground meeting place that served ritual purposes. The hole in the floor is a sipapu, symbolic link to the spirit world. Archaeologists infer the role of the kiva for the Anasazi from its use by their descendants, today's Pueblo Indians.*

***Bands of light** illuminate Casa Rinconada **(right)**, an Anasazi great kiva 63 feet wide in Chaco Canyon. Its size and location near several small village sites **(below)** suggest a community-wide role combined perhaps with administrative functions. Oddly, some great kivas lack sipapus.*

Midway between these camps stands a third group that takes a regional approach to the phenomenon.

Dr. Judge contends that the great pueblos, outliers, and roads formed the framework of an immense distribution system, administered from the canyon pueblos and designed to even out the availability of food in an area of variable climate. When patchy rains brought local scarcity, signal fires beaming from shrine to shrine may have borne the message to administrators back at Chaco. They in turn could have requisitioned foods from areas enjoying surpluses, or dispatched stores kept in the great pueblos, which served as massive silos.

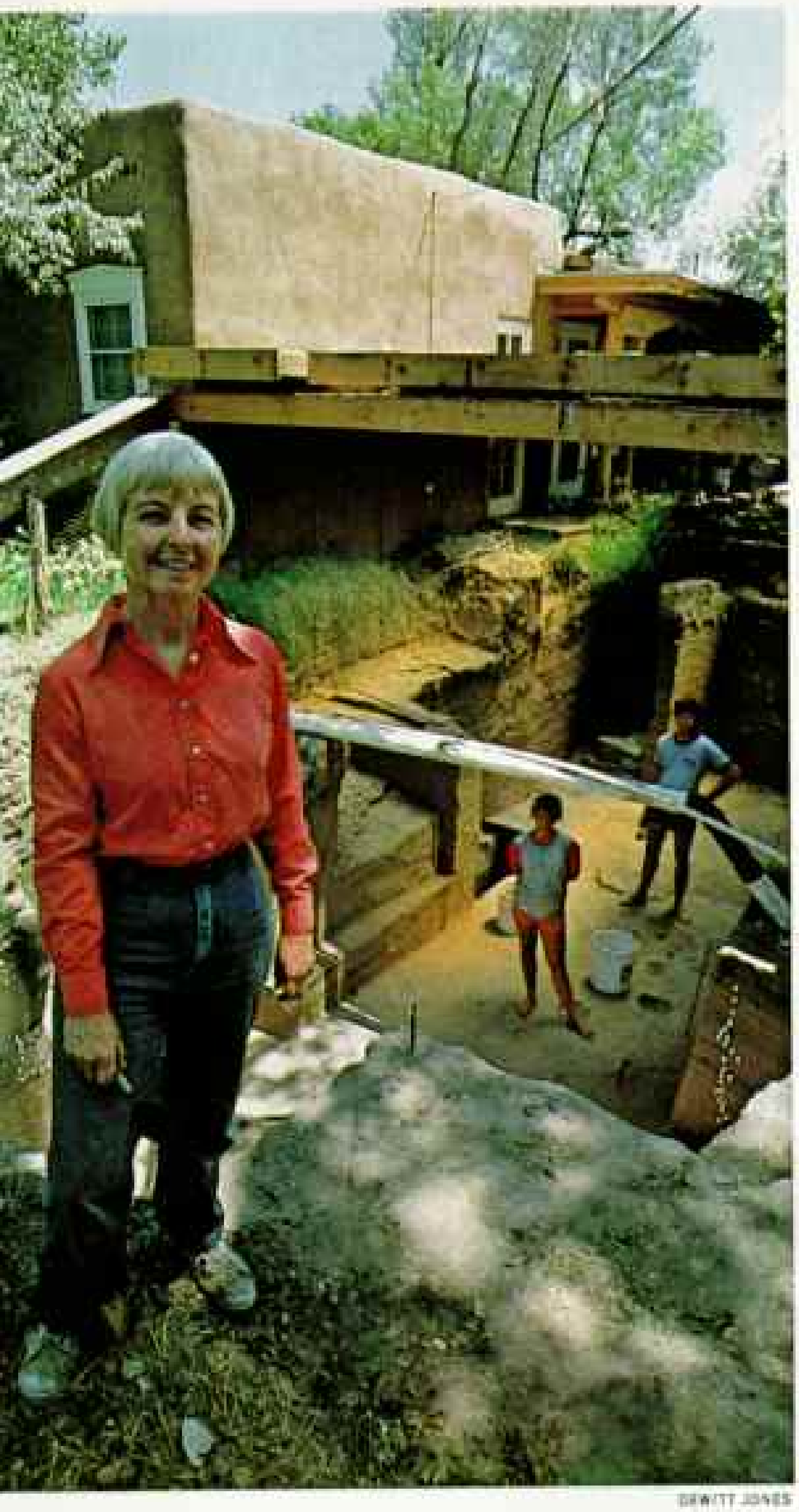
A number of archaeologists liken Chaco to a Hudson's Bay Company, in which relatively few agents organized the outliers to control local trade. Others see the great pueblos serving as largely ceremonial centers—meccas visited by pilgrims thronging

BOTH BY DAVID BRILL

the roads. This theory explains the puzzling scarcity of human burials at the great pueblos. An intriguing theory formulated by Albuquerque archaeologist Michael P. Marshall holds that the great pueblos were creations of the outlying districts, built as a sort of federal city for handling the outliers' trade and political alliances.

The roads hold the greatest of Chacoan enigmas. "Engineering them may have required more energy than building the great pueblos and outliers combined," said Michael Marshall. Adding little to the efficiency of foot-borne carriers, they perhaps served to symbolize the system's authority and to employ seasonally surplus labor.

By A.D. 1085 Pueblo Bonito stood virtually complete, although work continued on the other great pueblos. They hummed to the routine of everyday life: the endless grinding of corn, the bickering of traders, the tapping of masons shaping stones, the



DEWITT JONES

Backyard excavation *for a swimming pool and a studio became an adventure into the past for Albuquerque archaeologist Kit Sargeant. When a bulldozer turned up numerous Indian artifacts, she enlisted the help of graduate students from the University of New Mexico and began a systematic dig financed by herself and her husband.*

"We found six layers of occupation, the earliest dating to A.D. 1300," she says. The excavation yielded hundreds of potsherds, animal bones, corncobs, and a hole 12 feet deep. "It's our $10,000 hole," says Mrs. Sargeant.

soft footfalls of sandaled porters bearing foods along with other goods.

When storm clouds gathered and thunder signaled a summer downpour, people abandoned their tasks and rushed to the waterworks to manage the runoff that would spill from the canyon rim.

On mesas beyond the canyon, porters plied the roads bearing roof beams, firewood, food, and trade goods: pottery, baskets, and cloth. Messengers sped the spoken word between canyon and outliers; by night, lights on mesa-top shrines could have carried communications to distant points.

In the mid-1100s this even tempo faltered. Work on the great buildings halted. Gradually the social system collapsed, and before long most Chacoans enacted the Anasazi's ultimate response to stress: They abandoned the area.

What triggered the collapse?

The tree rings, faithfully keeping their chronicle, show that about 1150 drought struck, drought that would become more widespread and protracted than living Anasazi had ever known. As desiccation intensified and vegetation withered, eroding arroyos slashed the fields, lowering the water table and further crippling crops.

"With the entire system afflicted simultaneously, no part could respond to another's need," observed Dr. Linda S. Cordell, who with colleague Fred Plog has contributed numerous thoughtful analyses of the Anasazi. "And when the system collapsed, they were unable to return to the high level of energy necessary to reestablish it."

"When you look at the arid area it occupied," said Alden Hayes as an epitaph, "Chaco was a poor idea in the first place. It's a wonder it lasted as long as it did."

As Chaco writhed in its death throes, the Anasazi living on Mesa Verde were achieving their moment of destiny. Moving from the mesa top, for reasons still unknown, they descended to the tableland's vertical cliffs. There, beneath scores of rock overhangs, they built their citadels of stone.

Where Chaco stands as a monument to a grand design, Mesa Verde rings out as the Anasazi anthem. With a sweep of the eye I read this song from the overlook at Sun Point, my favorite vantage within the national park. Stone structures cling to the

cliffs like notes of a long-silent chord. Small dainty structures struck the high notes, while the bass echoed from enormous Cliff Palace, embracing 225 rooms.

"As large as that seems," warned Dr. Rohn of Wichita State, "recall that the park ruins reflect only a small fraction of the population that we call Mesa Verde Anasazi. Probably 95 percent of them lived off the mesa, some in giant communities that held thousands. More people lived in parts of southwestern Colorado then than now."

With Dr. Rohn I visited ruins scattered northwest of Cortez—low, sprawling mounds covering acres, hoary with sage and juniper. "The remains don't attract attention because they lack dramatic standing walls," said Dr. Rohn. "Yet some hold a thousand rooms, a hundred kivas. Their very size frightens away archaeologists; to excavate even one would cost a fortune."

The succession of droughts that had brought down Chaco persisted, and in the 1200s came the added peril of increasing cold. Spring arrived late, autumn struck early, and frosts preyed on crops.

But the Mesa Verde Anasazi hung on. "Nature favored them," said Dr. Petersen of the Dolores Program.

"From Mesa Verde west to Blanding, Utah, the Anasazi occupied the Great Sage Plain, a 4,000-square-mile area tilting slightly to the south. This tilt toward the sun creates a warm 'solar oasis' that extends the growing season a few crucial weeks."

AS THE 13TH CENTURY wore down, the cliff dwellers of Mesa Verde mounted a heroic effort to appease the gods. Above the mesa's strongest springhead they began construction of a magnificent masonry temple. Housing kivas three walls thick, it probably was oriented to record the annual seasons of the sun.

"I believe the Sun Temple represents a last great effort, born of despair, to read the heavens, to fathom the reason for the ordeal," said University of New Mexico anthropologist Alfonso Ortiz, himself a Pueblo Indian. "But before the temple was complete, the Mesa Verdeans too gave up hope and abandoned their homes."

Across most of the Four Corners region the land emptied. Silence claimed the teeming towns of the Great Sage Plain, the cliff dwellings of Canyon de Chelly and Tsegi Canyon, the parched western reaches of the Kayenta Anasazi.

For some, abandonment meant only a localized disruption. Anasazi who dwelled in Homolovi, a complex of thousands of rooms near Winslow, Arizona, simply climbed the bold mesas lying to the north, where they joined their relatives, the ancestors of today's Hopis.

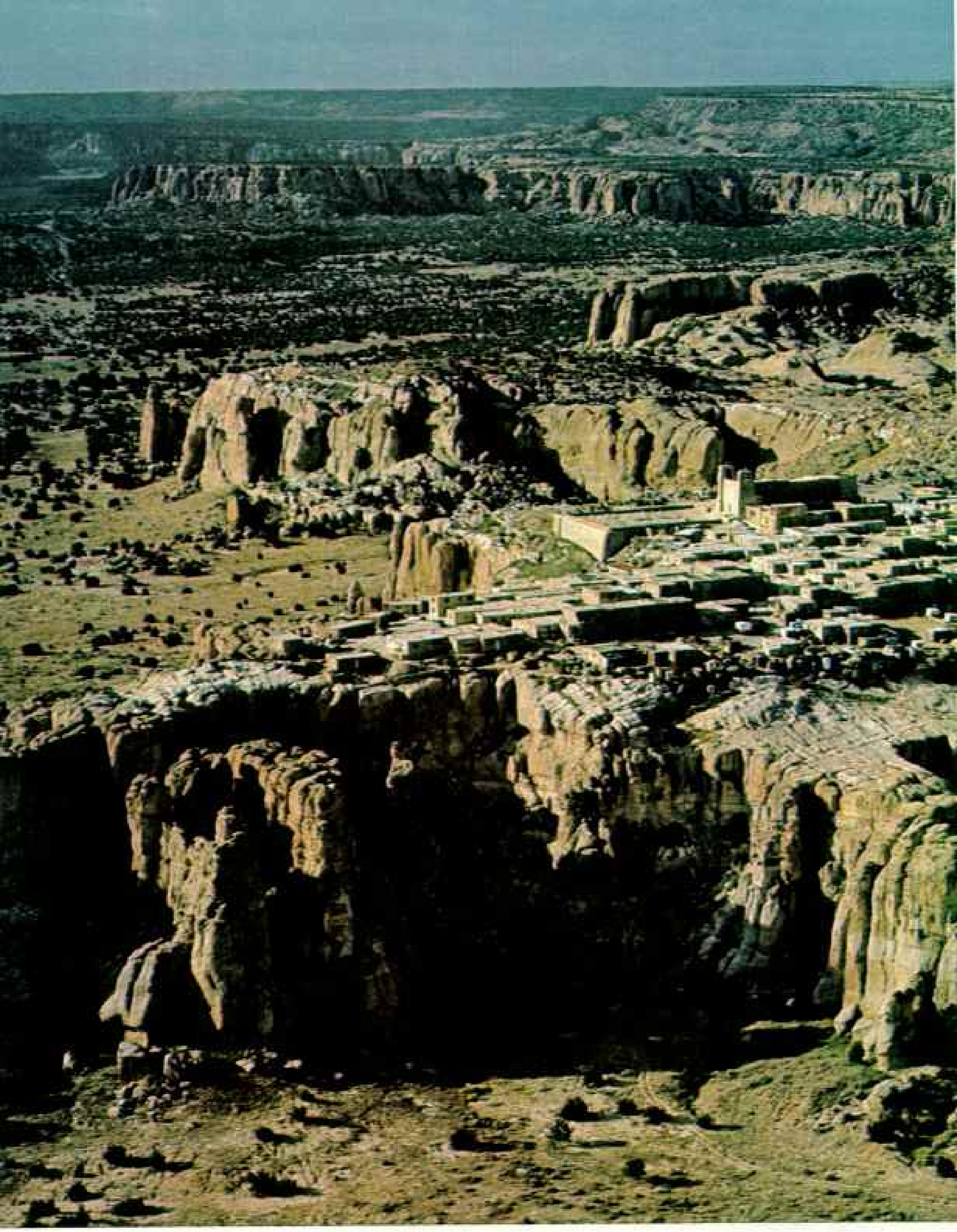
Some moved south, to beckoning green mountains of the Mogollon people. As with refugees everywhere, they were not always welcomed. At Point of Pines, a large Mogollon community in Arizona, archaeologist Emil Haury found evidence that the local populace rose up against an enclave of Anasazi immigrants and burned them out, then built a protective stockade around the town as if fearful of retaliation.

A number of the émigrés, however, made their way eastward, across the Continental Divide. Settling among their kind in the valley of the Rio Grande, they developed the final phase of Anasazi culture.

Since Basketmaker times a scattering of Anasazi had occupied the Rio Grande, from south of Albuquerque north to the present pueblo of Taos. Along with the gradual arrival of the immigrants came an increase in rainfall, and the communities flourished.

"The speed of the buildup was breathtaking," asserted Dr. Douglas W. Schwartz, president of the School of American Research in Santa Fe and excavator of Arroyo Hondo Pueblo. "About A.D. 1300 three families moved into an area above a spring and founded Arroyo Hondo. Within 30 years the population had soared to 1,500. The same happened all along this stretch of the river. Had more of these Anasazi built with stone instead of mud, the Rio Grande would be lined with dramatic ruins."

With Stewart Peckham, a veteran archaeologist at the Museum of New Mexico, I flew the upper Rio Grande to inspect these sprawling adobe citadels. Mr. Peckham pointed out the gaunt bones of Pecos Pueblo, occupied until 1838 by Anasazi descendants. We skimmed over the vague outline of Galisteo Pueblo, near a long igneous outcrop that the Anasazi had adorned with rock art.



Living link with the Anasazi? *Atop a mesa 65 miles west of Albuquerque, Acoma Pueblo was established late in the 12th century after the fragmentation of the Chaco culture. Though some 2,300 Acoma Indians maintain ancestral*

DEWITT JONES

homes here, most have permanent residences in nearby satellite communities—a seeming parallel to the Chaco Anasazi. The Acomas pursue lives as farmers, miners, and truck drivers, returning to the pueblo during times of celebrations.

Northward, Bandelier National Monument cupped homes and apartment caves hewn into canyon walls. Beyond marched more ruins, many holding hundreds of rooms: Puyé, Ku, Te'ewi, Sapawe, Posi. Most bore the craters of pothunters. Farther north, at the limit of corn country, lay the stark ruin of Palisade, whose 60 rooms protected by a stockade had been inhabited for only four years in the early 1300s.

Frequently I saw rectangular plots that appeared darker than surrounding fields. These marked an ingenious Anasazi effort to cultivate their hardscrabble land.

"I've identified seven different ways that the Rio Grande Anasazi coped," said Dr. David Bugé, formerly of California's Occidental College. "The dark fields you saw were mulched with gravel; there may have been thousands of acres of them. Stone mulch reduced the amount of water lost to evaporation, which explains why the fields produce lusher plant growth even today."

Intensive farming, supplemented by foraging and the raising of turkeys, supported large numbers of Anasazi along the Rio Grande from the 14th century through the 16th. That population density was creating problems for Kit and Arnold Sargeant, who had recently purchased an old adobe home in Albuquerque's North Valley area.

"We suspected that the gentle rise under our house was the ruins of a pueblo," said Mrs. Sargeant, showing me around. "As an archaeologist myself I planned someday to do a small excavation, literally in my backyard. But we didn't bargain for *this!*" she said, eyeing three large excavations.

"It began when I made a test pit where Arnold planned to put in a pool, and found crumbled adobe walls. Later we tested an area where we wanted to build a studio and encountered a small plaza surrounded by room blocks." We viewed the prospective studio, a hole 12 feet deep showing six different village levels. "Someday it will make a neat wine cellar," Mrs. Sargeant said.

FOR THE ANASAZI of the Rio Grande, a valued source of food lay available to the east. There, Indians of the southern plains—perhaps Apaches—hunted buffalo, whose fat and dried meat the Anasazi prized.

"From Taos to Socorro we find buffalo remains along the Rio Grande, where no bison grazed," said Dr. Richard I. Ford of the University of Michigan. "And on the Great Plains of Texas—buffalo country—we find Anasazi corn and pottery. This meant a trade network stretching more than 200 miles and crossing sharp cultural and language boundaries. Perhaps Plains Indians' dogs pulled travois that carried buffalo products westward and returned carrying Anasazi corn."

Always adept at painting and chipping designs on rocks, the Anasazi polished another art form during their flowering along the Rio Grande. "They painted marvelous murals on kiva walls," explained Dr. Jerry Brody, director of the University of New Mexico's Maxwell Museum. "These usually portrayed ritual themes of the supernatural world, such as symbols for clouds and lightning, and other devices associated with rainfall. The art also records details of the kachina cult, whose benign spirits are portrayed by the masked figurines so prominent in Pueblo religion today."

To see kiva art, I drove north of Albuquerque to Kuaua, a huge complex of 1,000 rooms restored at Coronado State Monument. Kiva walls, some bearing 85 coats of plaster, exhibited scenes of spirit dancers invoking rain and other blessings.

In this great adobe town the Anasazi lifeway encountered a force it could not surmount. From the south in 1540 came a strange procession: fair-skinned men encased in shiny metal, astride fearsome four-legged beasts.

For Francisco Coronado and his band of Spaniards, Kuaua was a place to winter during the quixotic search for cities of gold.

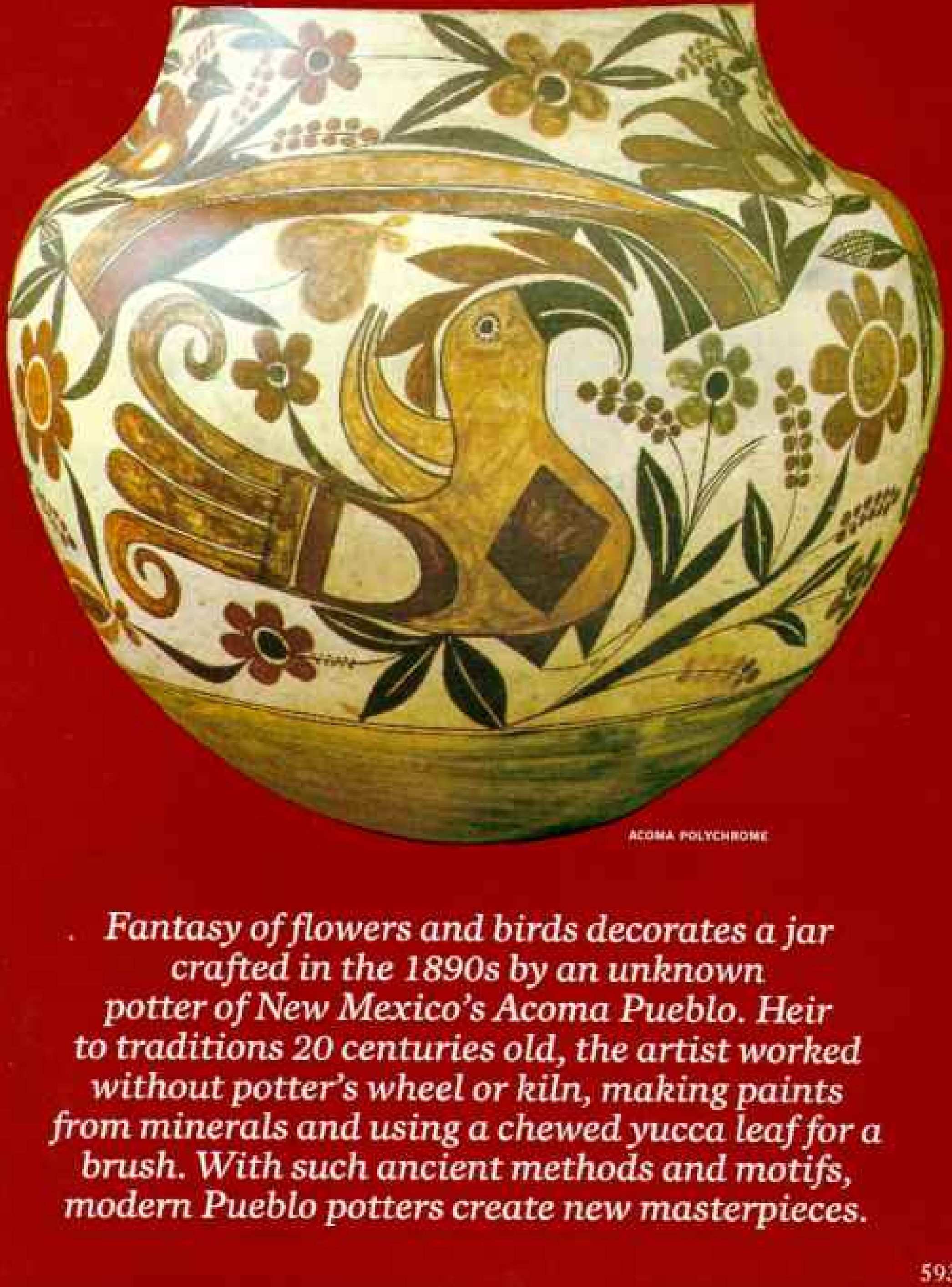
For the Anasazi, the Spanish *entrada* signaled a profound wrenching of 15 centuries of cultural development. Spanish officials seized farmlands, exacted tribute, and attacked the religion of the people they called the Pueblos. Navajos pressed in from the north, harassing the Pueblos. Soon the arrival of Anglos would impose new stresses.

Despite all, much of the Anasazi tradition survives with today's Pueblo Indians. Stolidly, stubbornly private in their ways, the Pueblos preserve this past with a tenacity as enduring as the silent ruins. □

Pueblo Pottery

2,000 YEARS OF ARTISTRY

By DAVID L. ARNOLD
NATIONAL GEOGRAPHIC STAFF



ACOMA POLYCHROME

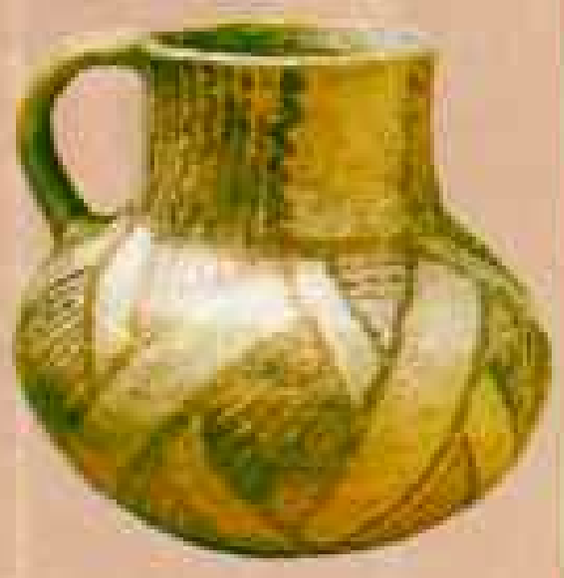
Fantasy of flowers and birds decorates a jar crafted in the 1890s by an unknown potter of New Mexico's Acoma Pueblo. Heir to traditions 20 centuries old, the artist worked without potter's wheel or kiln, making paints from minerals and using a chewed yucca leaf for a brush. With such ancient methods and motifs, modern Pueblo potters create new masterpieces.

HOHOKAM

VAHKI RED BOWL
[EARLIEST HOHOKAM STYLE]

ESTRELLA
RED-ON-GRAY PLATE

SACATON RED-ON-BUFF
EFFIGY VESSEL



CASA GRANDE
RED-ON-BUFF PITCHER

A.D. 1 200 1000 1200

Tracing a ceramic lineage

THREE MAJOR Southwest cultures—the Hohokam, Mogollon, and Anasazi—flourished almost simultaneously from the time of Christ until the late 13th century. Pottery became their most prolific artistic legacy, with creations of such distinctive form and design as to identify the time and place they were made.

The Hohokam from Mexico settled in present-day southern Arizona, bringing with them developed ceramic talents. Farmers skilled in irrigation, they thrived; so did their artists, whose designs became more and more complex. Their eastern neighbors, the Mogollon, created plain brownware with red paint designs until almost A.D. 900, when their work exploded in a sudden burst of black-on-white, a development borrowed from their northern neighbors, the Anasazi. This style reached great sophistication in the 11th century with the intricate geometric and pictorial renderings created by the Mimbres branch of the Mogollon (pages 600-601).

Although the Anasazi of the Four Corners area had traded for good fired pottery, their own first crude attempts consisted of shaping clay in baskets, which were then burned away. But within a few hundred years their creations blossomed with the diverse styles that still characterize the work of their modern Pueblo inheritors.

ANASAZI

BASKETMAKER II BOWL

MOGOLLON

SAN FRANCISCO RED BOWL. LIKE MOST EARLY CERAMICS, MOGOLLON AT FIRST WAS PLAIN AND UNPAINTED. A WASH OF RED CLAY LINES THE BOWL. ITS USE CONTINUED THROUGHOUT MOGOLLON HISTORY.

MOGOLLON RED-ON-BROWN PITCHER; TEXTILE DECORATION

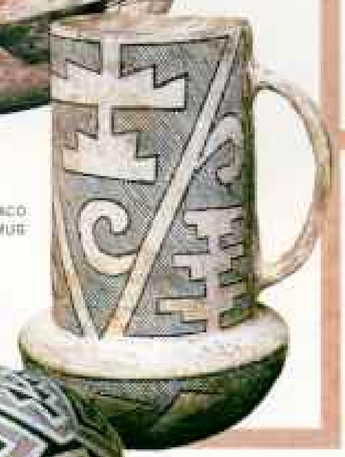
MIMBRES BLACK-ON-WHITE PLATE; FEATHER DESIGN

A.D. 1 900 1150

700 900 1100 1450 1800 1900

Florescence of Anasazi pottery coincided with the high-water mark of their civilization. Expanding populations in centers like Chaco Canyon and Mesa Verde supported pottery specialists. Ever growing trade created a need for group identification. Thus the ground was laid for regional variations of the Anasazi basic black-on-white.

MESA VERDE BLACK-ON-WHITE BOWL



CHACO BLACK-ON-WHITE MUG

LINO BLACK-ON-GRAY BOWL

TULAROSA BLACK-ON-WHITE JAR

First Anasazi painted ware followed two broad styles. Dot-filled design (above) presaged precise hatching on Anasazi black-on-white. Use of color in less formal patterns (below) foreshadowed later polychrome tradition.

KAYENTA BLACK-ON-WHITE BOWL

Abandoning their homes in the late 1200s, Anasazi groups relocated among other indigenous peoples. Although they continued for a time to make black-on-white pottery, soon new designs emerged, the result of cultural intermingling. Among the Hopis the polychrome tradition continued uninterrupted.

Checkerboard design over a cloud symbol adorns the neck of a pot from San Ildefonso.

RIO GRANDE GLAZE "C" BOWL

Spanish colonists arrived in 1598, six decades after Coronado's fruitless search near Zuni for the golden cities of Cibola. Their influence could soon be seen in new arabesque designs and the production of cups, soup plates, and high-necked jars.

Scalloped rim of Santa Clara blackware reflects Spanish influence. Black is carbon charged into clay when it is fired in oxygen-poor air, created by smothering flames with powdered dung.

SANTA CLARA BLACK JAR

Elements of nature — stars, lightning from sacred bears — decorate a ceremonial jar.

SAN ILDEFONSO BLACK-ON-WHITE JAR

SAN ILDEFONSO POLYCHROME JAR

Glaze decoration, a major departure from black-on-white, appears on the Rio Grande and Kwakina bowls.

Famous for thin walls and white clay, Acoma pottery moved from geometric figures to naturalistic motifs in the historic period.

ACOMITA POLYCHROME JAR

MCCARTYS POLYCHROME JAR

ACOMA POLYCHROME JAR

KWAKINA POLYCHROME BOWL

HAWIKUH GLAZE-ON-RED BOWL

Plate depicts a speared and emasculated figure with centipede. Masked kachina figure on the canteen wears a feather costume.

Pueblo potters used glazes for decoration, not waterproofing.

ASHIWI POLYCHROME BOWL

Heartline deer, a symbol in sub-arctic taiga art, may have come to the Zunis via Navajos arriving from the north.

ZUNI POLYCHROME JAR

ABAJO RED-ON-ORANGE BOWL

DOGOSZHI BLACK-ON-WHITE JAR

BIDAHOCHI POLYCHROME PLATE

JEDDITO BLACK-ON-YELLOW JAR

SIKYATKI POLYCHROME PARROT EFFIGY VESSEL

SIKYATKI POLYCHROME JAR

SIKYATKI POLYCHROME CANTEEN

Collectors' items even in the aboriginal world, Sikyatki polychromes and Jeddito black-on-yellow were traded widely. Early potters worked with an abandon of sweeping curves and brilliant colors. Frequent bird motifs reflected the importance of that magical creature that soared between man's world and the realm of the spirits.

POLACCA POLYCHROME JAR

A.D. 1350 1600 1900

SANTA CLARA

The tradition of making blackware continues at Santa Clara Pueblo, with innovations in carved designs.

ELIZABETH NARANJO

VIRGINIA EBELACKER

MELA YOUNGBLOOD

Santa Clara and nearby San Ildefonso share design elements such as the awanyu, a serpent, which is carved on a double-necked wedding vase, and the bear paw, sometimes inlaid with turquoise.

SAN ILDEFONSO

Pottery production declined at San Ildefonso near the end of the 1800s but today provides a large share of pueblo income.

TONY DA

Thousand-year-old Mimbres feather design reappears on a plate by Maria Martinez and her son, Popovi Da. A Mimbres-style figuree adorns an Emma Lewis jar. Vessels of Marie Chino and Lucy Lewis derive from Anasazi black-on-white.

MARIE Z. CHINO

LUCY M. LEWIS

ACOMA

Pictures in a notebook sparked interest in old designs at Acoma. Dr. Kenneth Chapman, who had long urged pueblos to retain their heritage, first showed Mimbres material to Acoma potters in the early 1940s.

HOPI

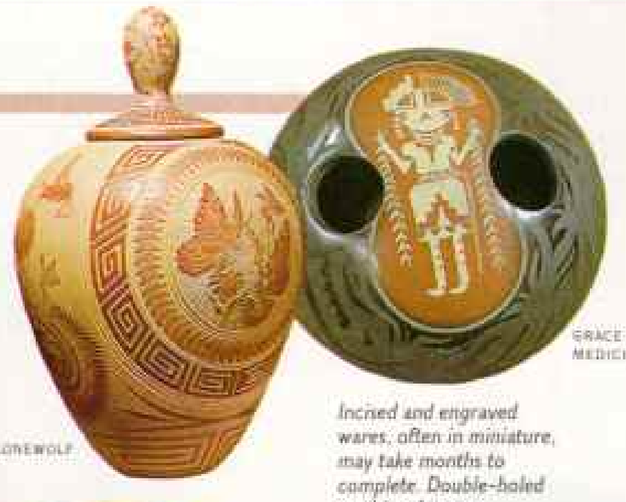
Old Sikyatki polychromes inspired Hopi potter Nampeyo and her artist husband, Lesou, who had helped excavate Sikyatki ruins in 1895. To re-create their heritage, they found clay like that used in the originals.

NAMPEYO

FANNIE NAMPEYO

JODY FOWELL

MELA YOUNGBLOOD



JOSEPH LONEWOLF

GRACE MEDICINE FLOWER

Incised and engraved wares, often in miniature, may take months to complete. Double-boiled seed jar shows a masked dancer holding evergreen boughs.

MARIA MARTINEZ AND POPOVI DA

MARIA MARTINEZ

TONY DA

BLUE CORN

Spirals on a canteen recall those of the 12th-century Tularosa black-on-white jar (page 595).

EMMA LEWIS

JUANA LINO

Mudhead figure, ritual clown of the Hopis, is a departure in Pueblo ceramics, though grounded in tribal culture.

JOY NAVASIE (FROG WOMAN)

AL QÖYAWAYMA

ELIZABETH WHITE

Ever experimenting, Al Qöyawayma applies new designs to traditional shapes and enlists scientists to help identify sources of Sikyatki clays.

COCHITI FIGURINES

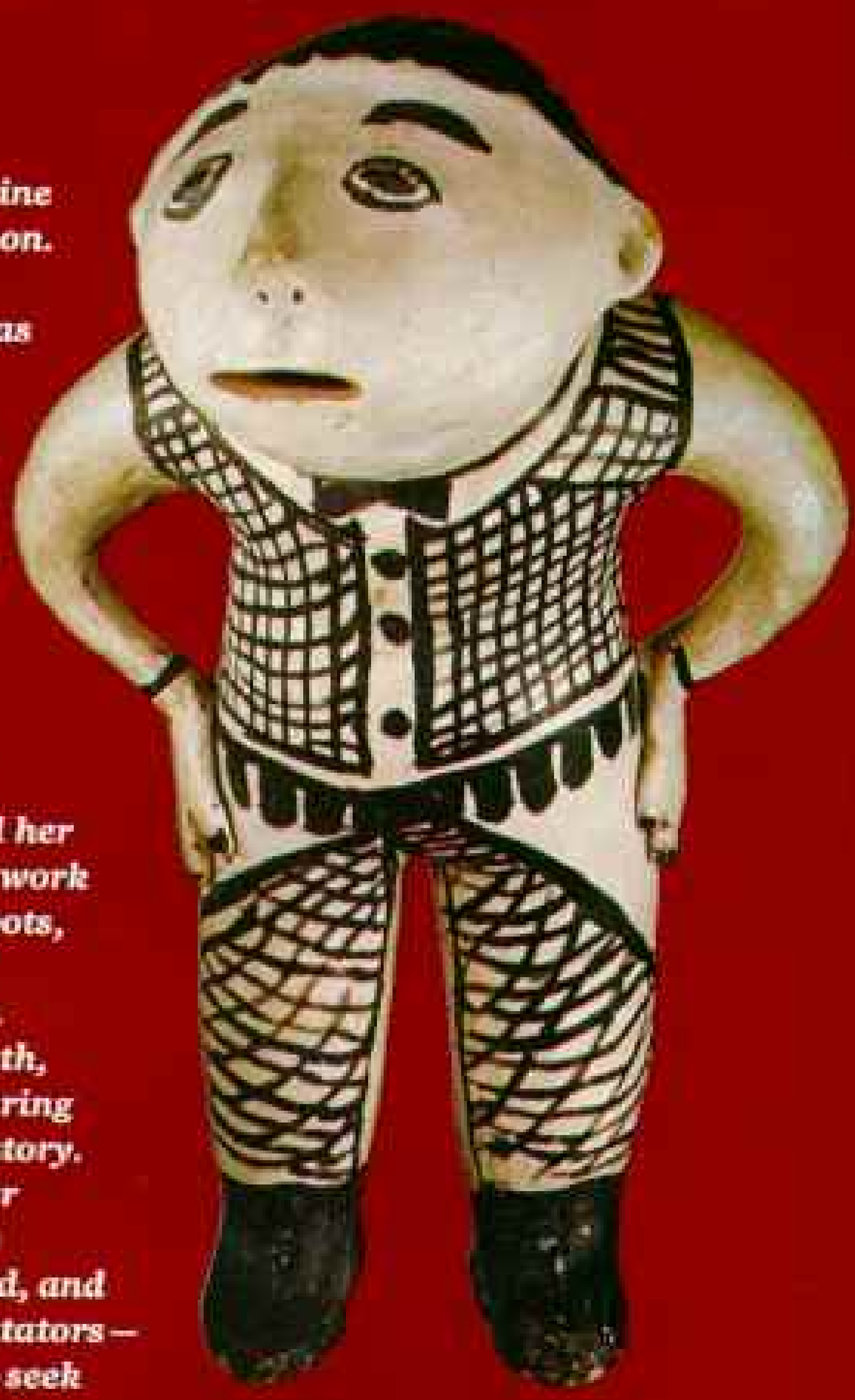
Characters in clay

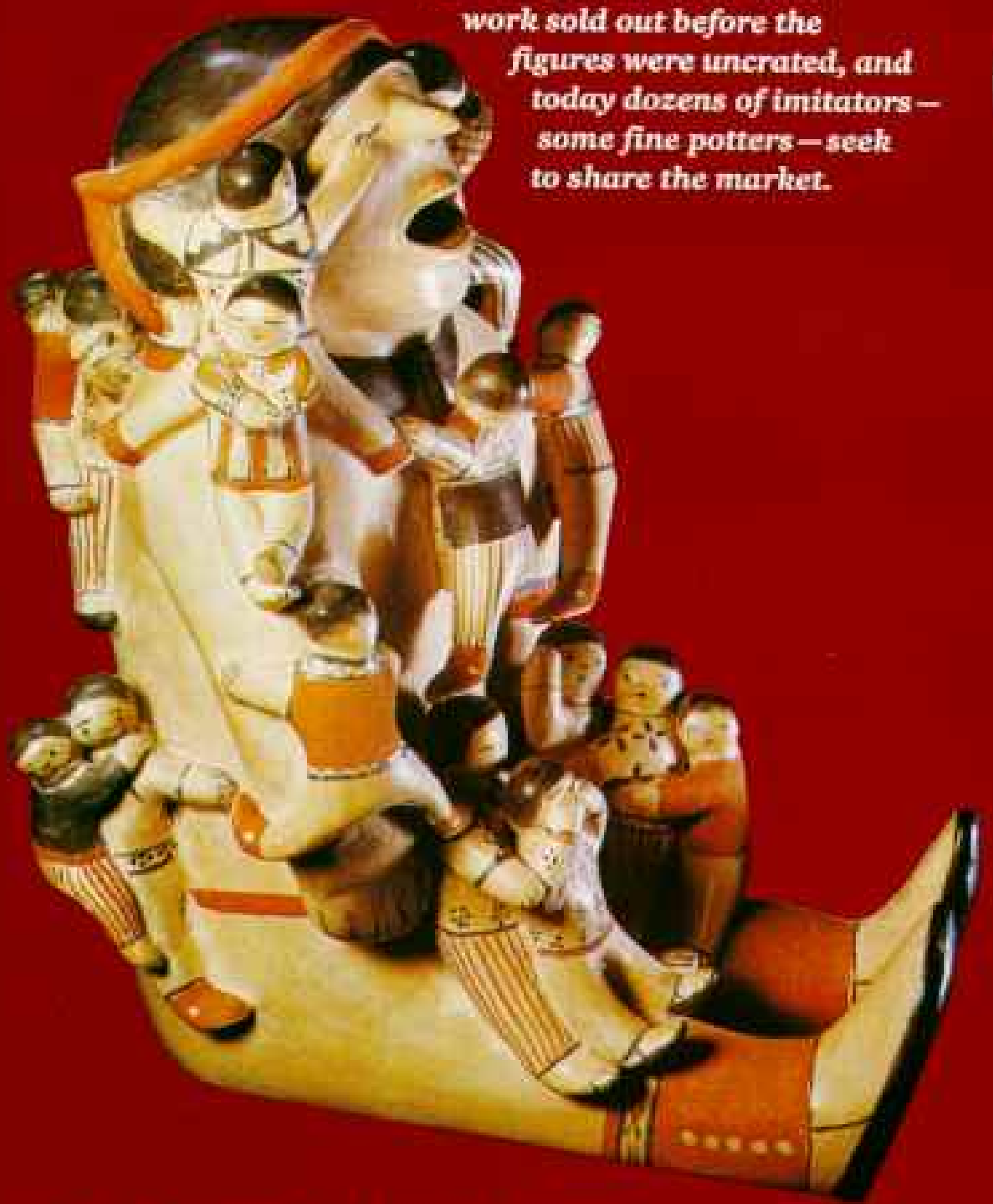
UNFLAPPABLE as Gary Cooper, a cowboy figurine (right) seems ready for a quick draw at high noon. Such clay caricatures, created by potters of New Mexico's Cochiti Pueblo, enjoyed brief popularity as collectors' items in the late 1800s. The vogue followed the coming of the railroad to the region, and artists delighted in mimicking their new visitors: supplicating padres, mustachioed Italian tenors, businessmen, two-headed people from circus shows, even dancing bears. "They were making fun of the white man," folklorist Barbara Babcock believes, "but they weren't malicious."

Figurines are still a popular product of Cochiti, thanks in large part to Helen Cordero, who created her first "Storyteller" figure in 1964. "I didn't begin to work in clay until I was 49," she says. She started with pots, but as she puts it, "They just didn't turn out right."

Cordero's storyteller model was her grandfather. Recalling with affection the tales he told in her youth, she models him (below) with clinging listeners wearing expressions of rapture or fright, depending on the story.

A recent gallery show of her work sold out before the figures were uncrated, and today dozens of imitators—some fine potters—seek to share the market.





The pottery in this presentation came from the following museums and private collections: Arizona State Museum, University of Arizona; Marjorie and Charles Benton; Margaret Cross; Rick Dillingham; Field Museum of Natural History; Hand and the Spirit Gallery; Heard Museum; Mr. and Mrs. William E. Hinkley; Richard M. Howard; Mr. and Mrs. Dennis Lyon; Mesa Verde National Park; Museum of the American Indian, Heye Foundation; Museum of Northern Arizona; Peabody Museum, Harvard University; Al Qöyawayma; Millicent Rogers Museum; School of American Research; Tanner's Indian Arts; University of Colorado Museum; Woodard's Indian Arts.

STANDING FIGURES

Mimbres art

THESE POTS tell stories, but what do they relate? Between A.D. 1000 and 1150—barely five generations—a small branch of Mogollon peoples living in the Mimbres Valley area of New Mexico produced an astonishing array of black-on-white and polychrome pottery. Most designs were elaborately geometric, but many portrayed human and animal figures that seemed to offer a glimpse of vanished life. But what is reality and what is myth?

A depiction of childbirth (lower right), with the newborn waving a greeting, seems the stuff of everyday life. So, too, does the scene of a man who appears to be snaring birds in a thicket (center). Yet modern Hopi Indians feel that a deeper, hidden meaning lies in the movement of the unsnared birds. Hopis also identified the standing figures (upper left), saying only a woman would wear a necklace and only a man armbands. Yet both wear headbands and facial marks, either tattoo or paint, a design repeated on the "bat man" (upper right), whose tail mimics that of a bat of the Southwest. Water bugs (bottom center) cross a pond under the gaze of two figures—or could it be one figure and its reflection?

Some experts believe the decapitation scene (lower left) may be a Mimbres rendition of the Aztec god Quetzalcoatl, since his style of headdress and human sacrifice were common in the land to the south, a major trade area of the Mogollon. Another interpretation: the last desperate attempt in times of severe drought to appease the rain deities through human sacrifice.

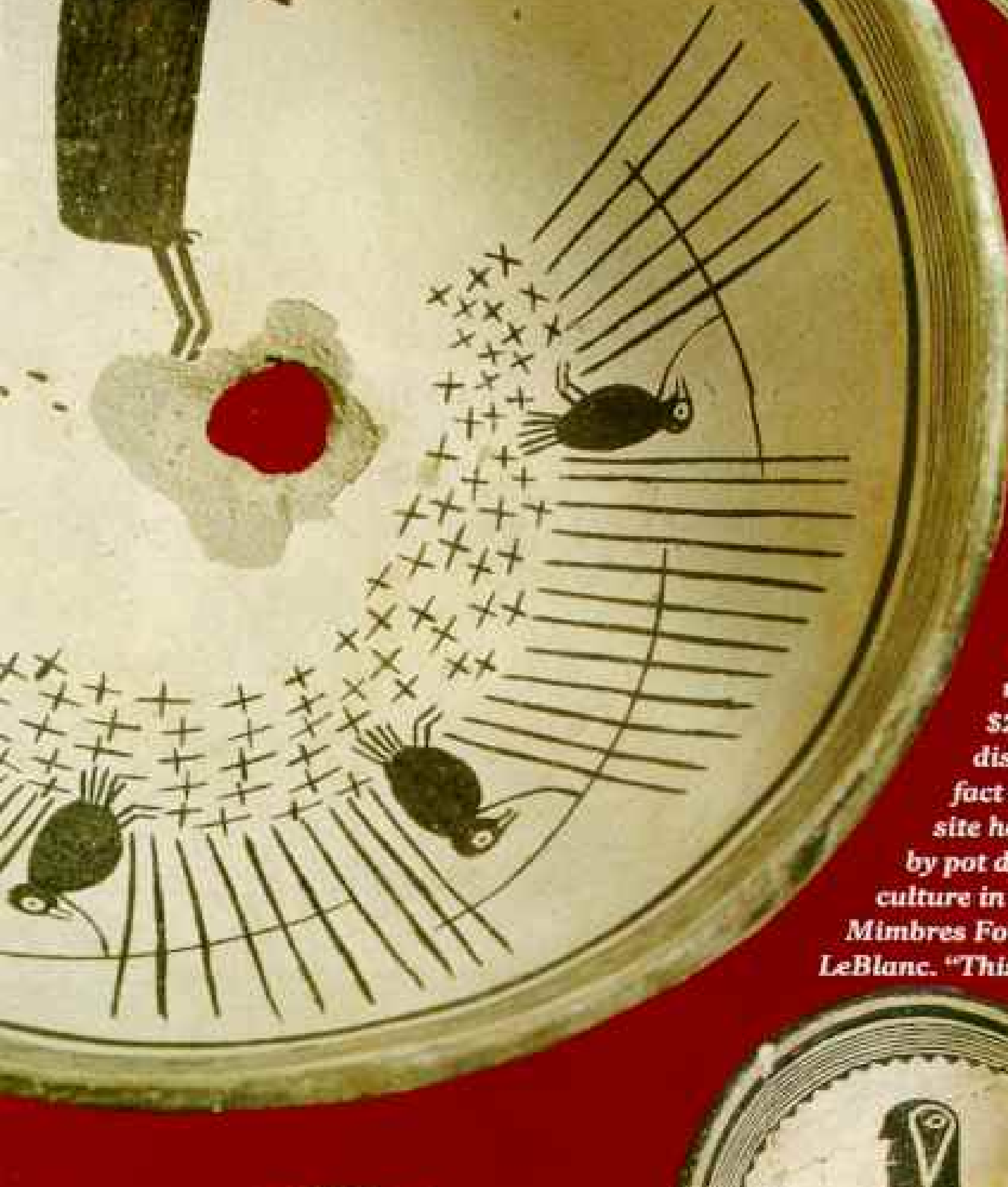
MAN TRAPPING BIRDS IN A GARDEN

DECAPITATION

MAN IN BAT COSTUME

FUNERARY OBJECTS, these Mimbres pots were buried upside down over the faces of the dead, and the pots themselves were "killed"—a hole punched in a ritualistic act of breakage that did little damage. In fact, many kill holes seem carefully placed to avoid design elements.

The Mimbreños' high regard for their art is shared by collectors today. Private sales of Mimbres material have reached $20,000 per pot. Most distressing, however, is the fact that almost every Mimbres site has been effectively destroyed by pot diggers. "It is the most looted culture in the United States," says Mimbres Foundation director Steven LeBlanc. "This makes it terribly difficult to understand these remarkable people."



TWO HEADS WITH WATER BUGS

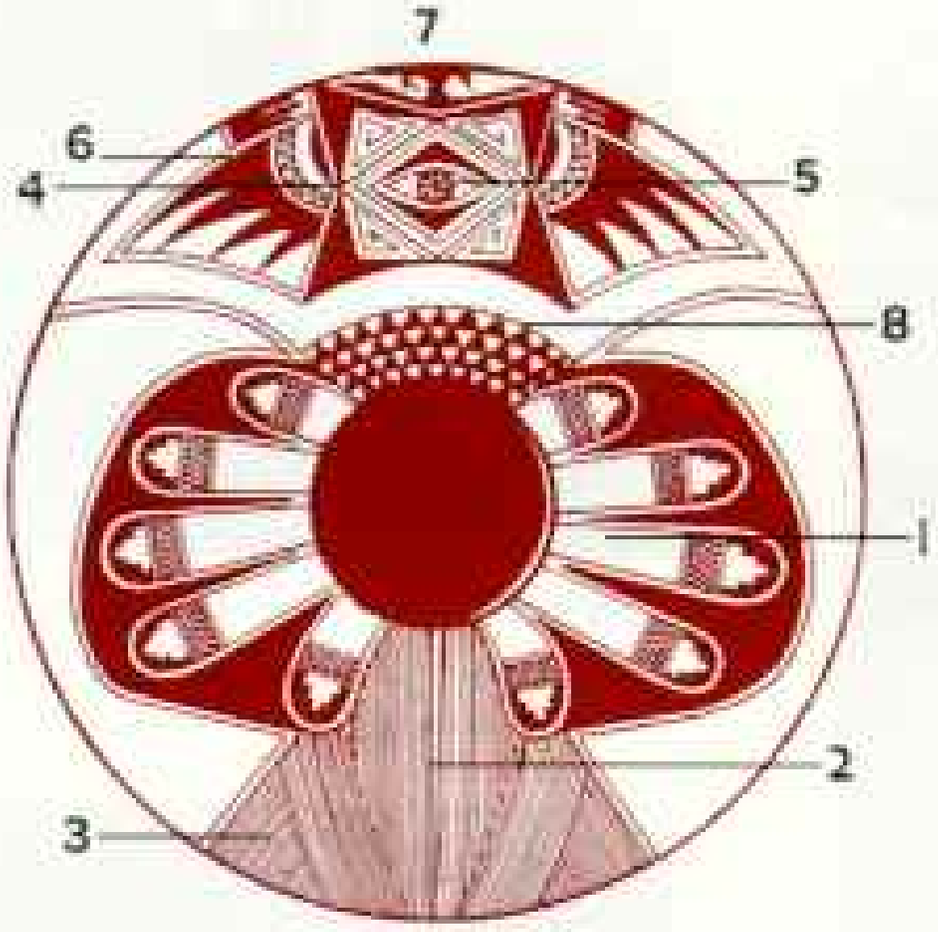
CHILDBIRTH

Age-old methods, timeless symbols

COIL UPON COIL, Hopi potter Dextra Quotskuyva builds a pot (right) using techniques passed down from mother to daughter since ancient times. With a piece of gourd, she shapes the vessel (center). After air drying and scraping, a slip, or thin wash of clay, is added before final polishing and painting (bottom). The piece will be fired in a crude oven of dung cakes. Only when the ashes are brushed away will Dextra know if she has succeeded or failed.

Great-granddaughter of the famed Hopi potter Nampeyo, Dextra did not make her first pot until 1967, when she was 39. "One day I asked my mother to let me help paint pots," she remembers. "She gave me a cracked one to start with, but when she saw how I could paint, she was sorry she had given me the cracked one. It came easily."

A completed seed jar (left) shares Dextra's worktable with stones holding organic and mineral paints, yucca-leaf brushes, polishing stone, and a 400-year-old sherd of Sikyatki polychrome, whose designs inspired her family and other modern potters.



Dextra explains her design: From the seed-jar hole in the center, representing the sipapu, or mythical hole in the earth, the Hopis emerged from the underworld. Hands reaching out (1) represent the Hopis and all other living things coming into this world. The womb of mother earth (2) is flanked by other lines (3) signifying the spirits of all unborn people entering the world. The four corners of the earth (4) surround the eye of the Great Spirit (5), itself centered in the wings (6) and head (7) of an eagle. Four rows of triangles (8) indicate the Hopis' reverence for groupings of four.

Continuing a rich legacy

ENTICED from her mesa-top home one day in 1901, an Acoma woman (below) brought on her head a work of art—the bread jar shown on page 593—to the hands of purchaser and photographer Henry G. Peabody. In that time his name was worth recording while hers was unknown. But Indian anonymity changed as the pueblos' need of income coincided with the white man's fascination with things Indian. Maria Martinez of San Ildefonso Pueblo (top right), first to sign her work, soon became famous both for her polychrome and black-on-black creations. Today scores of potters from 16 pueblos supply a growing market. Their products are art, and their craftsmanship—rooted in 2,000 years of tradition—endures.

*Best-known of modern pueblo potters, **Maria Martinez** led the artistic revival until her death in 1980.*

***Tony Da**—Maria's grandson and one of the few male traditional potters—adds new designs to old techniques.*

Polished blackware is the hallmark of ***Margaret Tafoya*** *of Santa Clara (above). Bear paws are a frequent motif. "They are good luck," she says. "The bear always knows where the water is."*

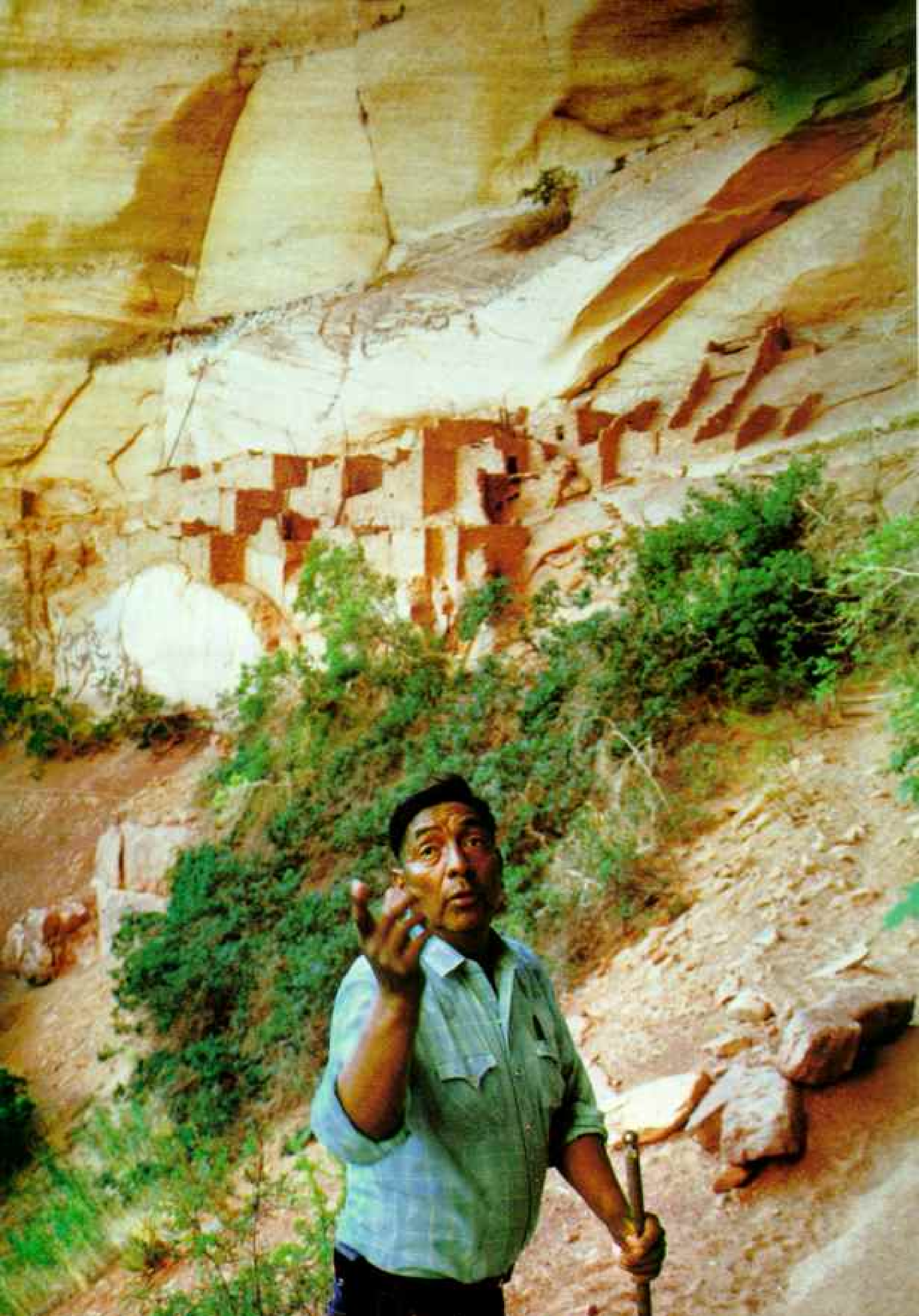
Jody Fowell *of Santa Clara combines incising with abstract slip-painted designs (above).*

Mimbres designs were made popular in Acoma by ***Lucy Lewis*** *(left).*

Joy Navaste *(Frog Woman) applies Sikyatki-style designs on almost pure white slip (above).*

Teacher ***Fannie Nampeyo*** *(left) has passed the artistic legacy of her famous mother to her daughters and granddaughters.* □

Dr. Alfred E. Dittert, Jr., of Arizona State University, was the major consultant for this presentation. The majority of the photographs were made by Jerry D. Jacka, with the following also contributing: American Federation of Arts, David L. Arnold, Peter L. Bloomer, Hillel Burger, Rick Dillingham, Susan Einstein, Lowell Georgia, Bob Hanson, Dewitt Jones, Robert Lightfoot III, Guy Monthan, Steve Northup, and Julia Vasquez.



Inside the Sacred Hopi Homeland

By JAKE PAGE

Photographs by SUSANNE PAGE

ALPH SECAKUKU, a member of the Hopi Snake Society, held out his pipe to me. Pungent smoke curled from its clay bowl, fashioned long ago into the form of a mountain lion.

We were squatting high on a hill that rises improbably some 500 feet above the flat plain south of Holbrook, Arizona. This was the last stop on a four-day, 1,100-mile trek made by eight Hopi priests accompanied by two Hopi drivers, my wife, Susanne, and myself. We now had visited the eight principal shrines that mark the boundaries of the Hopis' ancestral land.

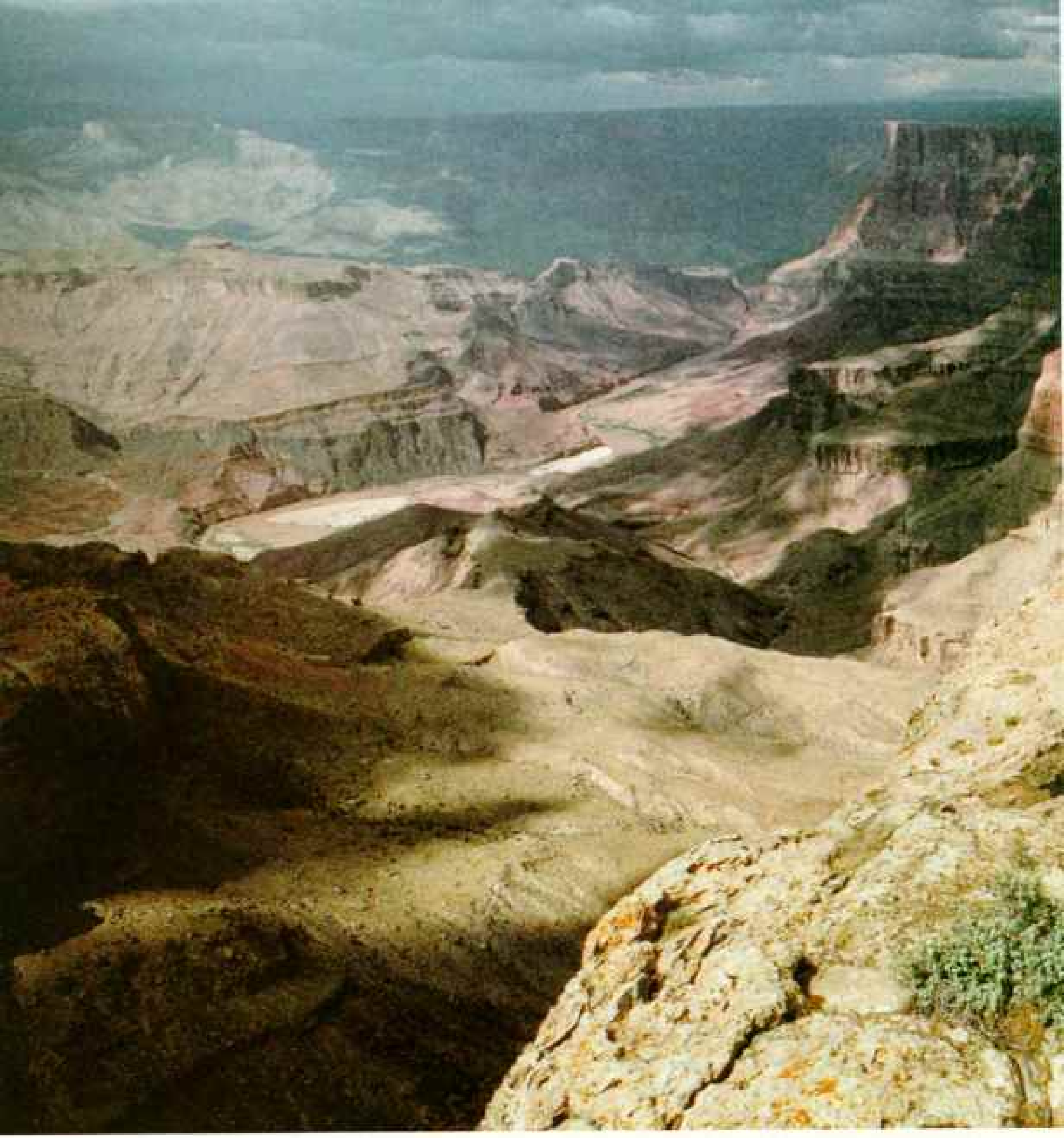
I took two puffs of the gray tobacco that the Hopis gather on the desert hillsides of the Southwest. Then, remembering that the Hopis do many things in series of four, I took two more puffs and handed the pipe back.

"I suppose," I joked, "that now I've smoked with you, I can't make fun of you any more." I had noticed the Hopi propensity to poke fun at one another even during solemn events. "No," Alph replied. "It means that you are now *ikwatsi*. That's a formal word for 'friend.' You see, each time we pass the pipe among us, we say 'uncle' or 'son' depending on who we're handing it to. The relationship is based on clan. Since you're not a Hopi, you have no clan. But you are our friend. Ikwatsi."

Susanne and I had made 18 visits to the Hopis in the previous seven years, and we counted many friends among this private people. Still, it was an honor to be addressed by this important word and to accompany Hopi priests on this sacred mission. No non-Hopis had ever stood at the secret places we had just visited; only 11 living Hopis have seen all of them. We had been invited to come along to document the shrines for NATIONAL GEOGRAPHIC on the Hopis' behalf.

The sacred sites themselves are unnoticeable, merely locations near rocks or bushes where generations of Hopis have made offerings. At each place, Dalton Taylor, a member of the Sun clan and a former rodeo cowboy from the village of Shongopovi, had dug in the dirt with his hands, guided by spiral-shaped carvings inscribed on nearby rocks. After some searching, he had found the buried offerings. The men then prayed,

Keeper of ancient rites, *a Hopi priest beckons to others on a pilgrimage to eight shrines marking their ancestral land; one lies near these ruins of the Kawestima cliff dwellings in northern Arizona. Old problems and new confront the traditional Hopi way: increasing commercial demands on tribal land, boundary disputes, and the reluctance of some younger Hopis to accept the often stern practices of their elders.*

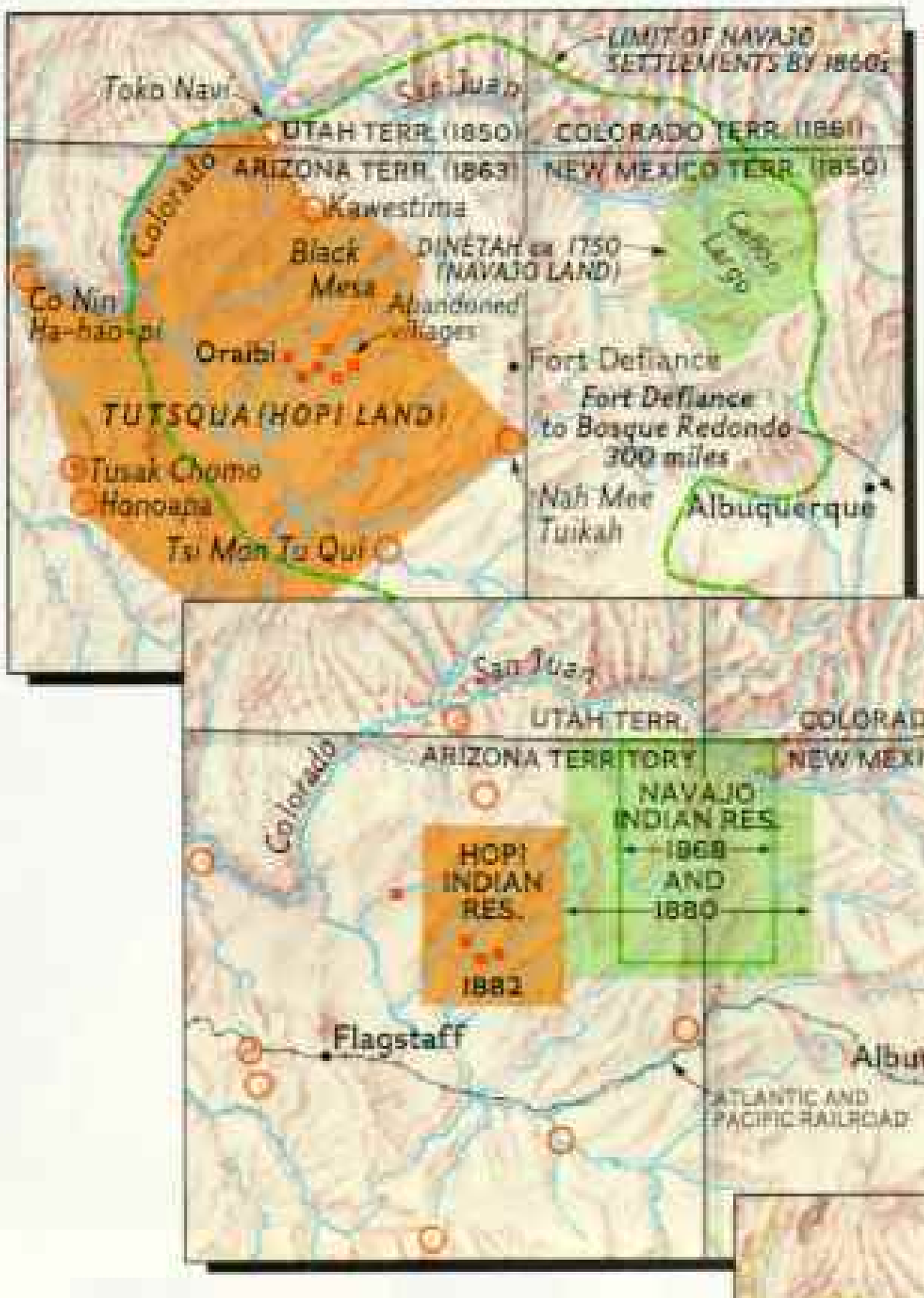


Prayers of thanks *for a salt deposit nearby are offered as the pilgrimage continues to the Grand Canyon* ***(above)****. After the placement of feather offerings* ***(right)****, the site is sprinkled with sacred cornmeal. Sending the prayers to the spirits, an elder then blows smoke over the feathers* ***(left)*** *after puffing on a pipe filled with ceremonial tobacco. The exact locations of the sacred sites, known only by a select few, are periodically disclosed to younger priests.*

Hopi versus Navajo

LONG BEFORE the Christian era, the Hopis' ancestors roamed the Southwest. By the 12th century several clans had gathered around Oraibi, one of the oldest continuously inhabited towns in the United States. Settled in the Black Mesa region, the Hopis enjoyed several generally peaceful centuries.

In the late 1700s the Navajos began to expand westward from



1700–1864

Navajo raids plagued the Southwest in the 1700s and 1800s. When Anglo settlers and Hopis demanded protection, the U. S. Army sent Col. Kit Carson to subdue the nomads. In the Long Walk of 1864, 8,000 Navajos were relocated at Bosque Redondo in eastern New Mexico.

1868–1882

Judged a failure, Bosque Redondo closed after four years, and the Navajos returned to their homeland, now a reservation. The tribe grew in power and population, encroaching again on Hopi land. In 1882 the Hopis were allotted their reservation of 2.5 million acres, but Navajos continued to move into the area.

1962

As Navajos settled closer and closer to Hopi villages, conflicting claims on the 1882 reservation were pursued in court. A federal panel ruled in 1962 that 1.8 million acres of the area would thereafter be owned jointly by the two tribes.

present-day New Mexico. The aggressive wanderers soon surrounded the Hopis. Though their villages were clustered on the First, Second, and Third Mesas, the Hopis used vast stretches of adjacent territory for hunting, gathering, grazing their sheep, and religious purposes.

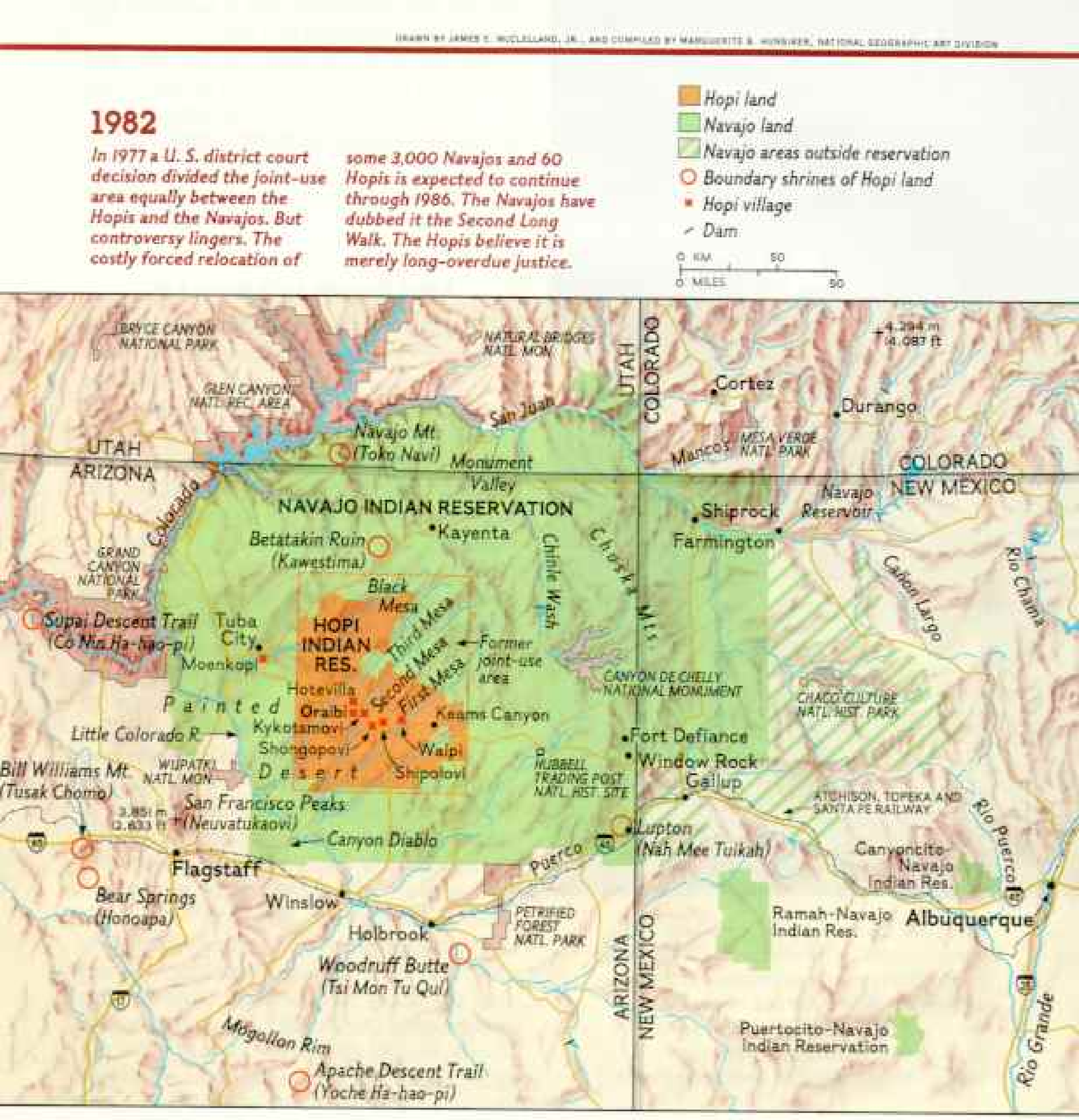
The problem of Hopi-Navajo conflict fell to the U. S. government after the Mexican War of 1848. But authorities did little to prevent the Navajo influx, even after designating separate reservations for each tribe in the late 1800s.

In this century the federal government has legislated the land dispute, principally through the partitioning of a joint-use area in 1977. But tensions remain, with the Hopis pressing their claims on the basis of historic precedence.

1982

In 1977 a U. S. district court decision divided the joint-use area equally between the Hopis and the Navajos. But controversy lingers. The costly forced relocation of some 3,000 Navajos and 60 Hopis is expected to continue through 1986. The Navajos have dubbed it the Second Long Walk. The Hopis believe it is merely long-overdue justice.

DRAWN BY JAMES E. MCCLELLAND, JR., AND COMPILED BY MARGUERITE B. HORNIKER, NATIONAL GEOGRAPHIC ART DIVISION



in a ritual that included depositing prayer feathers, sprinkling sacred cornmeal in the shrine, and smoking and meditating. Thus did the priests call forth the spirit chieftains—spirits who watch forever over the boundary markers—and ask blessings on the Hopis and all other people.

During our pilgrimage we had perched precariously on a ledge above the Grand Canyon. We had climbed 700 feet down into a smaller canyon that houses the National Park Service's Betatakin ruin, where the Hopis say their people lived long ago and which they call Kawestima. We had strained a four-wheel-drive vehicle to its limit trying to reach the top of torrent-drenched Navajo Mountain in Utah, and bushwhacked into a forgotten marsh called Bear Springs. We had stood in the shade of evergreen trees in the thin air of Bill Williams Mountain west of Flagstaff, and had climbed into a horizontal cleft in an unnamed and unnoticed cliff a hundred feet above a well-traveled dirt road.

The ogre Chaveyo, *a kachina spirit here depicted by a doll, carries a warning to the Hopis that misfortune will follow if their traditions are not respected. Spiritual helpmates, kachinas send rain and other blessings from their legendary home in San Francisco Peaks.*

All this to pay obeisance to the past and future of a tribe of some 8,500 people. They inhabit one of the least welcoming landscapes in the country, the dry, remote mesas and scrubland of northeastern Arizona, a bleak terrain of yellow sandstone crumbling down the sides of shiplike geologic remains, flat topped and forbidding.

Land Enough for Eternal Life

Throughout this region their ancestors wandered until, eight centuries ago or more, guided by their prophecies, they established their clans around three mesas. The eight shrines, in a sense, mark the last staging areas in the final migration inward to this place where they became the Hopis and built their homes. They now dwell in 12 villages, some relatively new and one, Oraibi, claiming to be the oldest continuously inhabited town in what is now the United States. The land that lies within the shrines—most of the northeastern quarter of Arizona—would be sufficient for all the people. With its use, as one Hopi friend told me, "The Hopis would live forever."

The pilgrimages have been made for centuries and will continue—expressions, the Hopis explain, of their continuing sense of responsibility for this area. Yet much of it is not legally Hopiland and is now crisscrossed by highways and inhabited by whites and other Indians, chiefly Navajos.

Pilgrimage over, the priests returned to the Hopi reservation. There they learned that the heavy rains at their campsite near the shrine in the Grand Canyon had caused floods, closing the area to tourists. The pilgrims heard this news with pleasure. It told them they had done well in their homage.

One of the major preoccupations of the Hopis is rain, upon which depends the corn that is at the center of their life. If it rains, it means the Hopis have performed their ceremonies properly and have lived a good life. It takes little precipitation to make Hopi corn grow—eight to twelve inches of snow and rain a year—but that little bit is crucial.

I remember one dawn when we made our way out on the desert floor just below the village of Shipolovi on Second Mesa. Leading us were Darlene Quavehema, her older brother, Phillip, and their father, Alonzo.

Alonzo lifted up a board from the dusty ground, revealing a deep pit—a Hopi oven for roasting corn. He filled the pit with sticks and limbs of saltbush. Soon fire erupted from the hole with a roar, tatters of flame disappearing into the wind, and Alonzo told us to go pick corn in a nearby field while he tended the fire. "Usually an old man tends the fire," Alonzo went on, adding that no old man had been available that morning. "You've got some gray hair," Phillip told his father (who is in his 40s). "You'll do fine."

Shortly after noon we arrived back at the smoking oven and dumped a truckload of corn into the hole. Then we covered it for the night. Next day at dawn Susanne and I met the three of them at the oven.

Alonzo stood and held out sacred cornmeal in his hand. Praying in a loud voice that reverberated through the thin air, he called on the spirits of the place to enjoy the corn roast with us. Then he lowered himself into the pit. Soon buckets of corn emerged from the hole. Before long Alonzo pulled himself up out of the oven, drenched with sweat. Phillip took his place. Then came my turn.

Though taller than most Hopis, I was way over my head in that oven. Corn rested on smoldering coals; heat penetrated through the soles of my boots. I scooped ears into the bucket and pushed it overhead—again and again. Soon I came up for air.

"Pretty good, pretty good," hooted Phillip. It was a kind of competition: Who could stay down there the longest? I lost.

We shucked some corn, eating amply. Then, our truck loaded, we headed for the village. There Alonzo's wife, Linda, delightedly called out "*Askwali, askwali,*" the word Hopi women use to say "thank you," and took charge of the corn. It had been Phillip's corn as it grew in his field, but once it was placed in Linda's house it became her property, as were the house and its furnishings in this strongly matrilineal society.

Sated with corn, I looked about. Four ears, each a different color, hung in a bunch on the living-room wall. "What are those different colors about?" I asked Alonzo.

"The four directions," he explained. "Yellow is north, blue is west, white is east, and red is south. Those directions we came from long ago when our clans gathered here."

The blue corn is used by a Hopi woman to make traditional piki, a kind of corn bread. She stirs ground blue corn, water, and a pinch of ashes into a thin gruel. Then, in a small stone house specially built for the purpose, she spreads the mixture on a smooth, hot rock that rests above a fire. In an instant the gruel turns into what looks like wet parchment. She peels it off the rock, folds it, and sets it aside to dry.

A Hopi woman may spend days in her dark little piki house, making this important blue corn bread—and developing a heavily callused hand in the process. Before ceremonies and other important events such as weddings, and even when a visitor drops by a Hopi house, piki and other foods are given out in astonishing bounty.

When Spirits Dwell Among Men

Having delivered the sweet corn to Linda, Alonzo drove 18 miles to the Keams Canyon boarding school, where he is a cook. After work he would spend an hour or two tending his cornfields and then proceed to his kiva, an underground chamber where men pray and make preparations for kachina dances and other ceremonies. He would stay in the kiva until after midnight, return home for a catnap, and rise at dawn for the fields.

Summers are exhaustingly busy times. Nowadays, many men like Alonzo have jobs on the reservation and must still find time to plant corn and keep vigil against weeds, rodents, and ravens. All the while, the villages are in the midst of the cycle of ceremonies.

In the Hopi religion kachinas are benevolent spirits; from late July until December

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Susanne and **Jake Page** are the authors of *Hopi*, published this month by Harry N. Abrams, Inc., New York. Free-lance journalists, they live in Waterford, Virginia.

Modern amenities are welcome *even in such conservative Hopi villages as Shipolovi, where neither television sets nor convenience foods have disrupted the old*

customs. Traditional family life prevails. A young girl still gets painstaking attention from her mother, at left, and aunt as they create a hairdo for a social dance.

Cross-cultural celebrations *enliven the village plazas when the Hopis add the trappings of other tribes to their own ceremonies. This eclectic spirit even overrides differences with the Navajos who surround them. A young man wears a hat, necklace, and belt of Navajo design* ***(above)*** *for his role as a singer at a dance* ***(right)*** *sponsored by a Shipolovi couple in honor of their daughter. Wearing Navajo-style garb, the dancers imitate—and sometimes poke fun at—the other tribe.*

*After emerging from a ceremonial chamber called a kiva (***above right,*** at left), two costumed men head for a buffalo dance. After the dance, shots are fired above the dancers' heads, symbolically sending the buffalo spirits to tell the spirits that the Hopis deserve rain to nourish the soil.*

FRED ROOTSWATENA (BELOW) & EUGENE SEKAQUAPTEWA (ABOVE)

Nature carved a grand redoubt *in Second Mesa. Founders of the village of Shipolovi had retreated to this summit during the late 1600s in*

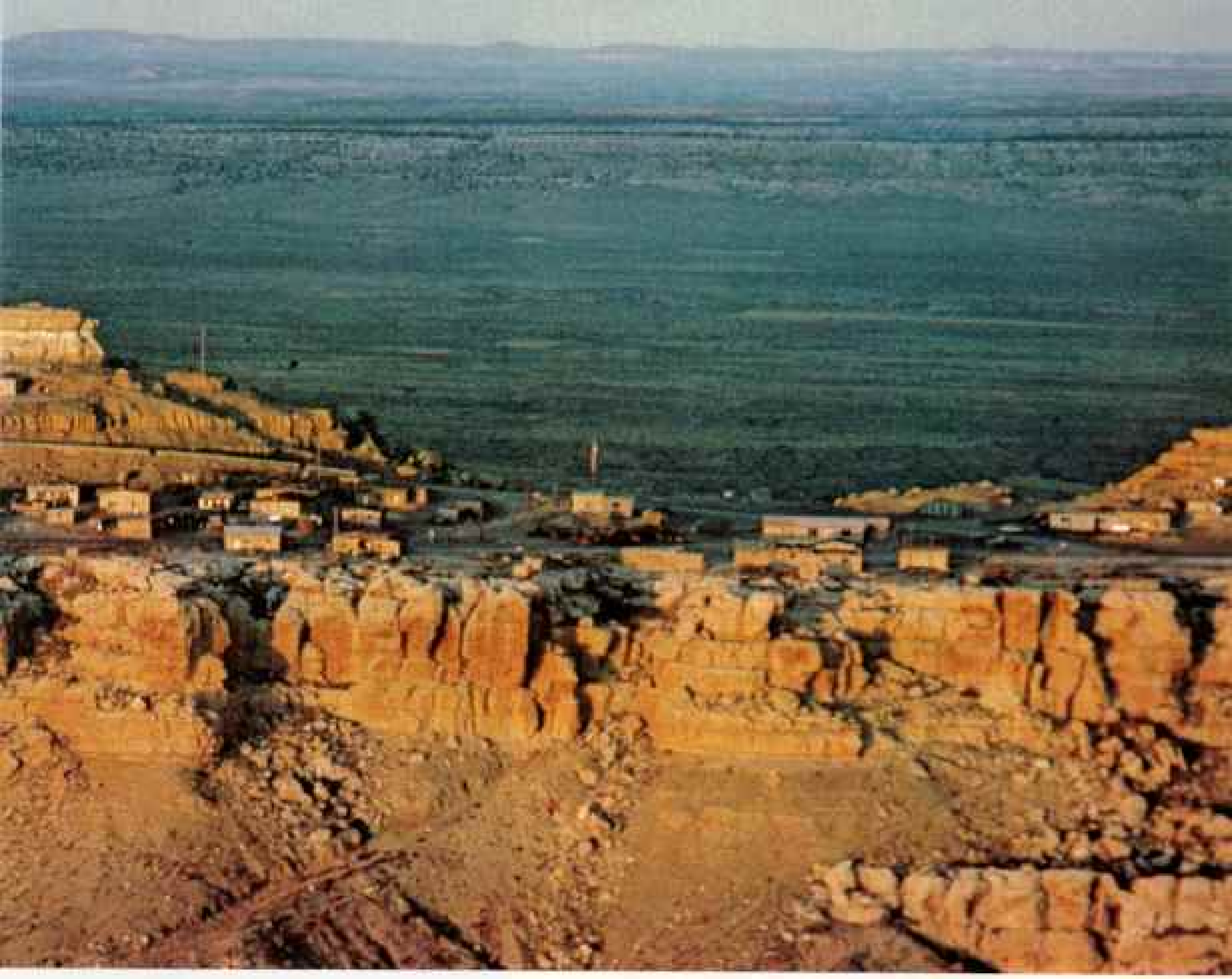
they live in San Francisco Peaks, one of which, at 12,633 feet, is the highest point in Arizona. An old volcanic formation, the peaks loom just north of Flagstaff, 75 miles from the Hopi villages, a visible presence on the Hopi people's horizon and one of their most important shrines.

To their sorrow, a ski lift hauls winter sportsmen and summer hikers to a point a few hundred feet below one of several sacred sites within the peaks. Priests, praying at these sacred places, must share them with gawking onlookers and their litter. Over the strenuous objections of the Hopi Tribal Council and Navajo medicine men (to whom San Francisco Peaks also are sacred), developers have obtained a permit from the U. S. Forest Service to build another ski lift and to expand the lodge.

The Hopis believe that the entire surface of the peaks is where the kachinas rehearse, or prepare themselves for the making of snow or rain. Hundreds of years of watching the kachinas manifest themselves as clouds over the peaks have now given this central religious tenet an unshakable force in the Hopi view of the world.

After the winter solstice, the kachinas begin to appear in the villages. There they join with men to pray for the new year, and to dance in the kivas and later in the plazas to bring rain. Among the most important of their early appearances is Powamu, also known as bean-dance time because of the bean sprouts miraculously grown by the kachinas in the dead of winter that, along with gifts, they hand out to children.

Throughout the ensuing months, in one or another of the 12 villages, the kachinas dance, usually throughout both days of a



anticipation of Spanish intrusions into their territory. Certain areas of the Hopi reservation remain off limits to non-Indians today.

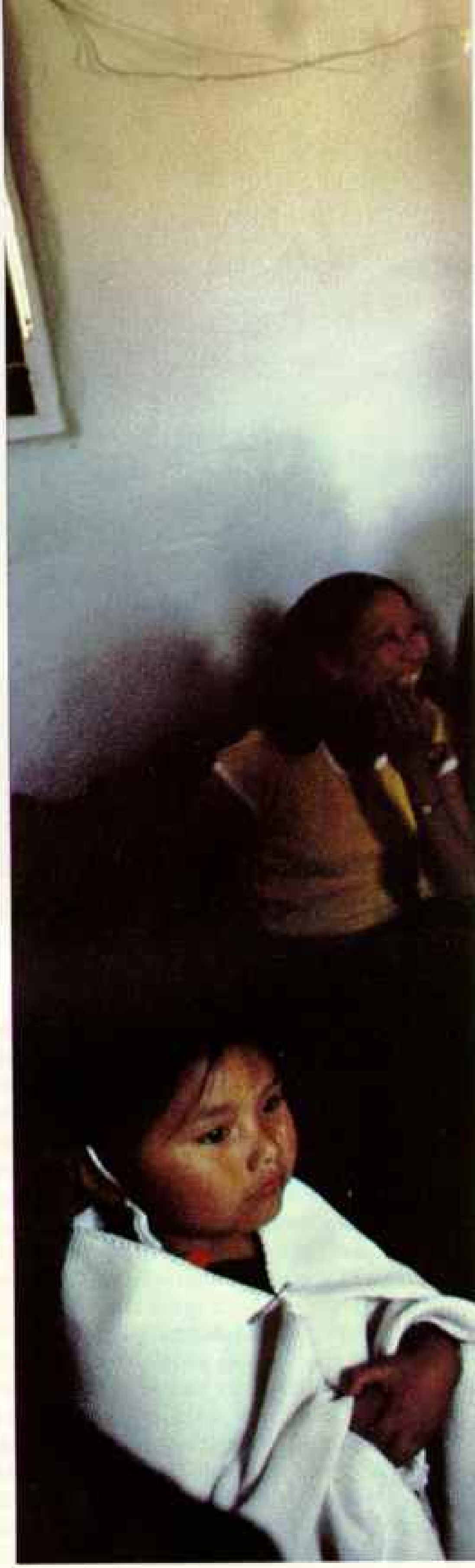
weekend. Art historian Vincent Scully of Yale University has described these dances as among the most important art forms in North American history. Many kachina dances feature clowns who present in often ribald and slapstick ways the Hopi version of *Everyman*, in which they fall further and further from the true Hopi way. Toward the end of the ceremony they are warned by the owl kachina, chastened by kachina whips, and brought back to the true path.

A visitor sees clowns, then, as part of a sacred rite; he sees people sitting around the edge of the plaza and perching on the rooftops, and children scurrying back and forth. The kachinas' rattles and turtle shells and bells tied around their knees provide a rhythmic counterpoint to the insistent beat of a drum, and they chant their songs and poems all day. A rising wind sends dust in sudden swirls, and at day's end clouds scud into view, breaking off from the tops of San Francisco Peaks. It is awesome.

The kachina cycle ends in late July as one village after another hosts the Niman ceremony, or home dance, so called because the kachinas are going home to their mountains. During the home dance, Hopi brides of the previous year are presented to the kachinas. Dressed in white cotton robes that are traditionally woven by their husbands' uncles, the brides stand solemnly as the kachinas chant and dance.

And when the bride presents her firstborn to the sun deity, she will wear her white robe again, and another just like it when she returns, finally, to the spirit world.

While the kachinas are at home, other ceremonies take place. Perhaps the most famous is the snake dance, in which priests



Clearing the air *before the wedding, the groom's family indulges in mock battles and good-natured insults. The mother of the groom* ***(above)*** *manages a smile after the customary mud fight in the village plaza. The groom's godfather cringes as relatives cut off locks of hair in a symbolic scalping* ***(below)****. During the traditional rites* ***(right)****, which often come months after the civil ceremony, the bride and her daughter, left, wear robes woven by the groom's uncles. A bundle in the bride's arms contains another robe, which she will save for her passage to the spirit world.*

of the Antelope Society chant while priests of the Snake Society dance around the plaza holding rattlers and other snakes in their teeth. Snakebite during these ceremonies is rare. When it does occur, Hopis will tell you that someone was not thinking good thoughts that day.

Snake Dances Prove Effective

At the end of the ceremony the snakes are released. They slither down the sides of the mesas back to the desert, in much the same manner as rivulets of water will snake their way off the mesa when it rains. For the snake dance is a prayer for rain. During or shortly after the three snake dances I have attended, it rained.

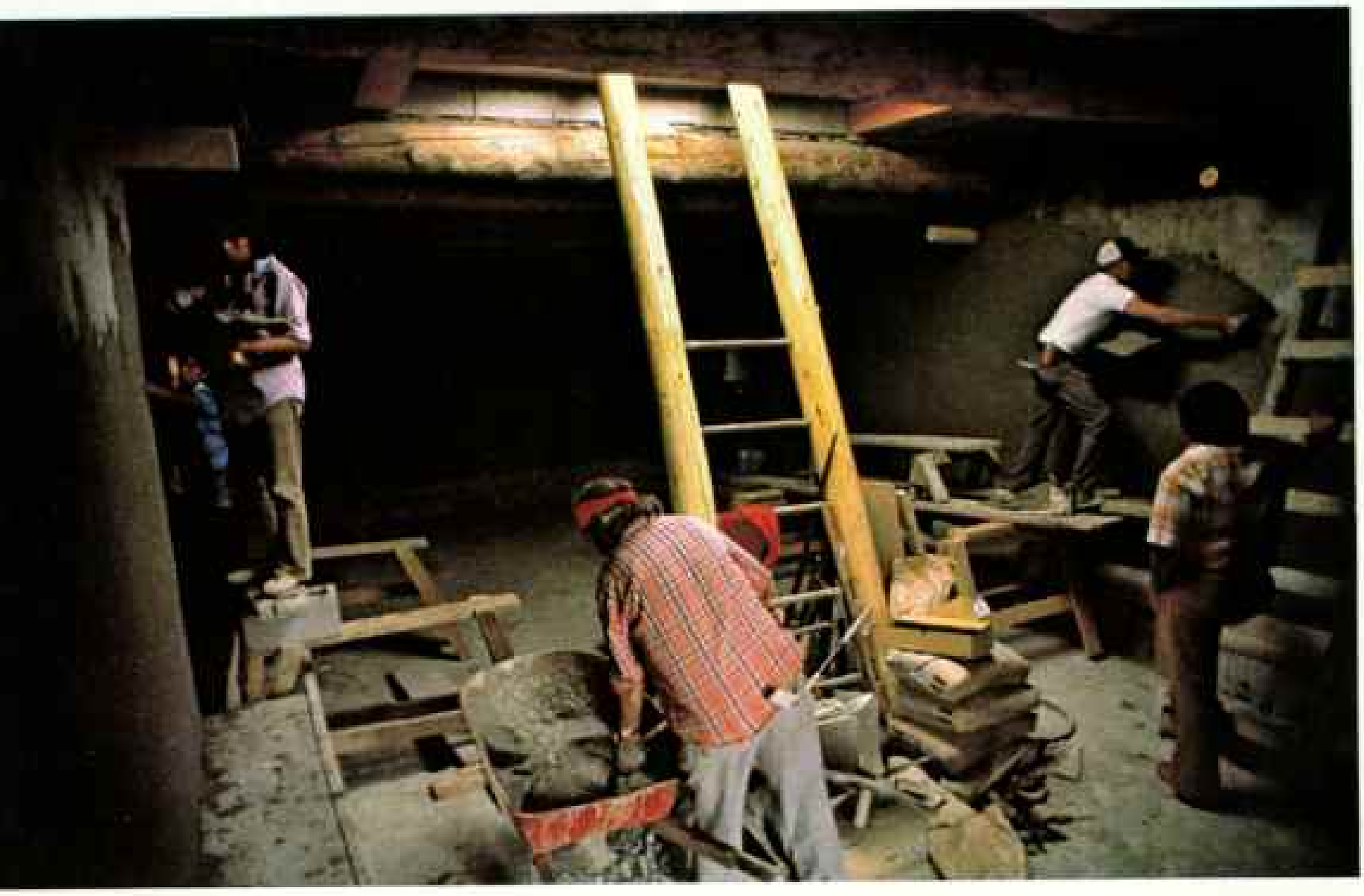
Still other ceremonies throughout the year are social dances. Boys and girls, men and unmarried women, dance together in buffalo dances, butterfly dances, or dances portraying other Indian tribes such as the Navajos and the Comanches.

Even the social dances are considered religious in nature and may not be photographed—except by Hopis. The kachinas may not be photographed under any circumstances. The Hopis have a well-defined sense of privacy. Not only are their ceremonies off limits to cameras, tape recording, or sketching, but so are most of the villages.

The ceremonies, the agricultural cycle, the land itself—all combine into an intricate tapestry of belief, custom, and behavior. It has allowed the Hopis to survive for a millennium in what would seem a hostile land. It has withstood the raveling effect of white man's society more successfully than any other native American culture.

Hopi students at the reservation grammar schools have one of the lowest dropout rates of any ethnic group in the United States. But there is no local high school, and they must attend government-financed boarding schools as far away as Riverside, California—600 miles. A few commute by bus to Winslow, Arizona, public schools, some 80 miles south.

I discussed this with Viets Lomeheftewa, one of the Hopi elders. He told me that the most important priority for the Hopis was a high school of their own so that the teenagers would learn traditional Hopi ways from the elders as well as the "white man's knowledge." In fact, a high school is now in the planning stages.



Hopi children increasingly are not learning their own language, and I have heard teenagers express dismay at the thought of attending a local Hopi high school. It would isolate them from outside friends and the adventures of being away from home. Life as a Hopi is hard, and the lure of the outside world is great.

Throughout their history the Hopis have been aided by isolation in their remote mesas. Down the centuries there were occasional raids by Apaches and Utes, but they were far fewer than the attacks on the Pueblo Indians of the Rio Grande area. The Hopis were relatively unaffected by the Spanish and the Mexicans, who ruled over what is now New Mexico and Arizona from 1540 to 1848.

Change Begins to Bear Down

Even into the 20th century, the thrust of American culture was felt less by the Hopis than other tribes. But now, with highways, television sets, and jobs in the tribal government, the Bureau of Indian Affairs, and on various construction projects, the threads of the Hopi tapestry are seriously stretched.

In a sense the Hopi people really were not a tribe throughout most of their history, but a loose association of autonomous villages each with its own political leadership, rather like the city-states of ancient Greece. The villages remained largely autonomous until 1934, when the United States government imposed on all Indian tribes a parliamentary form of government that gave rise to the tribal council. The Hopis resisted this form of government into the 1950s, and there are still a few vocal dissidents.

How to be a Hopi? Opinions range. The conservative seek to keep the old ways rigidly intact. The highly progressive would add to Hopi culture much of the white world's techniques and even attitudes.

Amy Taylor, a member of the Bear Strap clan, is community development officer of Shongopovi, an ultratraditional Hopi village that was among the first settled a millennium ago. She told me: "It's just crucial to get the two sides in our village to work together. That's one of the things I'm trying to achieve."

She gives the tribal council credit. "It is recognized as the Hopi government in Washington, D. C., and it has been very helpful, especially on the question of land."

Foundation of faith *goes deep as workmen put the final touches on a new kiva* **(left)**. *The ladder descending from a hole in the roof symbolizes access to the underworld from which the Hopi people originally emerged. In late winter the kivas throb with drumbeats as kachinas dance well into the night.*

Appealing to the spirits for a successful corn crop, a man casts offerings of cornmeal before tending his field **(right)**. *The Hopis grow more than 12 varieties with short stalks and deep roots to tap precious moisture. The grain sustains both flesh and spirit. According to their color, certain varieties fulfill specific roles in ceremonies.*

Naming the baby *falls not to the parents but to other relatives. For 19 days the newborn is kept indoors. At dawn on the 20th day, the paternal aunts and grandmother gather at the bride's mother's house. Each suggests a name for the child and blesses him (**below**) with a perfectly formed ear of corn, called Mother Corn, dipped in cornmeal and water. At sunrise the mother and grandmother take the infant outside and introduce him to the sun, an important deity. For the naming feast, family members cut mutton (**right**) as the child sleeps.*

"It's a matter of balance," declared Alonzo Quavehema, a former member of the tribal council. "We need both the traditional and the progressive views represented—and they are. If it weren't for the council, which knows both our ways and the white man's ways, we would have been overrun by the white man."

The tribal council has overseen the Hopi side of a land dispute that still festers and rages after a century. In 1882 President Chester A. Arthur set aside a rectangular area of 2.5 million acres as a reservation for the Hopis and other Indians that the secretary of the interior might designate. In part, this was done because the Navajos were encroaching on the traditional Hopi lands and often raiding the area.

But through the years the federal government looked the other way as Navajos continued to move onto the Hopi reservation, setting up their lonely sheep camps in the scrublands. By the 1930s the Navajo incursions had effectively restricted Hopis to a small part of the original reservation. This small area became District 6 when the entire area was broken up into land-management districts, and was to be exclusively for the Hopis. The rest of the original Hopi reservation later became joint-use land. Yet Hopi farming and grazing in the joint-use area were largely prohibited

by the powerful presence of the Navajos.

The Hopi tribal government continued to seek remedies. In 1974 Congress passed an act that led to a federal judge's dividing the joint-use area roughly in two, half for Hopis, half for Navajos.

A federal commission is overseeing the resettlement of some 3,000 Navajos and about 60 Hopis. It is a sad and difficult process that is to be completed by 1986, with generous cash settlements to the people involved. The Navajos call it a forced relocation. To the Hopis it is the force of law, of justice.

After a century on this land, the Navajos have developed religious roots of their own and, though their reservation is vast—stretching from Farmington in New Mexico nearly to Flagstaff—their population has grown to nearly 150,000. They feel they have no room for the relocated families.

Lands Vital to Hopi Future

In the summer of 1981 some 800 Navajos marched on the BIA headquarters in Keams Canyon, protesting federal efforts to impound their sheep and cattle as part of the resettlement. The Department of the Interior halted the removal of livestock and ordered the local BIA to issue subsistence grazing permits to Navajos in the Hopi partitioned land—ten sheep per individual, which is

more than the land's carrying capacity.

The Hopis know their claim to the land is far older than the Navajos', and their need for it just as great. Ivan Sidney, former Hopi police chief who was elected tribal chairman in 1981, feels very strongly about this. "We Hopis are the last of the frontier," he told me. "Everything else of the American frontier has changed, except the Hopis, who still do the traditional things more completely than anyone else. We have survived because it was in our prophecies. We will get that land back . . . so that we will endure."

I sat not long ago in the office of Abbott Sekaquaptewa, Sidney's predecessor as tribal chairman. "Why do we need the land? We need it for new settlements, for homesteading, and grazing. Our older villages are full. Young Hopis, coming back from school and college, deserve places to live."

The former chairman leaned back and looked off into a private distance. "But the most important thing is the shrines. The elders say that the shrines are our standards—the way white people raise flags over their territory. Without our shrines, our inheritance, we simply cannot continue as Hopis."

Many Hopis worry that the ancient lands beyond District 6 are being defaced, even destroyed. One June day Susanne and I accompanied Percy Lomahquahu, a weaver and an elder of the Eagle clan of the village of Hotevilla, to his traditional eagle nests along the high northern rim of Black Mesa. There were eight sites, in some of which eagles had nested every year since Percy had first visited them as a youth with his uncles. This time there were no eagles. Some of the nests had been deliberately destroyed.

Later we accompanied Alfred Joshongva of Shongopovi to his eagle nests southwest of the mesas, between Winslow and Flagstaff. On a ledge about 20 feet below the rim of Canyon Diablo, we saw a young golden eagle sitting on a nest. A few days later Alfred returned and judged the eaglet old enough to meet its destiny. This young eagle would become a messenger to its ancestral spirits. The eagle was taken to Shongopovi.

Next day before dawn some of Alfred's female relatives came to the eagle. Using a perfect ear of corn, called Mother Corn, the aunts anointed the eagle's head and back with sacred watery clay and gave it its

Lifted from its aerie, *a young golden eagle from Canyon Diablo* ***(above)*** *will begin a new life in Hopi ritual. Taken in the spring, the eaglet ceremonially becomes a member of the family* ***(right)*** *and is kept on a rooftop* ***(below)****. In late July, the bird is sacrificed to send its spirit to its ancestors with an appeal for rain. The practice is permitted by federal law for native Americans engaged in religious rituals.*

name, after Alfred's Spider clan: Hyeouma, or Hanging As It Comes Down. Then Hyeouma was carried outside and introduced to the sun, rising over the mesa. From that time on Hyeouma was a member of the family. In like manner Hopi babies are named, 20 days after they are born.

For more than a month Hyeouma would be tethered on the roof of the house in Shongopovi, fed with rabbits caught in the desert by Alfred and his nephews. From his perch the eagle could observe the village and see if the inhabitants were leading proper Hopi lives. Hyeouma would watch the home dance in late July and then, when the kachinas had returned to San Francisco Peaks, Hyeouma also would be "sent home." The eagle would be given traditional Hopi baby presents during the home dance by the kachinas—a doll, a bow and arrow, and a plaque made from yucca. Then it would be smothered—sacrificed.

Hyeouma's body, wing, and tail feathers would be removed and the body buried ceremonially along with the gifts. One primary feather would be left on each wing so that the

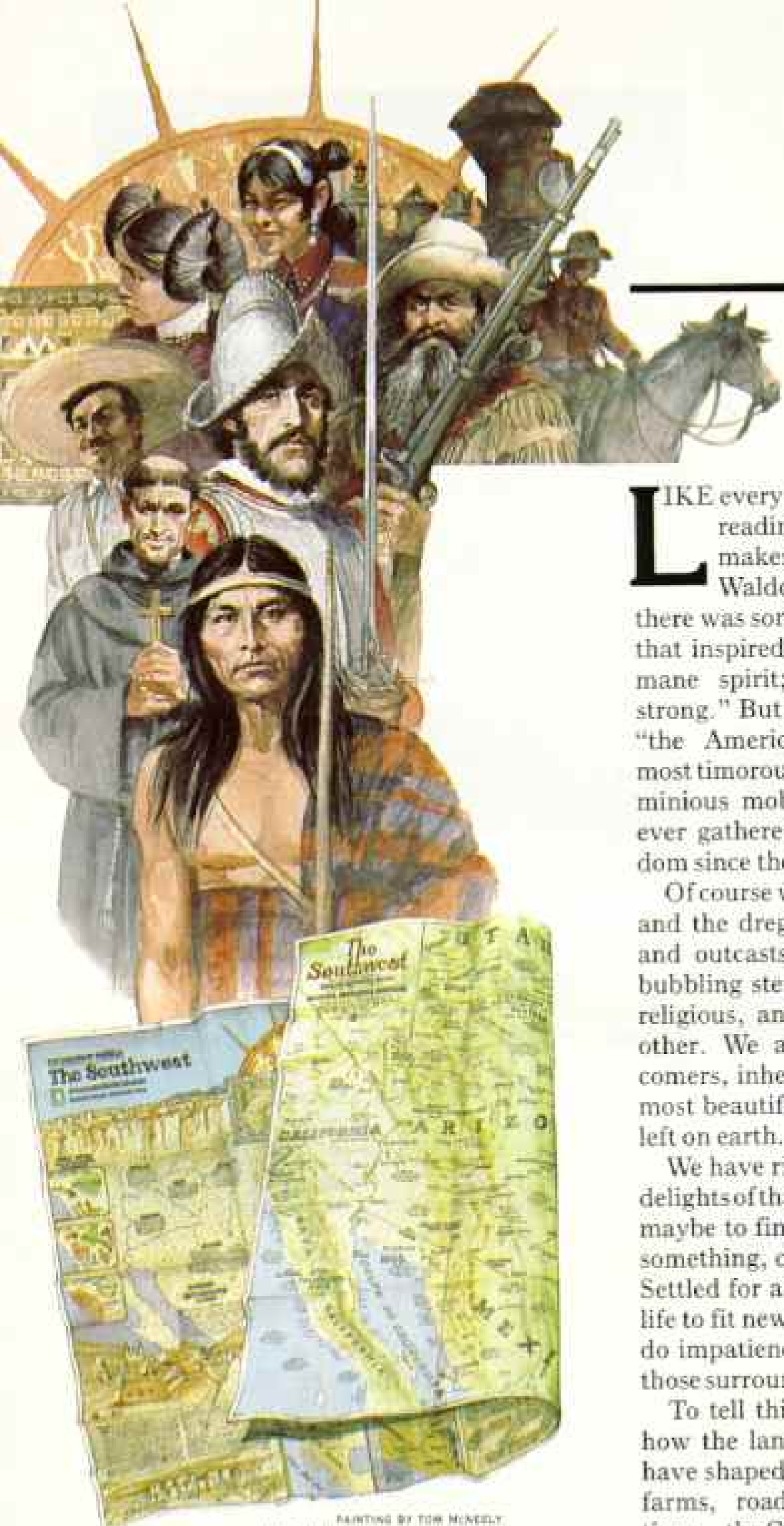
Winter winds *tug at prayer feathers tied to a bush in the hope of more harmonious times. The Hopis believe that the feathers are invested with evils that will be removed as the bush is stripped bare, making a spiritual space for the good that will replace them.*

The promise of a bright future shines in the eyes of a young woman ***(above)*** *wearing the butterfly hairstyle that signifies she is unmarried. Her generation too will tie feathers in the wind, ensuring that the customs of this ancient people will endure.*

eagle's spirit could fly up and join the other spirits in the mountains.

What became of Hyeouma's feathers? The tail feathers and primaries and coverlets are used in ceremonies in the plaza. Hyeouma will, in this way, remain in the village, participating in the ritual cycle of the Hopi religion year in, year out for several generations. And his down feathers have been made into prayer sticks, called pahos. Throughout the year, in ritual after ritual during which the Hopis purify themselves or attend to their shrines and religious duties, the pahos are deposited in sacred places, carrying the prayers of the Hopis for rain and crops and a good life for all creatures.

Later that summer, for example, when the priests made the long pilgrimage to the shrines that mark their ancestral land, Hyeouma's feathers embodied the Hopi prayers. And it is Hyeouma who today is standing guard around the perimeter of this region of desert and mountain, a holy land that the Hopis will watch over—in their way and on our behalf—for as long as people live on this planet. □



PAINTING BY TOM McNEELY
MAP DRAWN BY NATIONAL GEOGRAPHIC
ARTIST DOROTHY MICHELE NOVICK

Bloodlines *of Indians, Spanish, and Anglos have veined the Southwest's arid landscape. Their interwoven histories are featured in this issue's map supplement, first in a new series.*

The

17 NEW

LIKE every American, I enjoy talking and reading and arguing about what makes us different as a people. Ralph Waldo Emerson, for one, believed there was something unique about this land that inspired "the most expansive and humane spirit; new-born, free, healthful, strong." But H. L. Mencken declared that "the American people . . . constitute the most timorous, sniveling, poltroonish, ignominious mob of serfs and goose-steppers ever gathered under one flag in Christendom since the end of the Middle Ages."

Of course we are many peoples, the cream and the dregs of older societies, dreamers and outcasts, never a melting pot but a bubbling stew seasoned with more ethnic, religious, and racial ingredients than any other. We are a restless nation of newcomers, inheritors of one of the richest and most beautiful, diverse, and virginal lands left on earth.

We have risked the terrors and tasted the delights of that land, and still we push ahead, maybe to find something, maybe to escape something, or maybe just to be moving on. Settled for a while, we change our ways of life to fit new surroundings. Then with can-do impatience we turn around and uproot those surroundings to fit our shifting desires.

To tell this story in all its complexity—how the land has shaped us and how we have shaped the land with our axes, dams, farms, roads, bulldozers, and imaginations—the GEOGRAPHIC will present a series of 17 historical maps and accompanying articles on regions of the United States, including also the West Indies and parts of Canada and Mexico intimately meshed with our own history.

Under the direction of Senior Assistant

Making of America

MAPS TIE THE NATION TO ITS PAST

Editor for Cartography John Garver, we will be drawing upon the insights offered by the expanding field of historical geography and its scholars, such as D. W. Meinig, Maxwell Professor of Geography at Syracuse University, to take a fresh look at the special characteristics of each region and its development from the pre-European era to the present.

John Garver believes the series will be a major contribution to cartography. "We intend to show how every region owes its special qualities to the human groups of its past and how the marks they left are still there to be read in the landscape. We want to offer a unique view of our country as a means of gaining a more vivid sense of its development over the full span of our history. At the same time, the maps will serve as guides to travelers, virtual road maps to the past."

The first map, ***The Southwest,*** accompanies this issue. One side depicts the Southwest today, highlighting places where the remainders of the past can still be seen: cliff dwellings and village outlines of prehistoric Indians who spoke dozens of distinct languages; 17th- and 18th-century missions of Spanish priests; crumbling 19th-century adobe forts of the United States cavalry; and the 20th-century test site of the first atom bomb.

The other side portrays the historical processes and geographic patterns that have given the Southwest its special flavor, showing the changing imprints of settlement by Spanish and Anglo populations on land continuously occupied by Indians for a hundred centuries or more. It describes what brought each culture here, what tools and ways each introduced, and how each responded to the harsh challenges of the desert. It brings the story up-to-date with the boom in retirement, resorts, high technology, and other Sunbelt industries in the expanding cities of the Southwest.

Future maps will treat similar themes in such regions as the Great Lakes, the Central Rockies, and New England, revealing a diversity of physical habitats and in each area the dynamics of human geography.

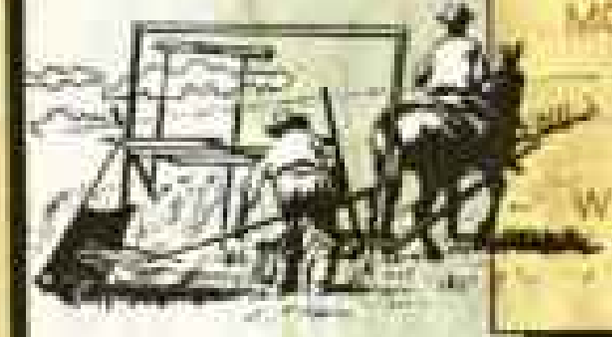
For example, the ascendancy of the Plains Indians during the 17th and 18th centuries can be linked to their mastery of Spanish horses to extend their bison-hunting culture far into new territory, ultimately reshaping the region and with it the course of human events. Subsequently new Anglo-American technology in the form of the steel plow, barbed wire, and the iron horse entered the same area, altering dramatically the Plains landscape, its resource base, and the lives of Indians and settlers alike down to their descendants today.

Every great sweep of peoples across land is a library of family histories, whether written or not. My own grandfather homesteaded in Missouri, and our family still owns some of that land. Although I am gone from it, it is not gone from me. I think of a very old photograph from a family album. It is of a young bride newly settled in Indiana. The groom was my great-grandfather, a British soldier who for reasons lost to family history fought for the Yankees in the U.S. Civil War. The bride, my great-grandmother, was a full-blooded Shawnee, and their story is one of those that make Americans different as a people.

Wilbur E. Garrett

EDITOR

ALASKA



NORTHERN PLAINS

PACIFIC NORTHWEST

CENTRAL PLAINS

The common destiny of

THIS ISSUE

SOUTHWEST

FAR WEST

HAWAII

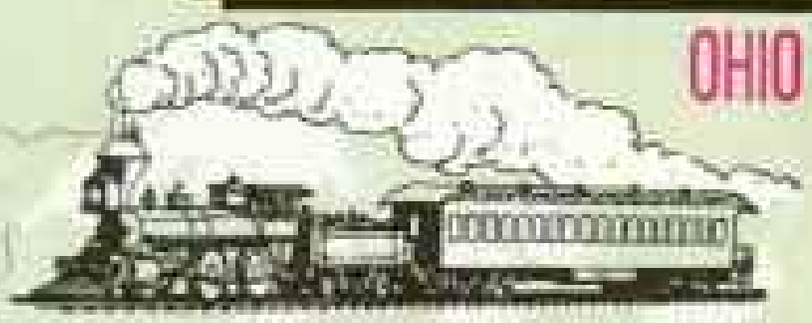
CENTRAL ROCKIES

TEXAS

GREAT LAKES

MAINE AND THE MARITIMES

OHIO VALLEY



NEW ENGLAND

ATLANTIC GATEWAYS

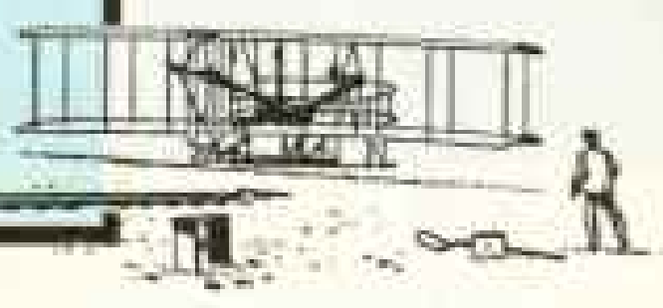
land and people

BEFORE BORDERS, before the shapes and names of nations and states became political facts and the stuff of grammar-school geography, there were the great passages. Indian migrations and changing cultures were long and diverse before any European ship made landfall.

Indians moved north to south and west to east. Generally, the Spanish explored south to north, the British and French east to west. The new GEOGRAPHIC series of 17 regional maps begins with the Southwest. In 1983 map supplements are planned on the Atlantic Gateways, Deep South, and Central Rockies.

Since human geography does not proceed along political boundaries, the nation's regions are mapped with a sense of how land and people were bound in common destinies by the dreams of each age and the opportunities of terrain. □

TIDEWATER



DEEP SOUTH

WEST INDIES

ILLUSTRATIONS BY MELBOURNE BRINDLE
MAP DRAWN BY JAMES E. MCCLELLAND, JR.
COMPILED BY GRAHAM J. TRYSCOTT
NATIONAL GEOGRAPHIC ART DIVISION

The Lost Fleet of Kublai Khan

A "DIVINE WIND," known to the Japanese as kamikaze, overwhelmed a Mongol invasion fleet off Japan in 1281, reportedly sinking 4,000 ships and claiming 100,000 lives—the second such storm to turn back Kublai Khan's plans for conquest. Thus was born the kamikaze legend.

By TORAO MOZAI

Photographs by
KOJI NAKAMURA

Paintings by ISSHO YADA
MONGOLIAN INVASION MEMORIAL MUSEUM, JAPAN

NEVER BEFORE in history—and perhaps never to this day—had such an armada been assembled. It numbered 4,400 ships with 142,000 troops aboard, and their orders were simple: Sail from ports in China and Korea, invade the islands of Japan, and conquer them in the name of the great Mongol emperor, Kublai Khan.

Instead, they themselves were conquered, not by naval action but by a storm so terrible that even today Japanese refer to it as *kamikaze*—divine wind. The year was 1281, the Mongol fleet was virtually destroyed, and Japan escaped foreign occupation for the next six and a half centuries, until the end of World War II.

As a student of naval history as well as a professor of engineering, I have long been fascinated by the Mongol invasion of Japan. In fact there were two invasions, one in 1274 and the second in 1281, both abruptly terminated by storms (map, opposite). The 1274 invasion was on a smaller scale than the one that followed, and thus it resulted in fewer losses. Yet together the two events cost Kublai Khan dearly and dashed his dream of an overseas empire.

The disaster of 1281 occurred at Takashima, a small island off Kyushu in the western part of my native Japan. There with a skilled team of divers, scientists, and engineers, I have spent the past three summers exploring for the sunken remains of the Mongol fleet, under a grant from the Japanese Ministry of Education. So far we have recovered a number of artifacts from the fleet and have developed promising new techniques for detection of other items buried beneath the ocean floor.

JAPANESE HISTORIES offer detailed accounts of the Mongol invasions. Both were launched by Kublai Khan, whose grandfather Genghis Khan founded the Mongol Empire. The noted 19th-century Japanese artist Issho Yada devoted a lifetime to producing such dramatic scenes from the invasions as the one shown on the preceding pages and others accompanying this article.

In 1268, having conquered northern China and Korea, Kublai Khan demanded submission from Japan. The Japanese ignored the command, and the khan prepared to invade their island stronghold. Finally, in November of 1274, a fleet of 900 ships and 40,000 Mongol, Chinese, and Korean troops arrived at Kyushu's Hakata Bay.

After a day's successful fighting, the invaders retired for the night. But that evening a storm threatened the fleet at anchor, forcing the ship captains to put to sea. The storm eventually overtook the fleet, sinking 200 ships and bringing the total cost in lives to 13,500.

Despite the toll, Kublai Khan prepared another attack. By the spring of 1281 a vast armada that would consist of 4,400 ships and 142,000 Mongol, Chinese, and Korean troops began assembling in ports of China and Korea for a second assault on Japan. (By contrast, the famed Spanish Armada three centuries later numbered only 130 ships and 27,500 men.)

This time the Japanese were well prepared. During the seven-year interval they had built a wall around Hakata Bay, a massive structure some 2.5 meters high and 20 kilometers long.

The Mongols apparently had no knowledge of the wall; they landed the advance portion of their army directly in front of it (page 649). The close quarters robbed them of their most successful tactic—the lightning cavalry charge that had routed the finest armies of Asia and Eastern Europe.

The two armies were closely matched, and skirmishes raged around Hakata Bay. Neither side could gain a clear advantage, and at length the invaders reembarked. Sailing westward, they joined the main body of their army, which had finally arrived after a two-month delay in China. At last all the ships and most of the troops were assembled. Toward the end of July the combined force attacked Takashima and prepared to invade mainland Kyushu.

Meanwhile the emperor of Japan and other high-ranking officials besought the aid of the gods, performing elaborate Shinto ceremonies at shrines throughout the country on behalf of the defending army. As if in answer to their prayers, the divine wind struck the Takashima area in August—with devastating effect.

Estimates of the Mongol losses vary, but most accounts set the ships sunk at 4,000.

Kamikaze! Divine wind saves Japan

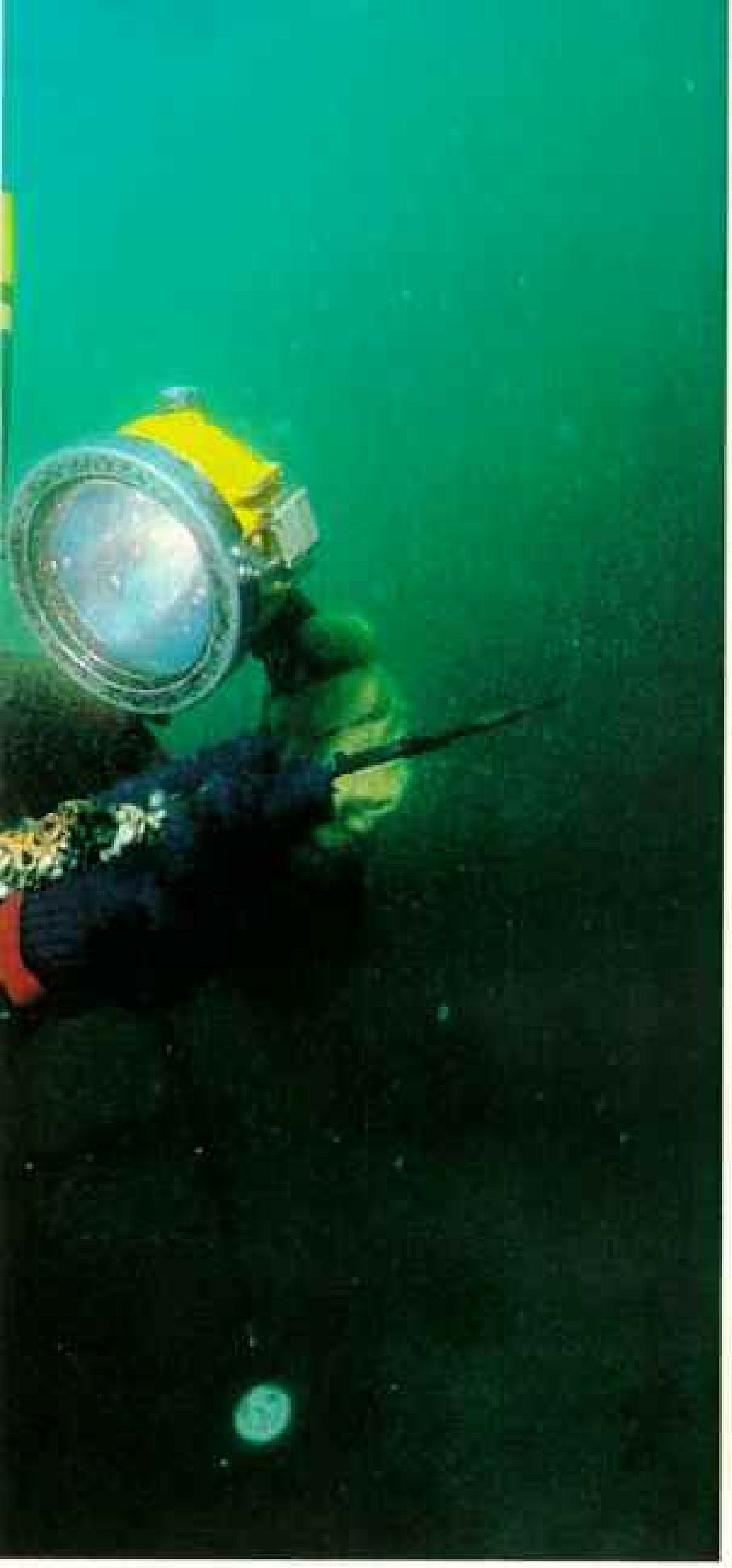
A FORTRESS with the sea its moat, Japan has never been successfully invaded, despite the two Mongol attempts in the 13th century. U. S. invasion plans during World War II were abandoned when Japan surrendered. Japanese suicide pilots in that war adopted the legendary title of kamikaze—divine wind—hoping to imitate the storms that defeated the Mongols in 1274 and 1281.

The troop casualties probably exceeded 100,000, including those drowned at sea and others slaughtered by the Japanese on Takashima. The Mongols never seriously threatened Japan again.

FOR SEVEN CENTURIES the remains of the Mongol fleet lay largely undisturbed on the seafloor off Takashima. Fishermen occasionally brought up by hand or in their nets such items as earthenware jars, stone bowls, and fragments of porcelain, but no systematic exploration of the artifact-rich site was ever undertaken.

In 1980 I received a three-year grant from the Japanese Ministry of Education to develop experimental techniques in underwater archaeology, a field in which Japan has lagged behind many other countries. With the Mongol fleet in mind, my colleagues and I selected the waters surrounding Takashima as ideal for testing those new methods. One of the major problems in undersea exploration is the difficulty of seeing beneath the ocean floor.

Until recently, nonmetallic objects buried



Sheathed in barnacles, *a sword believed to have been carried by a Mongol cavalry officer emerges from the bottom in the hands of divers* ***(left)****. Other artifacts recovered offshore fill cartons at Takashima's port* ***(below)****.*

beneath a foot or two of sand or silt were invisible even to the most sensitive underwater detection instruments, such as side-scan sonar and magnetometers. As a result, archaeologists could locate such objects only by choosing a likely spot on the seafloor and excavating it over a wide area.

For some years I had worked with Japan's pioneer underwater archaeologists: Professor Shinsuke Araki of Tokyo's Rikkyo University, Professor Yoshio Oe of Kyoto, and the distinguished Professor Emeritus Namio Egami of the University of Tokyo.

I had felt the challenge and frustrations of excavating whole areas of the ocean floor for the recovery of a few artifacts or, in some cases, no artifacts at all.

Geologists, I knew, employ a device known as a subbottom profiler, or sonoprobe, which uses sound waves to map formations of rock and sediment beneath the ocean floor. Although the instrument is designed to record massive layers of rock, I wondered if it could be used to locate smaller objects, such as buried artifacts.

I took the question to a firm in Tokyo,

NATIONAL PALACE MUSEUM, TAIWAN

The mighty Kublai Khan, *stern-faced in this portrait, ruled a domain stretching from the Black Sea to the South China Sea. His officers carried emblems of authority such as the bronze seal* ***(left)****, proclaiming its owner a leader of as many as a thousand soldiers.*

Mongol troops ***(facing page)*** *pierce the hands of a Japanese woman to pass ropes through the wounds and hang her, along with others, from the bow of a ship.*

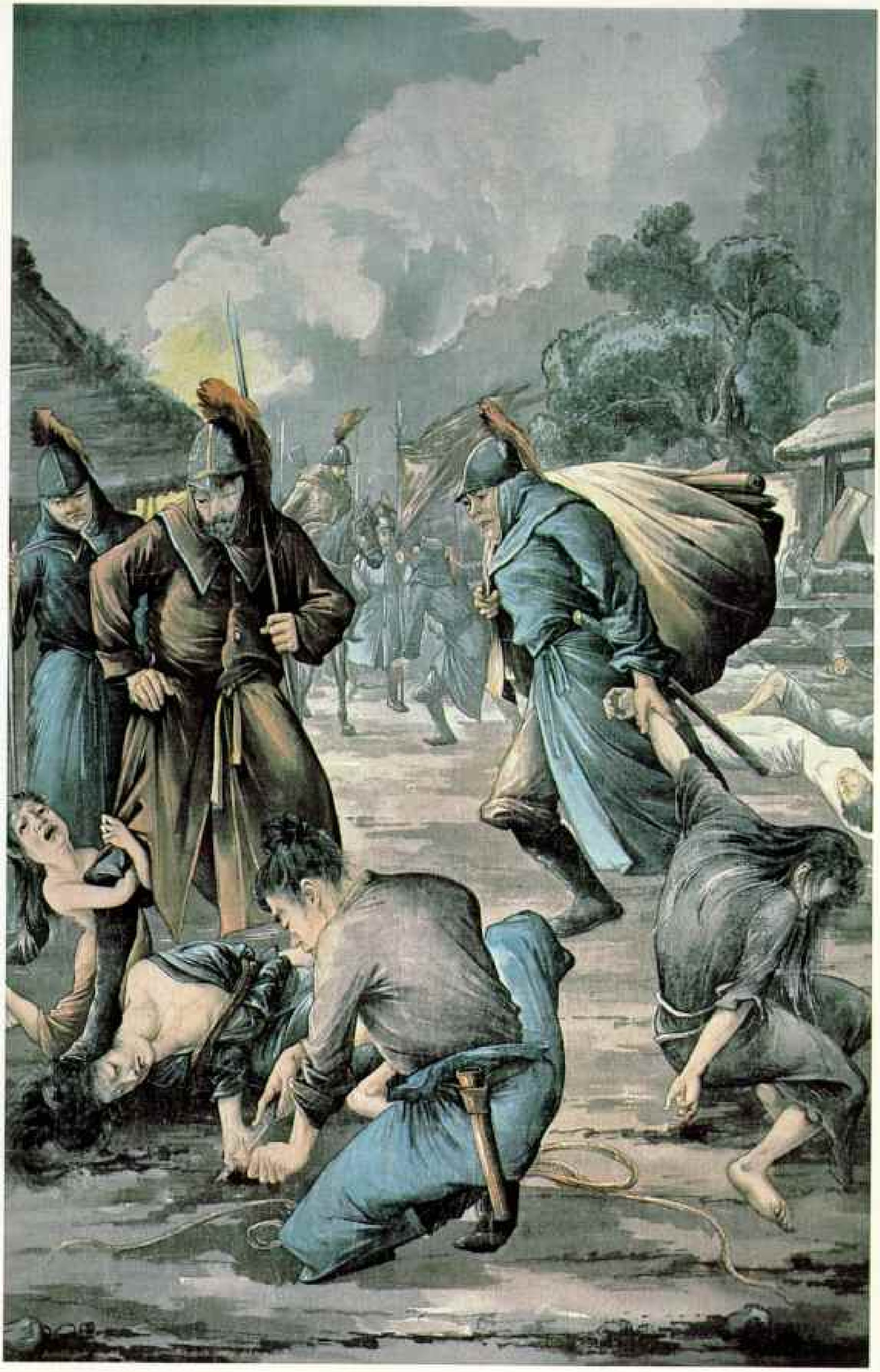
Kokusai Kogyo, Co., Ltd., which specializes in undersea geologic exploration. Could a sonoprobe—or a Sonostrater, as Kokusai Kogyo calls its version of the instrument—be used to locate small objects buried beneath the seafloor? Kokusai Kogyo believed it could. The firm generously loaned me one of its models, and with a small team of engineers I took it to Takashima for testing.

THE PRELIMINARY results were promising but inconclusive. With the Sonostrater mounted in a chartered boat, we crisscrossed an area where Chinese and Mongol artifacts had been brought up in the past by fishermen. As the Sonostrater scanned an area as deep as 30 meters beneath the ocean floor, its black-and-white recording paper revealed layers of subsurface rock, together with smaller features that might be artifacts, scattered debris, individual rocks, or merely buried clumps of seashells. Although the Sonostrater could indeed distinguish between massive layers of rock and smaller objects, it gave few clues as to what those smaller objects were. Clearly it needed to be modified for use in underwater archaeology.

Back in Tokyo I went to see a friend, Iso Tanaka, the vice president of Koden Electronics Co., Ltd. Several years earlier Koden had developed a type of color sonar designed to locate schools of fish and to indicate their type as well as the size of the school. If we could adapt Koden's color process to the Sonostrater, we might have a truly remarkable instrument, one that could locate buried objects and give some clue as to the materials they were made of. Such a device I call simply a color probe.

Koden's engineers took on the job, and by late 1980 they had produced an experimental model. The instrument analyzes the relative hardness of buried objects by using varying wavelengths of sound, in much the same way a prism separates light into the various colors of the spectrum.

Objects made of the hardest materials, such as stone, metal, or porcelain, register on the color probe's screen as bright red. Softer materials, such as wood, appear orange, and even softer materials, such as sand and silt, register yellow or light green. At the end of the scale in terms of softness,



Like human surf, *wave after wave of Mongol warriors sweeps ashore at Hakata Bay on Kyushu in their second invasion of Japan. Unaware of the wall built by the Japanese after the 1274 invasion, the khan's advance forces landed at the same point and met with fierce resistance at water's edge. In the Mongol arsenal of weapons were poisoned arrows, maces, lassos, and javelins that could be hurled great*

distances. The Japanese fought back with bows and arrows, spears, swords, and wooden shields, and with a great fierceness inspired by defense of homeland. During the first invasion Japanese warriors were hampered by their tradition of individual combat, in contrast to the Mongols' large-scale troop maneuvers. By 1281, however, the defenders knew their enemy's ways, and proved a match for the invaders.

water appears in its natural color, blue.

In the summer of 1981 we returned to Takashima with the color probe and a volunteer team of some 30 divers, scientists, and technicians. The search for the Mongol fleet had begun.

WHILE my engineering colleagues and I experimented with the color probe, our divers began recovering sunken artifacts almost at once. By means of hand tools and air lifts they scoured the ocean floor off Takashima, bringing up a variety of items including what appear to be 13th-century Chinese and Korean tools and implements.

Not all our finds were antique. In the seven centuries since Kublai Khan's fleet went to the bottom, countless Japanese and foreign vessels have followed it, not to mention seven centuries' worth of items lost or thrown overboard. So our finds include everything from a barnacle-encrusted sword, probably worn by a 13th-century Mongol officer, to a modern *tako tsubo*—an earthenware octopus trap.

The variety of older items was nonetheless remarkable. Within less than two weeks our diving teams recovered iron spearheads, iron and copper nails, stone anchors, heavy stone bowls, curiously shaped bricks, iron ingots, and quantities of porcelain and earthenware pots, vases, bowls, and dishes. Most of the ceramic artifacts had long been reduced to fragments, but a few were recovered intact.

The condition of the artifacts provided clues to their history under the sea. In general the longer a bowl or spearhead had remained on the surface of the ocean floor, the more badly it was corroded or encrusted with marine growth.

The cavalry sword offered a perfect example (pages 638-9). It had sunk in shallow water and by chance landed upright, with its point and part of the blade embedded in the sand. The buried section was in quite good condition, while the exposed portion was so heavily encrusted that it was almost unrecognizable.

With the color probe still in an experimental stage, we continued to rely on our divers for the search and recovery of artifacts. One of their most common finds, the heavy stone bowls, intrigued me. Each bowl had a distinctive notch in its rim, obviously for the purpose of pouring.

I theorized that the bowls may have been used for mixing gunpowder, since historical accounts mention the use of stone vessels in that process.

Among our most intriguing finds off Takashima were bricks. They were slightly thinner than modern bricks, and some historians believe the Mongols used them to build small blacksmith forges aboard ship for making horseshoes and repairing weapons. Other scholars maintain that the bricks were carried by Chinese troops, perhaps to build shrines ashore as soon as they landed in order to pray for victory. In 1281 the Chinese never had time to erect shrines; the bricks went down with the invaders.

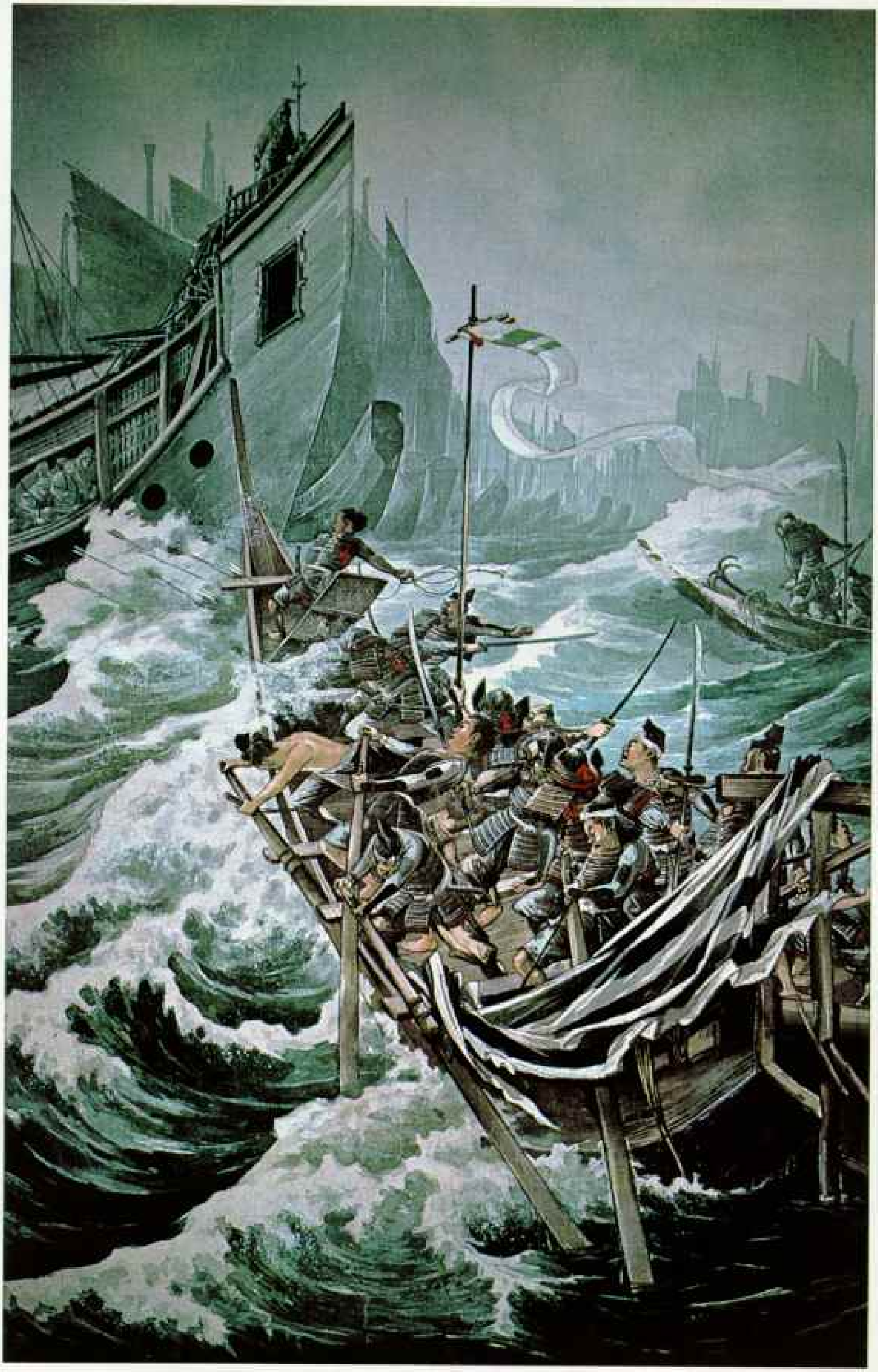
During our stay on Takashima, the 4,000 islanders became increasingly fascinated with our work. By chance we had arrived during the 700th anniversary of the invasion of 1281, an event that the islanders celebrate every 50 years with a festival.

Over the years fishermen of Takashima have brought up most of the historical treasures recovered from the Mongol fleet. Some of the artifacts were sold to private collectors, but others made their way into museums such as the one at Hakata Bay, now the site of the modern port city of Fukuoka.

In a lecture I congratulated the islanders for donating a number of their finds for public display, and I suggested the time had come for Takashima to have its own museum. The museum could be furnished with the artifacts we had recovered and with others retrieved by the islanders.

Next day an assortment of about 30

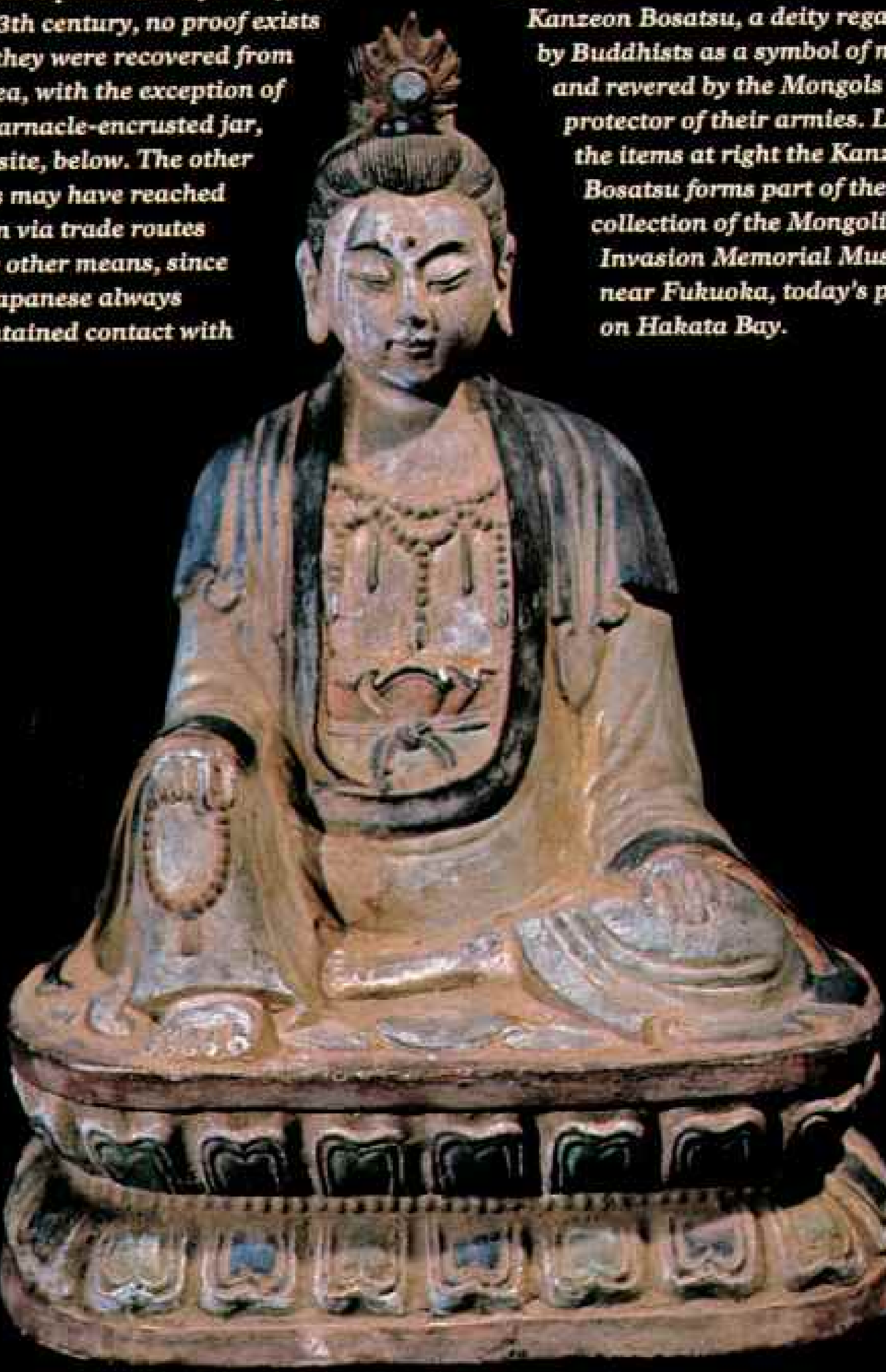
Hit-and-run raiders *in a small Japanese boarding craft launch a lightning attack on the Mongol fleet as it lies at anchor in Hakata Bay. Lacking a large navy in 1281, Japanese authorities also enlisted local pirates to harass the enemy at sea. So successful were the raids that Chinese and Korean ship captains took to chaining their vessels together in long lines abreast to minimize boarding opportunities.*



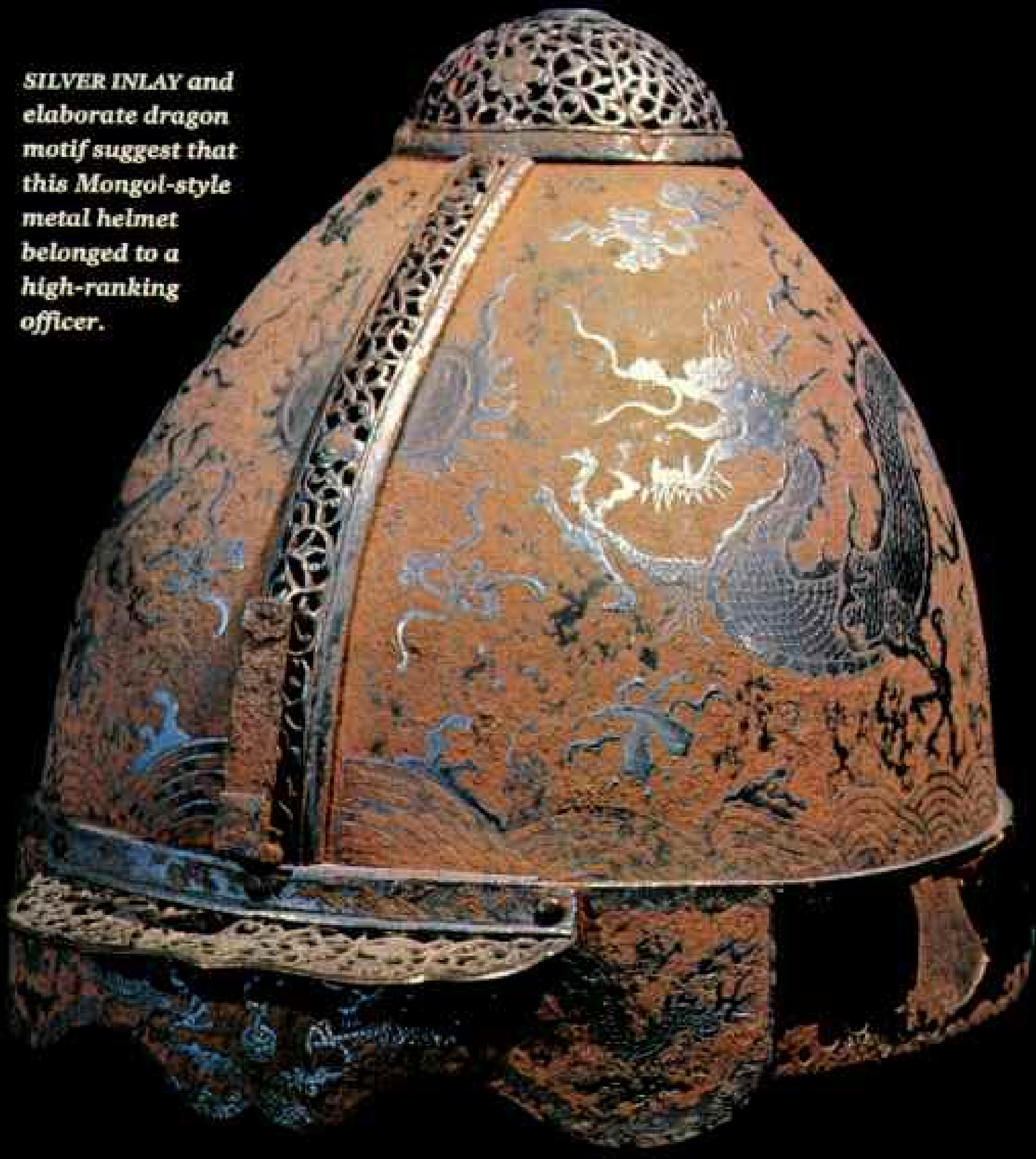
Symbols of a doomed mission

UNTIL THE AUTHOR BEGAN a systematic search for remains of the Mongol fleet, the only artifacts recovered were those brought up accidentally in fishermen's nets. Although the historic treasures pictured may date from the 13th century, no proof exists that they were recovered from the sea, with the exception of the barnacle-encrusted jar, opposite, below. The other items may have reached Japan via trade routes or by other means, since the Japanese always maintained contact with the Asian mainland. Yet scholars agree that these artifacts are typical of the possessions the invaders carried aboard ship on an overseas campaign.

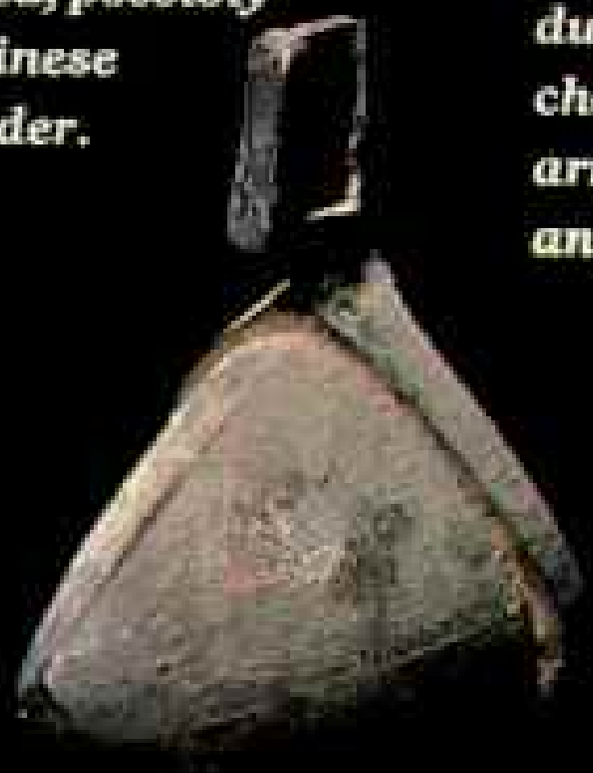
The one-foot-high statue (below) is a representation of the so-called Kanzeon Bosatsu, a deity regarded by Buddhists as a symbol of mercy and revered by the Mongols as a protector of their armies. Like the items at right the Kanzeon Bosatsu forms part of the collection of the Mongolian Invasion Memorial Museum near Fukuoka, today's port city on Hakata Bay.



SILVER INLAY and elaborate dragon motif suggest that this Mongol-style metal helmet belonged to a high-ranking officer.



STONEWARE JAR, now barnacle encrusted, possibly held Chinese gunpowder.



IRON STIRRUPS protected the feet of Mongol horsemen during lightning cavalry charges that terrorized the armies of Eastern Europe and Asia.

ceramic artifacts retrieved from the ocean floor were donated by various islanders toward the start of a local museum.

One of the donations was an almost unbelievable treasure: a perfectly preserved bronze seal measuring 6.5 centimeters square, with an inscription engraved in the face (page 640). The seal was presented to me by an islander named Kuniichi Mukae, who had found it seven years before on one of Takashima's beaches and had tossed the curiosity into his toolbox. There the seal lay forgotten until Mr. Mukae heard my lecture, whereupon he retrieved it as something of possible interest.

Interest was immediate, for the seal was a rarity. The inscription was in a written form of Mongolian language commissioned by Kublai Khan himself. The dynasty had had no official written language until the year 1271, when the khan ordered a Tibetan monk by the name of Phags-pa to create one.

The seal must have belonged to an officer, for the inscription reads: "The seal of a leader of between one hundred and one thousand soldiers." On the back of the seal a date—"the 14th year of Zhi-yuan"—appears in Chinese characters. Zhi-yuan was the name given the era of Kublai Khan's rule, so the year was actually 1277.

From the two inscriptions we can deduce that the owner of the seal was an officer of some importance, who may have taken part in the first invasion of Japan and who probably died in the course of the second one.

AS WE PROBED the seafloor off Takashima, we gradually developed a picture of how the Mongol fleet had perished. The majority of ships, we decided, must have been anchored to the south of the island, the direction from which the divine wind had struck. As a consequence the vessels were either sunk or driven ashore along Takashima's southern coast, which is where we found nearly all the artifacts. The bronze officer's seal had also been discovered on one of the island's southern beaches.

Though Takashima's offshore waters proved to be immensely rich in artifacts, we brought up only a small fraction of what we found. Our funds were limited, and it would have been senseless to remove artifacts we knew we could not hope to preserve.

Stone and ceramic items suffer relatively little damage out of water, but those of wood or metal quickly deteriorate when exposed to air. They are safer left buried beneath the seafloor, where they have survived for centuries, and retrieved only when they can be properly cared for.

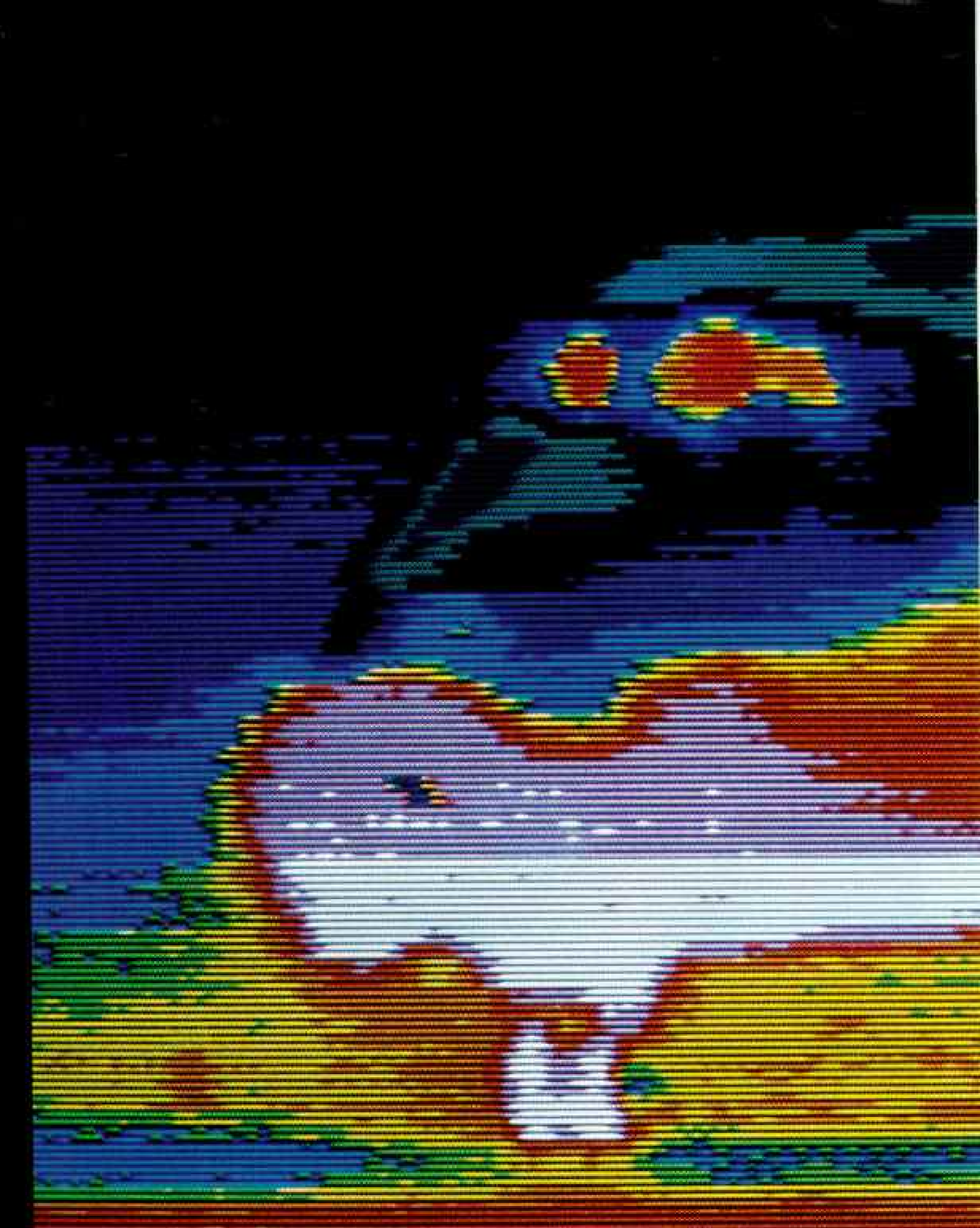
After three weeks of exploration we ceased operations and left Takashima for Tokyo, where further experiments with the color probe convinced me that the device was a potentially valuable tool in underwater archaeological research.

So it has turned out. During the past summer season the color probe has led our divers to a number of artifacts buried as much as a meter beneath the seafloor. The 1982 season has seen a variety of additional finds and has contributed substantially to our knowledge of a critical period in Japanese history.

THERE IS a great deal more to learn. We have yet to find the actual remains of a ship lost in 1281, and no one has located the 200 or more vessels that sank following the invasion of 1274. Three small islands lying between Kyushu and Korea—Tsushima, Iki, and Hirado Jima—figured prominently in one or both invasions, and their waters have yet to be explored.

The color probe has proved extremely promising, but it requires additional work. I believe that in time it can be improved to the point of defining the shape of an artifact as well as determining its location and the material from which it is made. The applications of such a device are limitless, not only in underwater archaeology but also in the other ocean sciences. The search for Kublai Khan's fleet is merely a beginning. □

Japanese counterattack *routs the Mongol invaders before the defense wall at Hakata Bay in 1281. For the second invasion the Japanese were superbly prepared, with an army of 100,000 stationed on Kyushu and 25,000 troops in reserve on the neighboring island of Honshu. The latter were unnecessary; the kamikaze dealt the final blow, putting an end to Kublai Khan's dream of an overseas empire.*



Heat Paints Columbia's

Portrait

MOSAIC OF HUES *painted by a computer that has read varying temperatures from an infrared image produces a striking view of the space shuttle "Columbia" as it touches down last July 4 at Edwards Air Force Base, California.*

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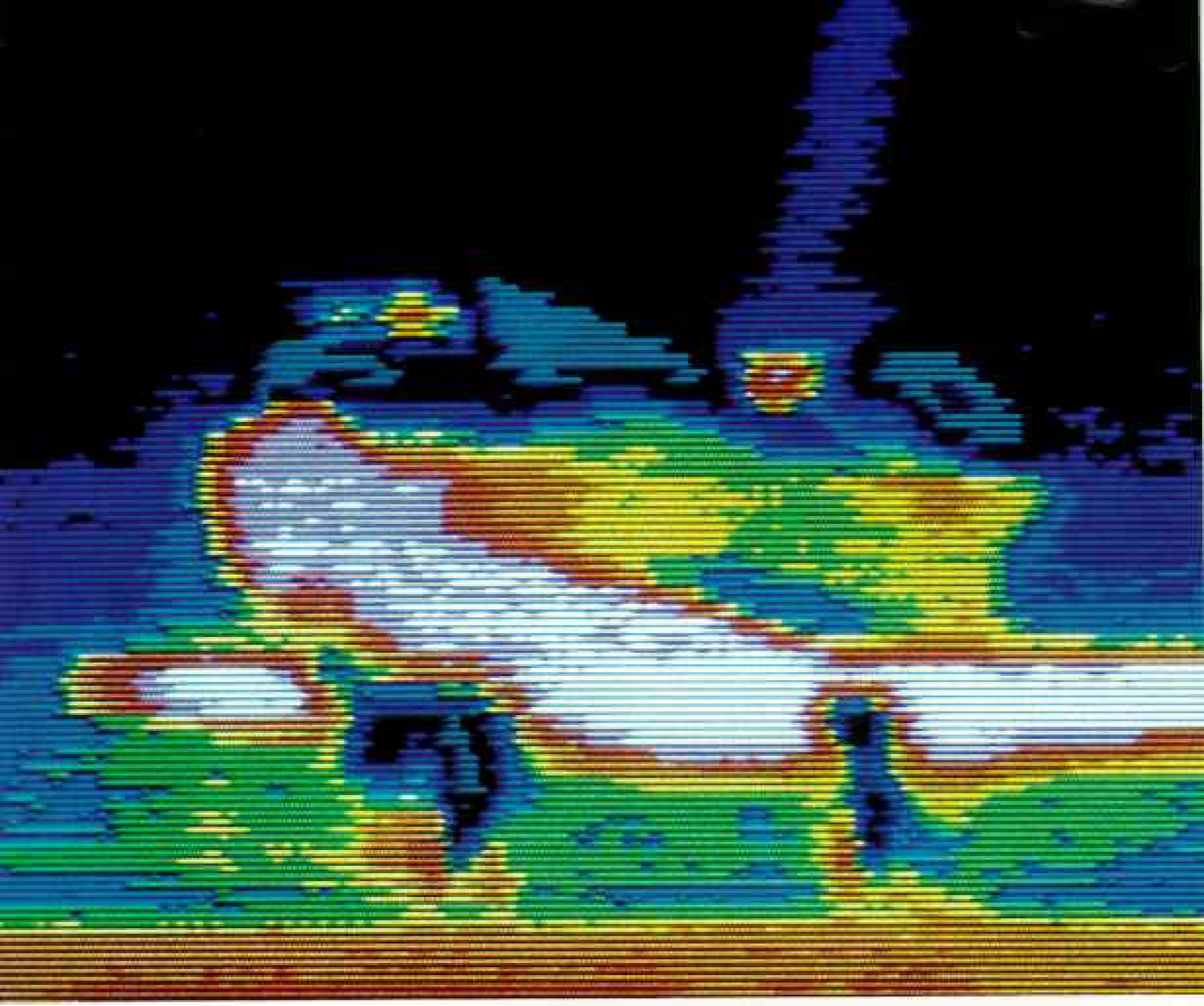
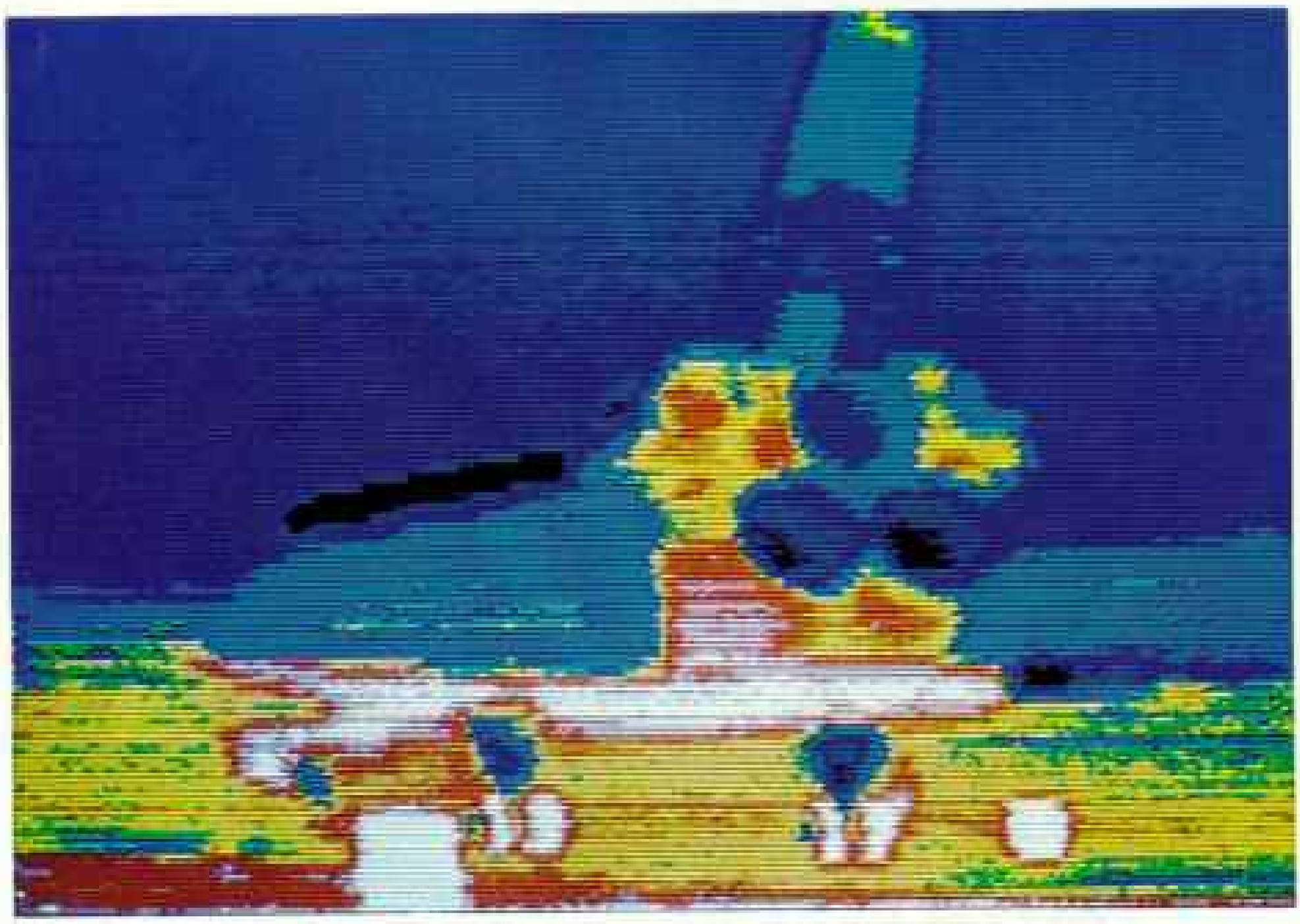
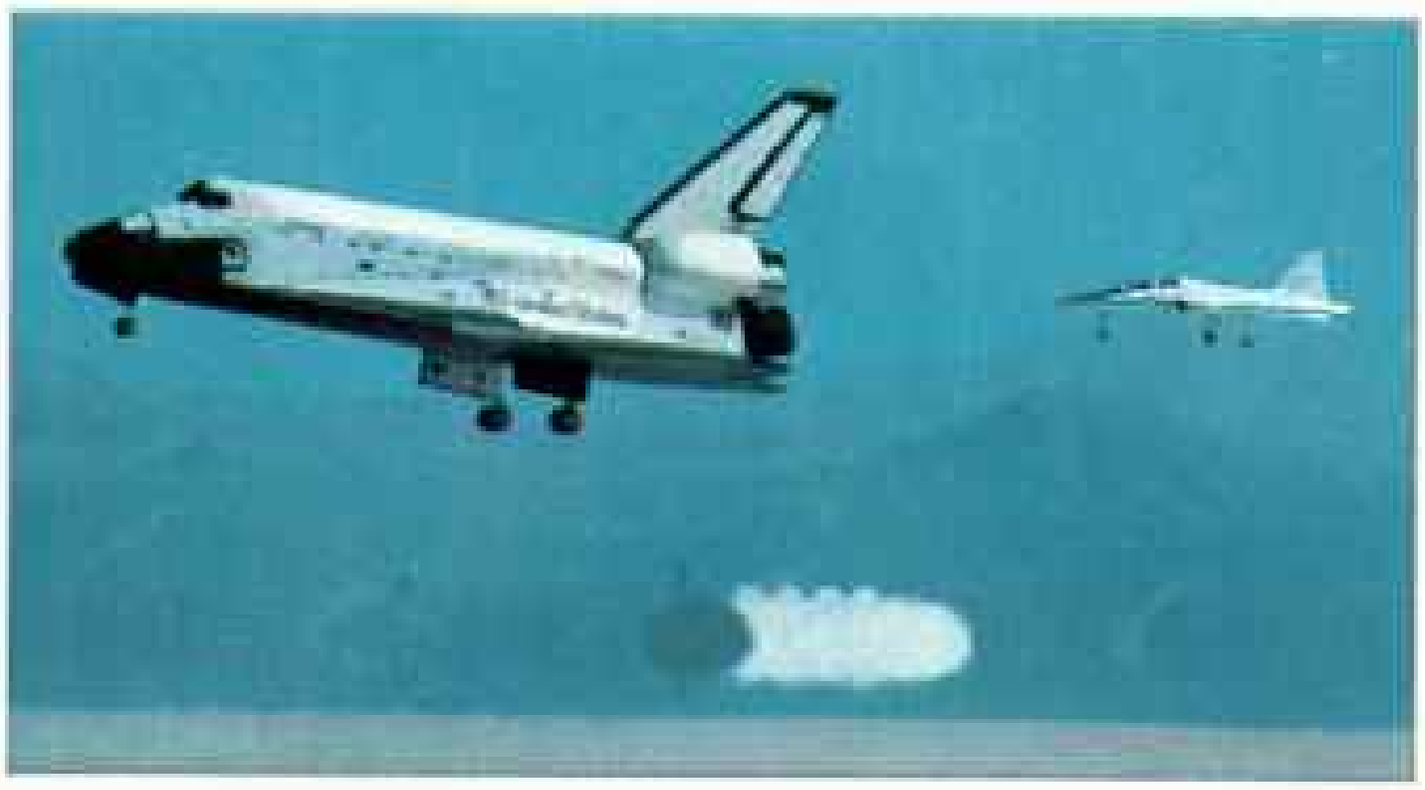
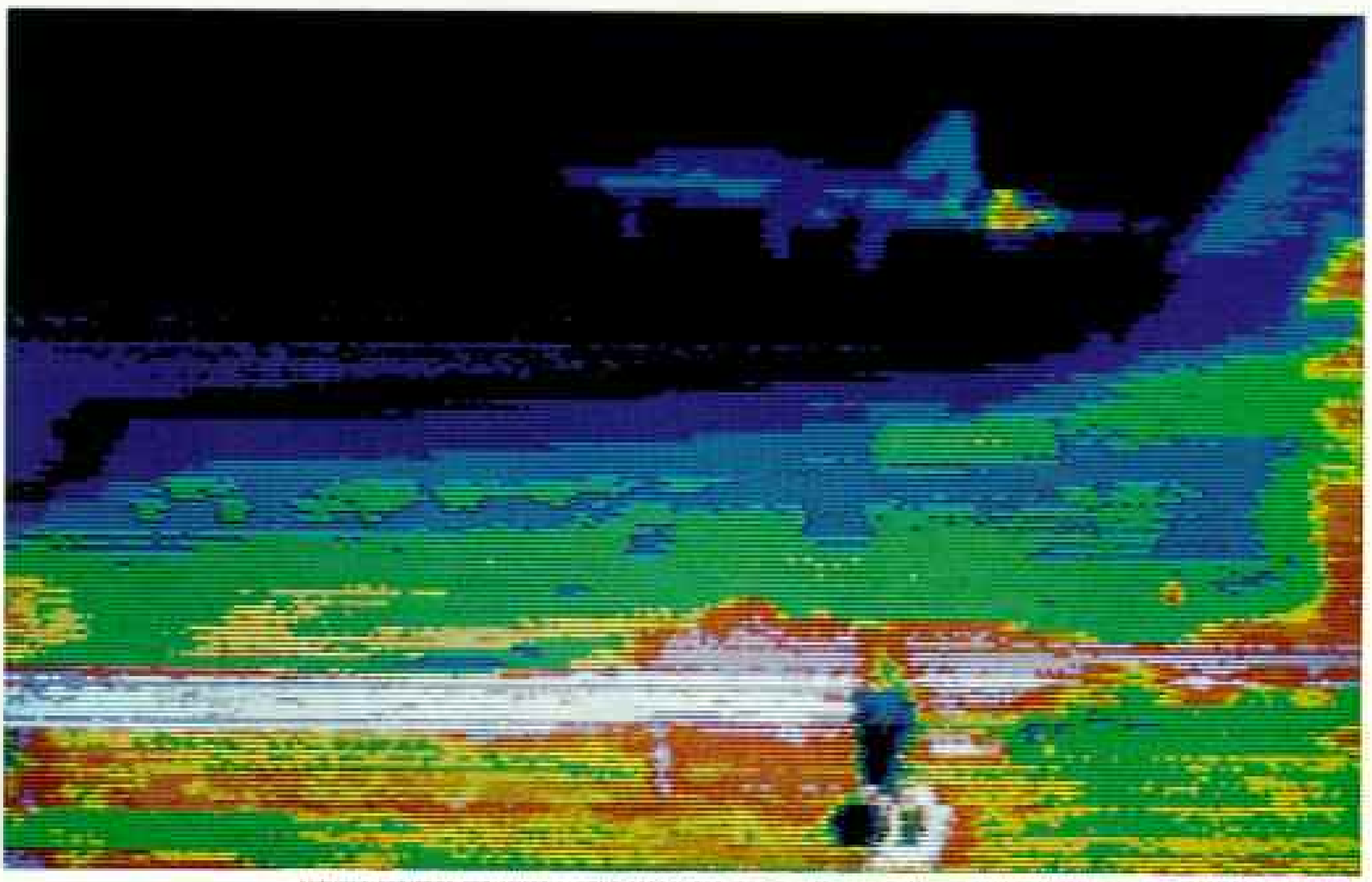




ARTISTRY WITH HEAT: Computer technicians at Inframetrics, Inc., in Bedford, Massachusetts, based their palette of colors on temperature differences within a 10°C (18°F) range—assigning a specific color to each degree of heat. The computer worked from black-and-white infrared images recorded on a videotape as the shuttle touched down. The tape recorded both reflected and emitted heat—the warmth of the sun and the desert runway and the burn of a jet engine as the T-38 chase plane (***below and bottom***) darted away. Hotter temperatures appear in traditional hot colors (***left and bottom***)—orange, violet, and white. Cooler areas appear in black, blue, and green. Useful in such fields as thermal design and architecture, thermography does not replace the shuttle's on-board sensors, since thermograms such as these do not take into account variables created by differing surfaces and refraction from curved areas. They do give us expressionistic views of an exciting moment. □

BY CLIFF TARPY
NATIONAL GEOGRAPHIC EDITORIAL STAFF





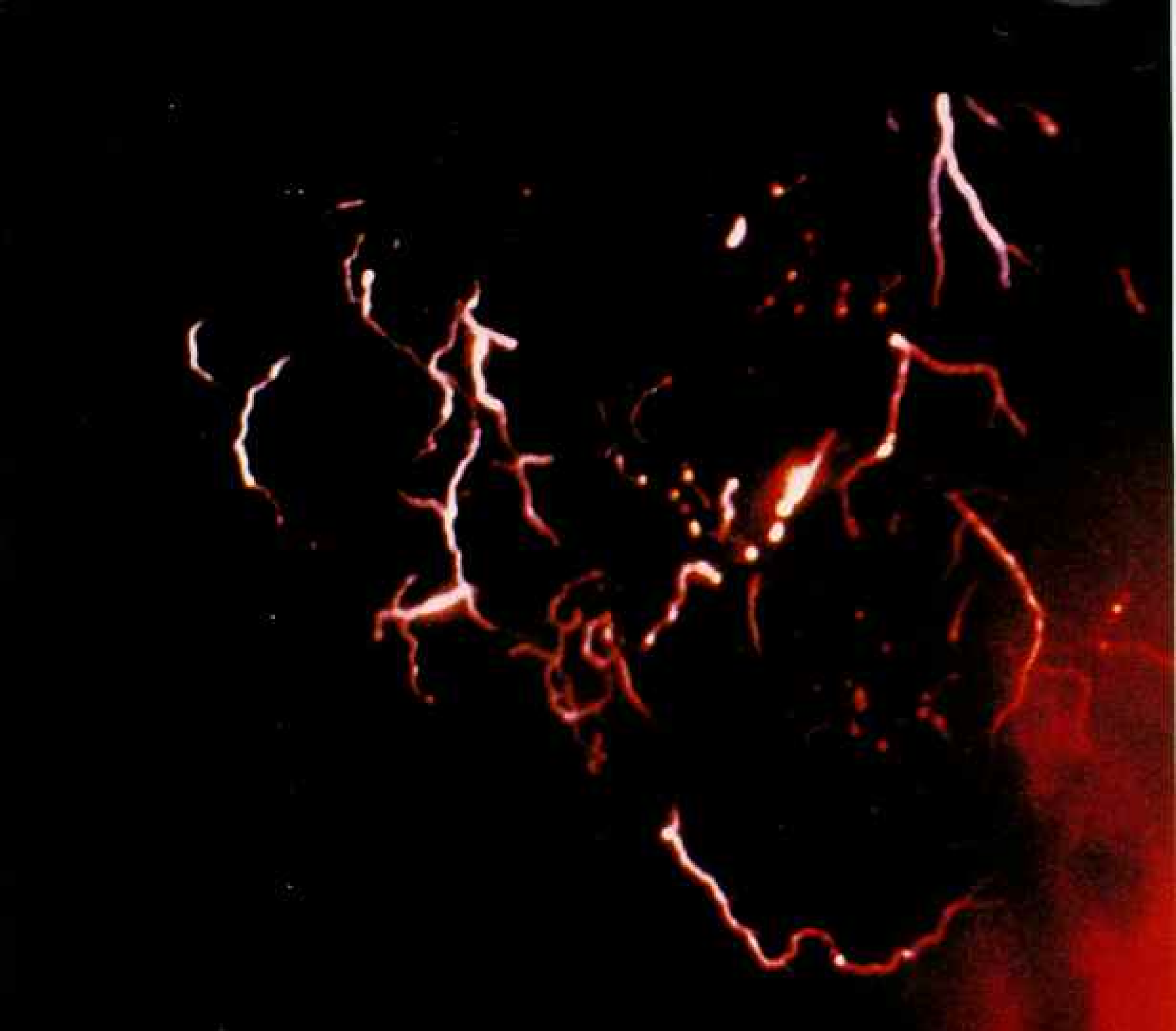
ANTHONY PERITORA FOR JAMES L. LONG ASSOCIATES (TOP RIGHT); COLOR IMAGES BY INFRAMETRICS, INC., FROM NASA VIDEOTAPE

The Disaster of El Chichón

Photographs by GUILLERMO ALDANA E.
and KENNETH GARRETT

MARKED AGAINST ABRASIVE ASH, RESIDENTS OF SAN CRISTÓBAL DE LAS CASAS CLEAN THEIR STREETS AT NOON. GUILLERMO ALDANA E.

Day became night in southern Mexico last spring as villagers near El Chichón volcano struggled with the aftermath of explosions that rivaled Mount St. Helens' and may affect world climate.



A fireball of ash and gases blazes down El Chichón's west flank in this rare photograph, as lightning dances like

SERVANCO DE LA CRUZ-REYNA, INSTITUTO DE GEOFÍSICA, UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

fireworks in the night sky. Part of the second major explosion, on April 3, this flare fortunately hit no villages.

GUILLERMO ALDANA E. (ABOVE); KENNETH GARRETT

Consigned to the ash heap of volcanic history, the village of El Naranjo bakes in the sun. Most inhabitants within El Chichón's ring of destruction fled after the first eruption on March 28, some masked against the dust. Many who remained or returned were killed in more violent upheavals a week later.

Fire and Ash, Darkness at Noon

By BORIS WEINTRAUB
NATIONAL GEOGRAPHIC STAFF

I STOOD ATOP El Chichón and peered at the seething mass below, at what was left after the volcano blew.

It had been a steep climb to the edge of the crater from the helicopter's landing point. The grayish black slope was scarred by deep gashes cut through compacted ash by heavy rains.

A hundred meters below me lay overlapping lakes of dark blue and green water (above), their temperature an estimated 200°C (nearly 400°F). In one spot, water bubbled as though fed by an underground spring; in another, a black object—a tree?—bobbed up and down, hurled to the surface again and again.

KENNETH GARRETT

Steam rose from the water in heavy clouds, evidence of the heat and of the activity within the magmatic chamber. Steam seeped from the crater walls, the sulfur content turning them yellowish green and then rust colored as it mixed with oxygen.

El Chichón, in the Mexican state of Chiapas, had never looked like much from the ground: a mere 1,260 meters (4,134 feet) high, with a peak that recalled the colloquial meaning of *chichón*—a lump or a breast.

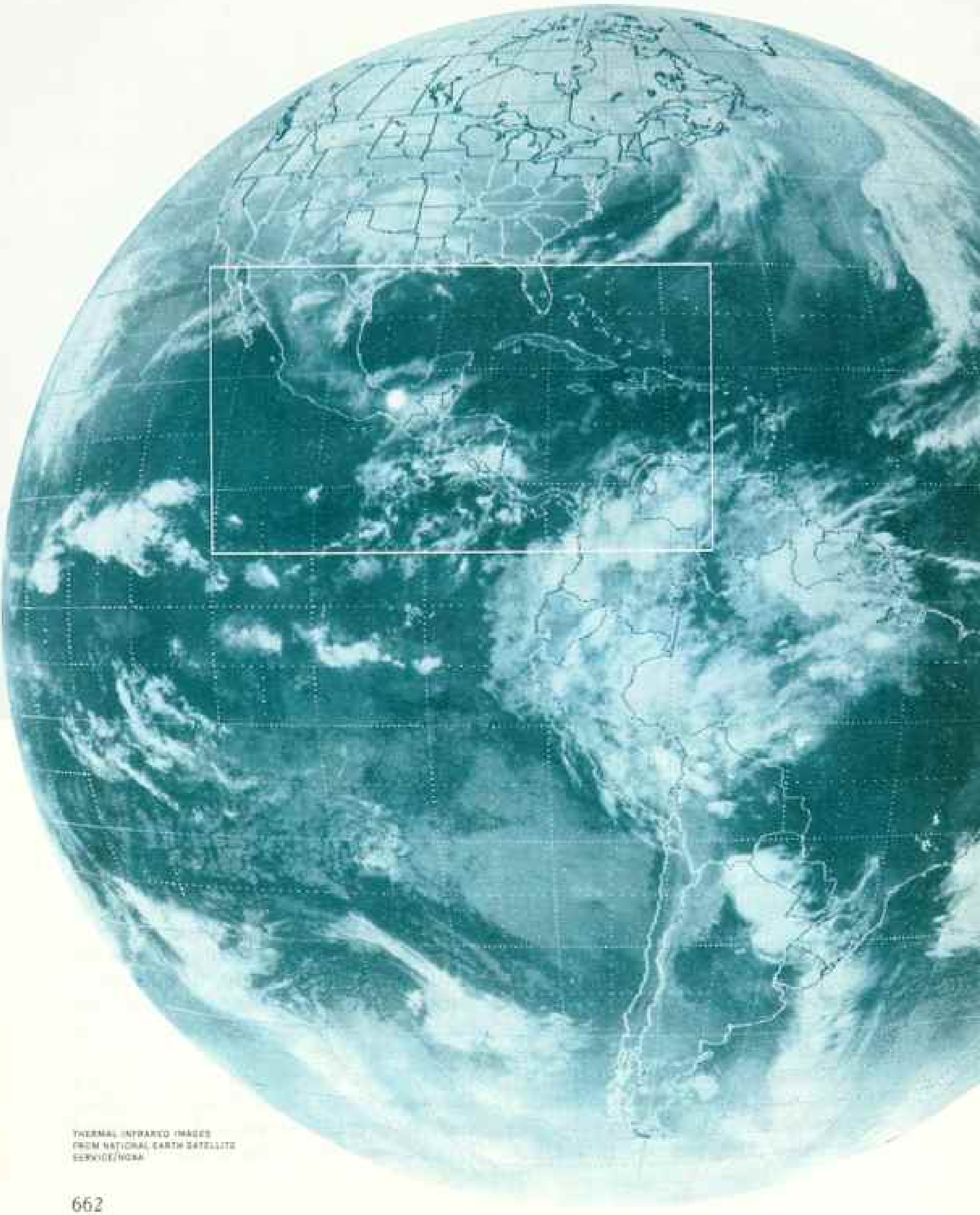
But up here, as I stared into the crater formed after a series of violent eruptions last March and April blew away the mountain's dome, it was much more impressive. The caldron below hinted at the power that brought devastation to the southern Mexican countryside and inflicted a toll of human life that may never be accurately tallied.

Because of its remoteness, the catastrophe of El Chichón was scantily reported in the world press. But this volcano pumped at least ten times as much sunlight-screening ash and gases into the stratosphere as did Mount St. Helens in 1980, threatening to lower temperatures around the world. (See the article by volcanologist Robert I. Tilling on pages 672-5.)

El Chichón was "discovered" in 1928 by a German scientist named Frederick Müller-reid. Its previous eruptions had occurred long before—the folklore of some villagers

Blast on earth—view from space

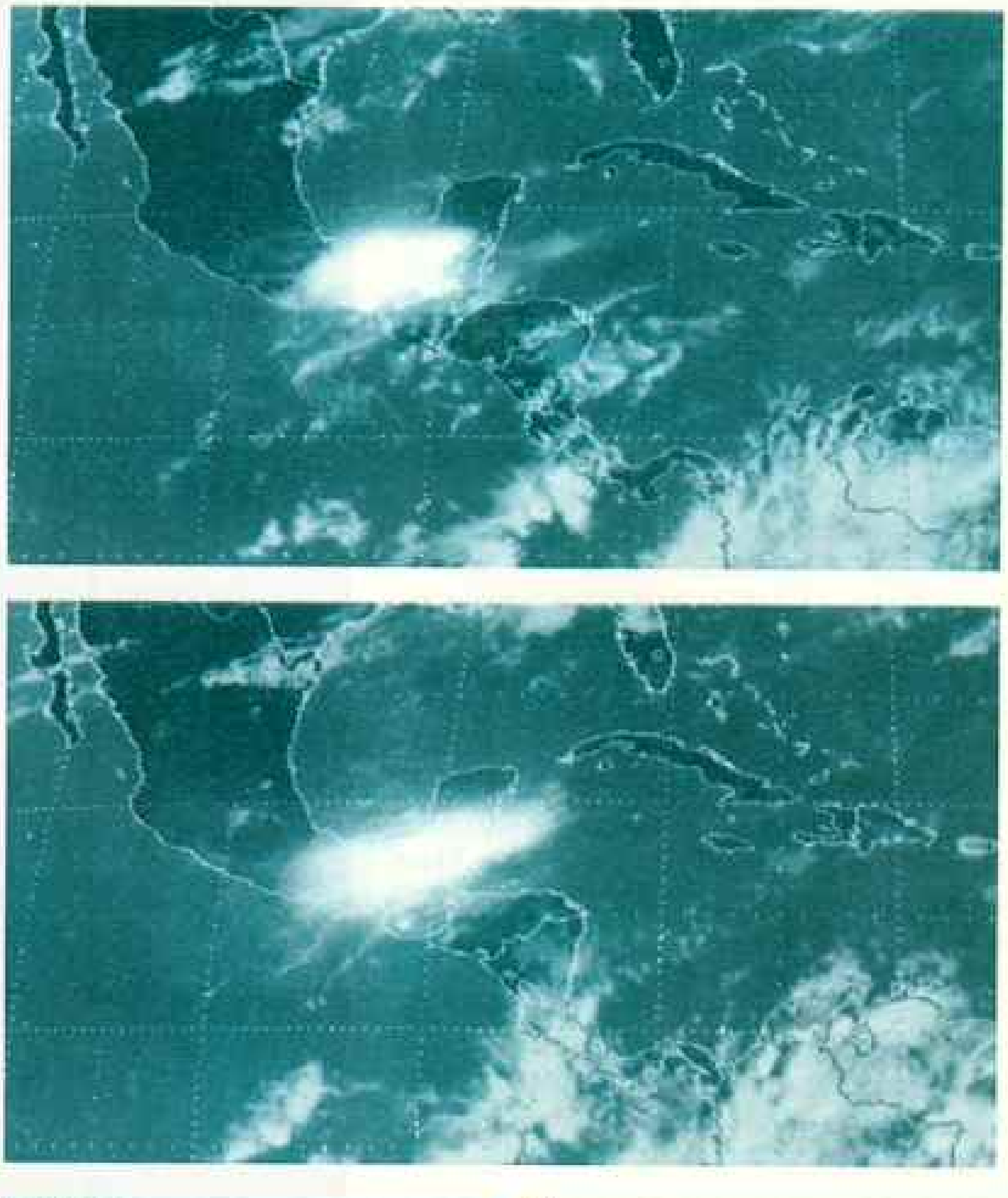
COLOSSAL PLUME of natural air pollutants, the largest in the Northern Hemisphere since the eruption of Alaska's Mount Katmai in 1912, El Chichón's April 4 explosion is seen as a bright circular puff over Mexico's isthmus in this weather-



THERMAL INFRARED IMAGES FROM NATIONAL EARTH SATELLITE SERVICE/NOAA

*satellite image (**left**). Within six hours the cloud of fine ash and sulfur dioxide has expanded over a wide region (**right top**). Five hours later (**right center**) the cloud is torn between the lower atmosphere—with southwest winds prevailing—and the stratosphere, whose lofty winds will carry it westward around the globe.*

Meanwhile, gravity claimed most of the debris for El Chichón's surroundings, where ash blanketed the countryside and flows of superhot ash and gases wreaked total devastation.



ASH FLOW DATA FROM THE INSTITUTO DE GEOLOGIA, UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO
DRAWN BY ROBERT W. CRONAN, NATIONAL GEOGRAPHIC ART DIVISION

held that the most recent was about 130 years ago, but most experts estimated it was thousands of years in the past.

Few gave the mountain any thought. And why should they have? It was well away from most other Mexican volcanoes, those located where the Cocos and American plates rub against each other. It had been little studied since Müllerreid, and most recent geologic work in the area had been to assess its potential for geothermal energy.

Oh, sure, some of the Zoque Indian farmers and some local ranchers had been complaining of earthquakes since last November, and a Comisión Federal de Electricidad (CFE) geologist, René Canul, reported he felt tremors and heard rumbling noises the winter before that. The water in nearby rivers was warming and emitting a sulfurous smell. And there was always a cloud of steam over the mountain.

But that was precisely the point, officials said later. That steam cloud had always been there, and there had always been reports of rumbling in the ground in these mountains. What were they supposed to do? Evacuate thousands of residents? When? What if nothing happened?

Nevertheless, as seismic activity intensified late in March, the government prepared to dispatch scientists to the scene. Most came from the Universidad Nacional Autónoma in Mexico City.

"We have a station in Chiapas that picked up some seismic activity at El Chichón," Ignacio Galindo, director of the university's geophysical institute, told me. "We decided to send a team of seismologists to do fieldwork there."

Volcano Follows Its Own Schedule

"We were going to go the Wednesday before the first eruption, but we couldn't get a helicopter," said Servando de la Cruz-Reyna, who coordinated the team's activities. "The trip was postponed until Friday, and then to the following Monday."

The CFE sent its own geologic team, headed by Federico Mooser, a volcano expert who became a controversial figure.

Before the scientists could arrive, however—at 11:32 p.m. on March 28, a Sunday—there was a local earthquake that registered 3.5 on the Richter scale. The eruption that

An arid rain *choked scores of towns on "Ash Sunday," the sunless day of the predawn April 4 eruption. Enduring a*

GUILLERMO ALDANA E.

weekend of fear and confusion, people queue in San Cristóbal de las Casas to stockpile food. The camera's flash makes spots of ash. Unaware at first of the natural catastrophe, many thought they were being punished for their sins.

followed ejected a column of ash, rocks, and gases, sending ash hurtling 17 kilometers into the sky.

That eruption caused a number of deaths and posed danger to the villages scattered around the mountain. But it was merely a prelude; the worst was yet to come.

The next Saturday, April 3, seismographs in six locations around El Chichón recorded more than 500 seismic events. They climaxed with a powerful eruption at 7:32 p.m., then scaled down again until the major blast at 5:20 the next morning, Palm Sunday. A priest some distance away called it Ash Sunday; for 44 hours the sky was dark with ash.

After those two weekends, the map, the entire landscape, had changed. Villages, ranches, communal farms no longer existed. The army evacuated thousands of residents; thousands of others fled.

Many people were dead. The exact toll will never be known; census figures in rural Mexico are imprecise, and even government authorities emphasize that official death counts are just that: the number of victims officially tallied.

On the one hand, Gen. José Moguel Cal y Mayor, the army's field commander in the area, told me in May that the death toll was 75, and the governor of the state of Tabasco said 114 were killed.

But many believe the toll is far higher than the army's final body count of 187; unofficial estimates of the number of dead run into the thousands. A director of the federal agricultural-insurance agency showed me claims that had been filed on behalf of 3,638 missing people. A survey compiled for the Chiapas state government listed the affected rural farm population as 13,410, with only 8,754 in shelters in May; a footnote added that inclusion of urban areas could increase the affected population by 50 percent.

Among those unaccounted for many surely are alive elsewhere; many surely are not.

Even two months after those terrible weekends, the signs of destruction were chilling. Four of us—photographer Guillermo Aldana E.; our friend and assistant Alfonso Morales; our guide, Pedro Cruz Altunár, until recently a resident of the area; and I—rode muleback for six grueling hours from Ixtacomitán, some 28 kilometers up, down, and around the mountains, to survey the desolation.

Ten kilometers from the summit, as we entered the restricted zone where only those with army permits could go, we saw a stone marker: a skull and crossbones and the words, "*peligro: volcán*—danger: volcano."

Abandoned clothing lay strewn on barbed wire, mute signs of the desperation felt by the Zoque Indians as they fled along the

CHRIS JOHNS, BLACK STAR

A spectacular intermission *followed El Chichón's first eruption. As it steamed and rumbled for a week, wary scientists and the military surveyed its flanks to learn about this little-known peak, far removed from Mexico's volcanic belt. When the activity failed to subside, the army began evacuating close-in villages—a process still under way when the major eruptions began April 3.*

mountainous path to the relative safety of the highway.

Along our route: crushed roofs, trees turned to charcoal, rocks that had fallen from the sky, and the daytime quiet, so devoid of life that the whinny of an abandoned mule was startling. What had been a fertile valley was now a dead, gray, barren desert.

The survivors remember only too well how it happened.

Potential Victims Dare to Stay

During the week between the major eruptions, the people of the nearby hamlets and villages—even the 18,000 residents of Pichucalco, the closest sizable town, 23 kilometers from the summit—asked a common question: Do I stay, or do I leave?

The government set up a plan to deal with the damage, designating 150 million pesos—about three million U. S. dollars at the time—for relief efforts. The army evacuated residents, many against their will; they did not want to leave their land, and many trickled back. Local radio stations broadcast, in several Indian languages, the names of survivors who had become separated from their families.

Servando de la Cruz and his team arrived late on March 30 and set up a seismic station at Ixtacomitán the next day. Other stations were added at Juárez and Ostuacán. They recorded increasing activity deeper within the volcano's core.

Federico Mooser's CFE group also arrived that week.

"The Tuesday after the first eruption we flew down in a special plane; the atmosphere was filled with fine pumice dust that would have filtered into jet engines," Mooser said in his Mexico City home on Volcano Drive.

"The next day we flew over the volcano and saw strong activity. Thursday we went to Pichucalco and reported to the governor. He was distributing food to those Indians who had, wisely, abandoned the region.

"Panic took over; they were advised to evacuate even Pichucalco. We said calm, calm, you shouldn't act so fast."

On Friday, Mooser and another geologist, Salvador Soto Pineda, flew by helicopter to the village of Francisco León.

"We saw for the first time roofs that had caved in, but also many that had not. The whole thing looked peaceful. We were there about 25 minutes when the pilot came and said they wanted to talk to me at army headquarters in Pichucalco."

Soto decided to remain while Mooser flew off to see Gen. Félix Galván López, Mexico's Secretary of Defense. The army promised, Mooser said, to return for Soto.

"We knew most people had left the immediate area," Mooser said, recalling the meeting. "We decided to assume a position of waiting, not ask for the army to go in and evacuate everyone, because you can't do that. It's too drastic."

General Galván later told news reporters angrily that he had relied on Mooser's advice, and that he would not rely on others again. Mooser told me he had simply urged calm and a careful watch on the situation.

When he emerged from the meeting, he learned that the helicopter had not returned for Soto and three soldiers who had remained with him in Francisco León. Soto was in radio contact and he reported each hour that everything was normal.

At 11 p.m. there was no report. Soto was never heard or seen again. Nor were the three soldiers, nor was anyone else who remained in Francisco León.

Exactly what happened—and how many died there—probably will never be learned. Mooser believes there were 30 or 40 others in the village when he flew out that Friday. Was it an unreported deadly ashfall, or simply radio failure, that canceled Soto's 11 p.m. report? Did he and the others survive until the cataclysms of the next two days—Ash Sunday weekend? No one knows.

Rescue workers reached the town nearly two weeks later; only a bit of a church wall was visible. Everything else, every building and certainly every human being, was buried. The first bodies found included a boy clutching his puppy.

Though Francisco León suffered the greatest damage, there were many such tiny villages—Nicapa, Chapultenango, Esquipula Guayabal, El Naranjo—that have passed into the folklore of the volcano.

I met Vasilio Jiménez Juárez in the Pichucalco plaza. He is from Nicapa, a village with several hundred residents that is—was—about seven kilometers from El Chichón.

"I had 20 cattle and a few horses," he told me. "The fire that came burned everything. I had corn, beans, coffee, and everything now is flat ground."

Vasilio was away from home during the first eruption; some friends, a family of seven, had been closer to Nicapa, closer to the volcano. All had died, he said.

"The next morning I went to Nicapa, and a rock fell from the sky and hit me on the hand," he said. "I couldn't work. All the people from Nicapa came to Pichucalco in trucks. I was here for eight days, so I was here when the second eruption came. No way I was going back in there!"

Vasilio, his wife, and five children eventually went to a refugee center in Villahermosa, a bustling city of 185,000 about 75 kilometers north of the volcano. He stayed there for a month, then returned to Pichucalco to live with relatives.

Disaster Signaled by Low Rumble

On Friday night, April 2, the hot ash and gases began to spew out again. The ash spread south and east, and in San Cristóbal de las Casas, 90 kilometers away, a fear spread: God is punishing us, the world is ending. Bishop Samuel Ruíz García went on the radio to say that it wasn't so, that the ash and darkness were natural phenomena.

The next day, that fateful Saturday, Servando de la Cruz was at his seismic station at Ostuacán, 11 kilometers from the volcano.

"The ash emissions were very frequent, about every five minutes," he told me. "Then the wind would clear the area, and then came another emission.

"But at 1932 [7:32 p.m.] the next emission wasn't ash, it was an explosion. It startled me completely. The electrical activity was very intense; by the lightning you could see the eruption going on. The noise wasn't very loud, just a low rumble. But the impressive thing about it was that it appeared to come from everywhere."

Servando saw a rolling avalanche of ash, gas, and rocks heading his way. It was the same type of avalanche as the one that buried Francisco León.

"It appeared to be very close to us; reddish light came from about two kilometers away, it seemed. I learned later that it was actually six kilometers away."

All Saturday night and all day Sunday people poured out of the mountains on foot, carrying what little they could.

In one group was Federico Mooser. He had driven into the area, but his car became stuck in the deepening ash and he remained in Chapultenango, radioing the army and now urging total evacuation. On Sunday he walked ten hours on the mountain path to safety at Ixtacomitán.

Not everyone was so fortunate. As we rode our mules on that same path two months later, Pedro pointed out places at which people fleeing had slipped, had tumbled down rocks, and were killed. In Chapultenango we saw a school and a large church; both roofs had caved in, as had the roofs of most of the houses. Pedro's was among them.

Even in Pichucalco, damage was heavy. The roofs of the new market and of the town's only movie theater had collapsed. So had the roofs of many houses there.

TIM CHAPMAN, BLACK STAR (FACING PAGE); GUILLERMO ALDANA E.

Deadly missiles, *volcanic rocks bombarded an evacuated Chapultenango school* ***(above)*** *and slaughtered livestock worth millions of dollars* ***(opposite)***.

Guillermo Ruíz Vargas, a Pichucalco laborer, lives in a three-room wood shack with a dirt floor and cardboard walls lined with gift-wrap paper. Eleven people, including three babies, share the house with him.

"The fire started coming out of the sky," he told me, "and we didn't know whether to leave or stay. Ash and sand were falling, and rocks came through the roof like bullets.

"After the first time, I rebuilt the roof. Then it all happened a second time."

Shelters were set up in Villahermosa and Cárdenas in Tabasco; in Pichucalco, Ixtacomitán, Tuxtla Gutiérrez, and elsewhere in

ALL BY GUILLERMO ALDAMA E.

Under bombardment, *the loosely anchored metal roofs of rural Mexican homes fell to El Chichón's ash and rock. In evacuated Chapultenango* ***(lower left)****, only ten kilometers from the crater, scarcely a roof was left intact. Residents of Pichucalco, 23 kilometers away, decided to stay and worked frantically to keep their roofs clear* ***(upper left)****. Construction worker Guillermo Ruíz Vargas (***right,** *at left), who shares his home with 11 others, had to replace his roof a second time, after the final eruption.*

Such scenes of destruction raise speculation about the number of lives lost. Counting only recovered bodies, the Mexican Army gives an official toll of 187, though many fear the number is in the thousands. Incomplete census data make it difficult to determine missing persons.

Chiapas. At one point 40,000 people lived in them; late in May more than 12,000 remained. The Mexicans have a word for these people. They are called *damnificados*—damaged ones.

Most of the seriously injured—those severely burned or hit by falling rocks—were taken to a public hospital in Villahermosa. But everyone who came in contact with the ash complained of eye irritation and breathing problems.

"If these people went often into an area with dust like this, as miners do, there would be a problem," I was told by Dr. Francisco Jiménez Falcón, head of medical services for the agency that operates the hospital. "But if they were exposed to it this one time, it will only be a temporary problem."

"The eruption didn't cause anything new," said Dr. Héctor Lozano Buenrostro, public health coordinator for the state of Tabasco. "The sicknesses we had were natural: diarrhea, respiratory problems, some sore throats, dehydration.

"This population is poor, under stress, malnourished. It's dangerous. They are weak, they have no defenses."

Dr. Lozano and J. Mauricio Cerda y Priego, Tabasco's chief health engineer, emphasized that the shelters were clean, with latrines and running water. Refugees were vaccinated against numerous diseases.

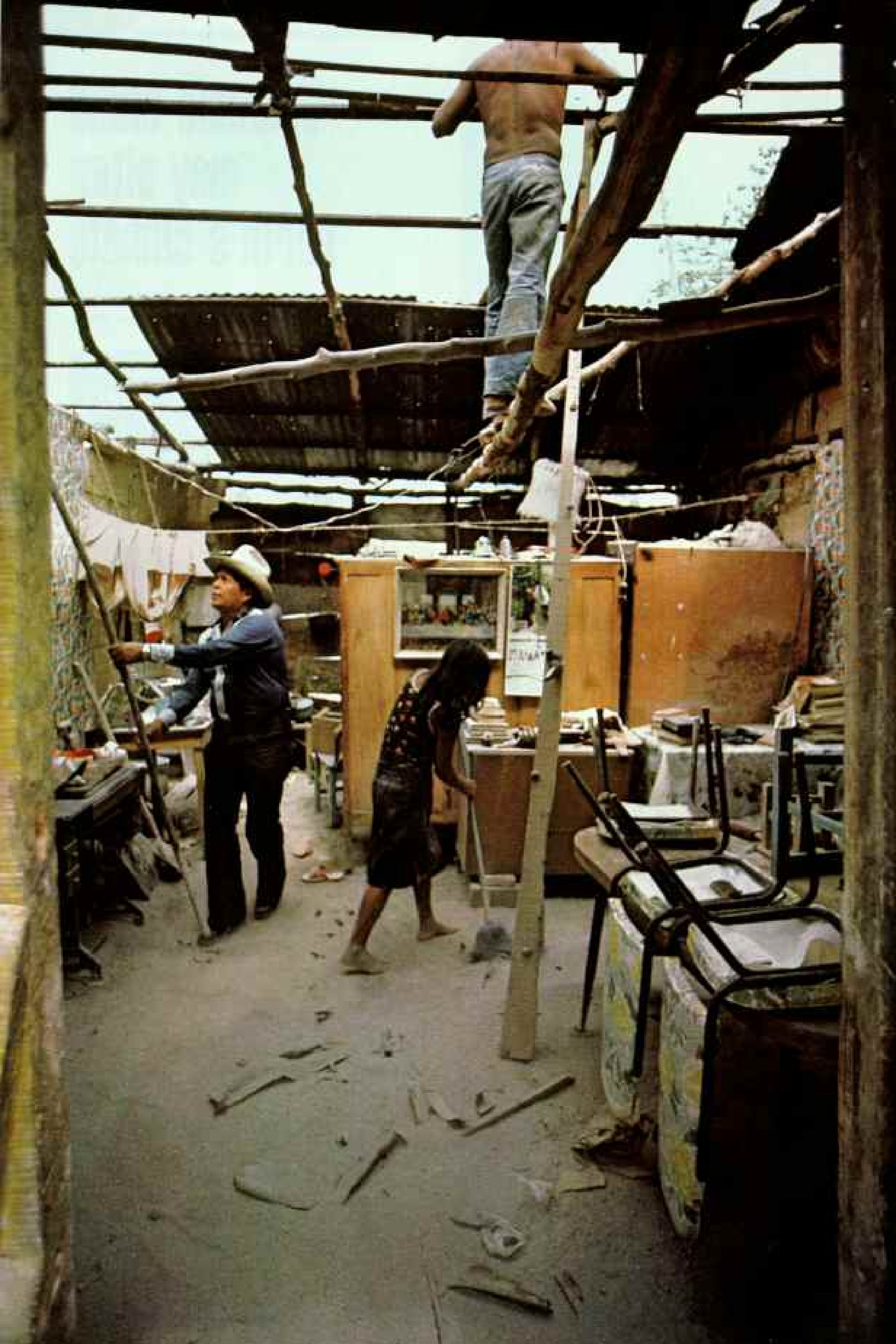
Even Survivors Fear All Is Lost

José Cerna García, Tabasco's public security director, whose police gymnasium became a shelter, put it bluntly: "Thanks to the volcano, more are being saved than would have been otherwise."

But most refugees were not used to such facilities; many became temporarily ill simply from eating a balanced diet.

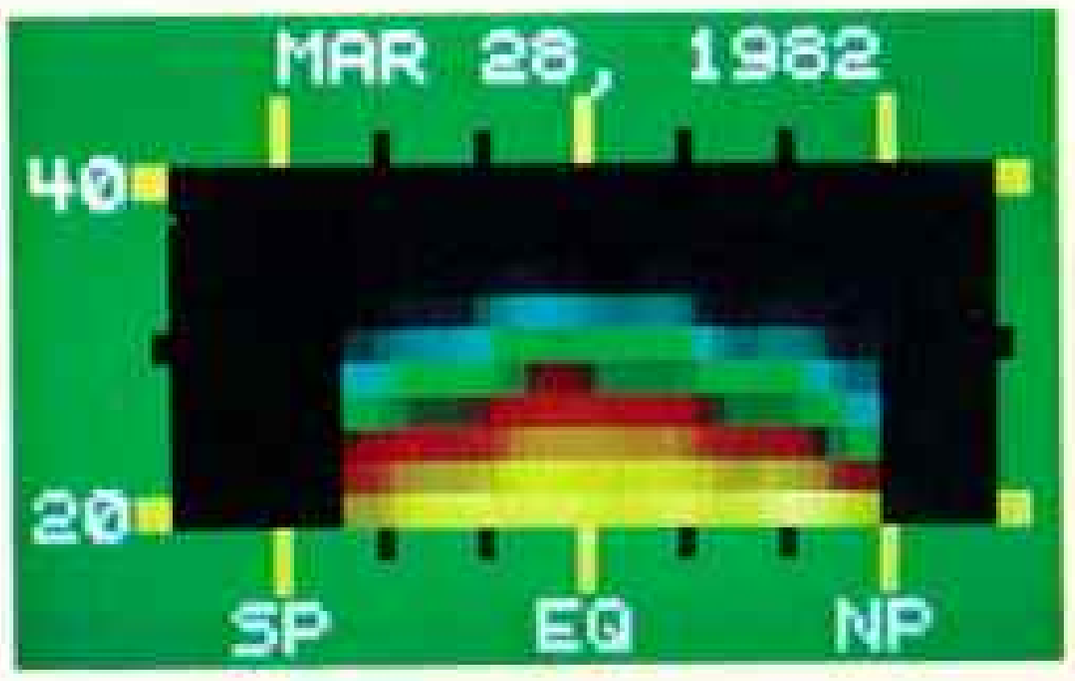
"There were many who were not injured physically, but they lost everything," Dr. Lozano said. "They are suffering now, not because they are sick but because they have nothing."

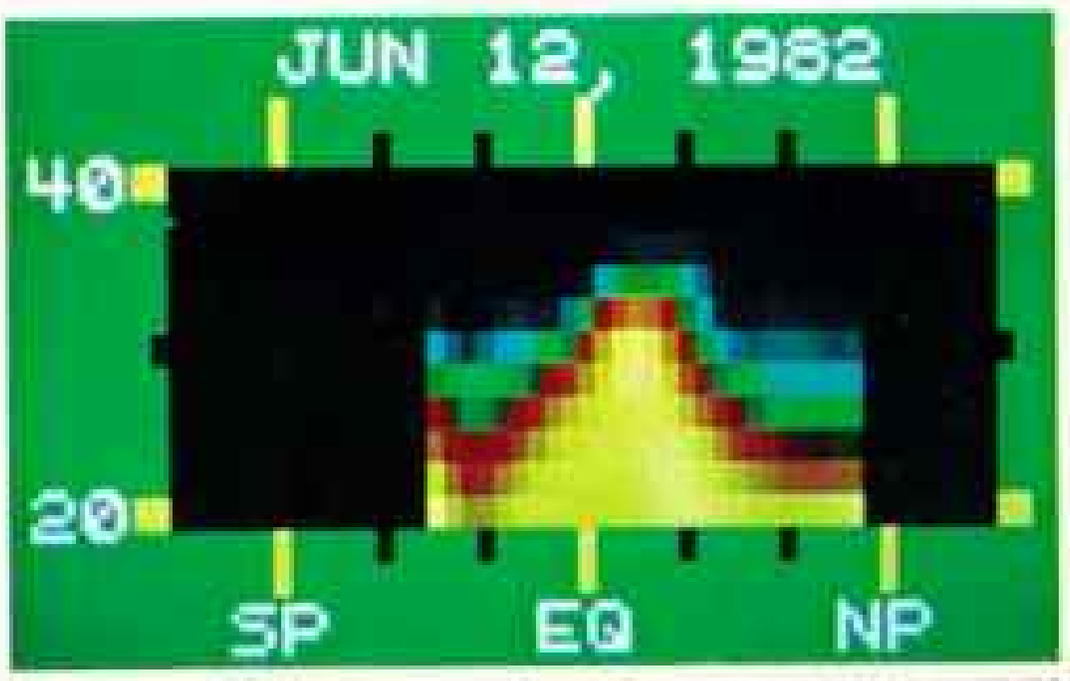
The refugees in the police shelter in Villahermosa were primarily old people, women, and children. *(Continued on page 676)*



Volcanic cloud may alter earth's climate

By ROBERT I. TILLING
U. S. GEOLOGICAL SURVEY





LABORATORY FOR ATMOSPHERIC AND SPACE PHYSICS, UNIVERSITY OF COLORADO

Computer profiles *of satellite data taken over Europe document the cloud's spread through the stratosphere. The March 28 preeruption chart shows a normal view. On May 6 the cloud tops 30 kilometers; air currents confine it to the Northern Hemisphere. By June 12 the cloud has spread south of the Equator.*

IF THE NEXT WINTER or two seem especially stormy, or if next summer is colder than usual, perhaps you can blame El Chichón.

Atmospheric scientists report that its volcanic cloud is the largest observed in the Northern Hemisphere in seven decades. To find its equal one has to go back to the 1912 eruption of Katmai in Alaska.

Most of the 500 million metric tons of dust, ash, and gases El Chichón hurled into the atmosphere last March and April has settled out. But what remains is cutting down on solar radiation and will continue to do so for perhaps two or three years.

According to scientists the resulting drop in average temperature—though slight—could noticeably change the weather.

Thus, as so often happens, the long arm of misfortune may touch people far removed from the scene of a tragedy.

Because El Chichón is so isolated, and because there was little evidence of any recent eruption (carbon dating has since shown that one blast occurred about 1,200 years ago), the volcano was never considered a threat.

Moreover, El Chichón lies apart from the circumpacific "ring of fire," where volcanoes are triggered by colliding tectonic plates. It is a stratovolcano, formed of alternating layers of lava, ash, and other debris forced up through ancient limestone and sedimentary strata by repeated eruptions. Geologists do not really understand why there would be magma, or molten rock, to erupt here in the first place.

Thus it was a surprise when the ancient peak roared to life last March with an explosion detected as far away as Antarctica.

Comparisons with Mount St. Helens are inevitable. In both cases the ashfall, after being compacted by rainfall, had an estimated bulk of about half a cubic kilometer, the equivalent of a football field piled 100 kilometers high.

At Mount St. Helens the total volume of ejected material was probably six to seven times larger than at El Chichón; ground devastation was correspondingly greater.

But the atmospheric impact of the Mexican volcano is far greater than that of Mount St. Helens. Three factors help explain: atmospheric conditions favorable to stratospheric penetration and transport of the El Chichón aerosols, unusually high sulfur dioxide content of the El Chichón magmas, and eruption energy almost entirely upward at El Chichón, whereas the energy at Mount St. Helens was spent horizontally more than vertically.

Fortunately for scientists, El Chichón's high-altitude cloud passed directly over the National Oceanic and Atmospheric Administration's Mauna Loa Observatory in Hawaii. Its laser radar recorded the cloud as more than a hundred times denser than that from Mount St. Helens.

Further evidence comes from a satellite, the Solar Mesosphere Explorer, which watches the cloud as it spreads to the north and south while circling the globe. By the time you read this, the cloud will probably have become an uneven veil over much of the earth. At its base it is some 18 kilometers (60,000 feet) high, and at its top it reaches roughly 38 kilometers. Thus it is above the level of the earth's active weather systems.

That does not mean, however, that the veil will not affect the weather. The cloud contains fine volcanic ash, particles as small as five-thousandths of a millimeter. It also contains, surprisingly, crystals of salt, something never before found in the clouds of land volcanoes. This salt comes from ancient deposits three to four kilometers below the volcano.

But by far the most abundant constituent is aerosols—tiny droplets of sulfuric acid produced when sulfur dioxide gases from the volcano interact with sunlight and atmospheric moisture. Both ash particles and droplets reduce the solar energy reaching earth. This phenomenon was first recorded in 1783 by Benjamin Franklin, when he noticed after a volcanic eruption that sunlight through a magnifying glass would no longer set fire to a piece of paper.

Brian Toon, an atmospheric scientist at NASA's Ames Research Center near Mountain View, California, expects the average surface temperature in the Northern Hemisphere to cool by at least one quarter of a degree Celsius (about half a degree Fahrenheit), perhaps twice that much. That is an average; the figure at any given locality could be different.

"I haven't heard much debate among meteorologists over these figures," he says. "There *is* debate over whether we can detect that much change. The average

Cork in a cannon, *El Chichón's jungle-covered dome* ***(below)*** *topped an unremarkable 1,260 meters on the Chiapas highlands. Pressure within the volcano blew it away, creating a sharply defined new crater 200 meters lower* ***(left)****. The encircling saddle marks an ancient crater.*

GUILLERMO ALDANA E. (LEFT); COMISIÓN FEDERAL DE ELECTRICIDAD

temperature varies from year to year by about half a degree Celsius anyway, so the volcano could simply cancel some other influence, or it could augment it.

"People ask: 'Will it be much colder here?' 'Will frosts be earlier?' 'Will there be worse storms?' This is beyond the capacity of meteorologists to predict."

However, Dr. Toon adds, we can learn something by looking at the experience with earlier volcanic eruptions. For one thing, people complain about colder weather the year *after* an eruption. Thus in 1913, the year after the Katmai eruption, Vienna and Budapest experienced the coldest summer on record—more than two degrees Celsius below normal.

El Chichón's effects next year will likely not be that great—or as severe as those following the 1815 eruption of Tambora in Indonesia. The "year without a summer," 1816, saw big snowstorms late in June in New England, with a heavy frost in July.

How much sunlight will be lost because of El Chichón? If one measures directly in line with the sun, the decrease may be as much as 25 to 30 percent. But though the sun is less bright, the surrounding sky is brighter because of light scattered by the cloud. Thus the total loss of sunlight at the ground would be 5 percent or less.

That, however, can produce a decidedly noticeable effect—as we may see for ourselves next year. * * *

(Continued from page 670) Since the city is the center of a construction boom, many of the men of working age had been able to find jobs as laborers. Their wives and children wandered around the gymnasium.

"My husband used to be a farmer, but now he is working in Villahermosa," said Gloria Domínguez Sánchez. She sat on a bunk, holding one of her five children, and as she talked, she looked stunned, as though the events that drove her family from Chapultenango had happened the day before, rather than weeks earlier.

"My husband says pretty soon Chiapas will give us a place, and we are waiting for it," she said.

Was she afraid of starting over?

"*Sí, sí,*" she replied, "especially with the children. I don't want to go back there. I don't have anything. All my clothes, my dishes, everything is lost."

"What do you want to do?" I asked. There was a long pause. She had no answer.

Refugees Pack Fairgrounds

Fewer than a hundred people remained in the Villahermosa shelter when I visited late in May. But at another shelter, at the Chiapas state fairgrounds in Tuxtla Gutiérrez, the population was still 4,138.

Each family lived in a stall that normally held farm animals or things to be sold to fairgoers. Children wandered about barefoot. Latrines stank. A parade float, Cinderella's coach, a relic of past gaiety, lent ironic contrast.

"Tomorrow will be two months that people have been coming here," said Gerónimo Cruz, who escaped with his family from El Naranjo. "When the eruptions began, we grabbed our few clothes and ran. It took eight days to get here."

The shelter's staff struggled to help. Doctors and nurses were everywhere, as were signs in Spanish and Zoque giving sanitary and medical advice: "Go to the doctor." "Use the latrines." "Flies bring sickness—kill them."

But the odds were overwhelming. My most vivid image of the volcano area was of an obviously malnourished baby sitting naked on the floor at this shelter, crying piteously, his protruding belly and scrawny arms and legs covered with flies.

On the crumbly lip, *the author and his party examine Mexico's newest active volcano—one of more than a dozen that*

KENNETH GARRETT

worry the government. Considered still young geologically, El Chichón is now being studied intensively. New evidence indicates two previous eruptions in the past 1,200 years, and some scientists give it a 70 percent chance of exploding again in the foreseeable future.

"It's hard to create new habits in these people, but we are trying," I was told by Enrique Parera, the shelter's administrator. "We are discovering the sicknesses they had before. We are getting a clearer picture of Indian health than we have ever had."

Parera said that Chiapas state was seeking new homes for the refugees; in fact, Demetrio Mondragón Barajas, who was in charge of all the state's efforts to deal with the impact of the volcano, was flying over the area that day, looking for land.

"Within ten kilometers of the volcano, no one will be able to use the land for several years," explained a weary Mondragón in his office that evening. "Within five kilometers it could take ten years.

"At first we thought half the state would be a disaster area. Now it seems only the immediate area is affected. Outside it the grass is standing up again."

There were other signs of resurgent life. At a shelter in Ixtacomitán I saw families run to climb on a cattle truck bound for a new communal farm. The land was far from their ruined village, but they had been in four shelters in two months, and they wanted permanent homes.

The economic effects were serious. Farmers eventually filed claims for 240 million pesos (about 2.5 million dollars) in lost livestock. I watched some of those destitute farmers in an insurance office in Pichucalco; they looked lost themselves, as if they felt useless without their few cows.

Waiting for Land, Work, Answers

And there was the frustration of people like Vasilio Jiménez Juárez of Nicapa: homeless, landless, jobless.

"I'm waiting to find a job, waiting for land, waiting for the government to do something," he said. "At least a piece of land to put a house on. I worked my whole life to get a piece of land, some animals, a house. Now I have to start over. I would like to work, but there is no work."

But Leandro Rovirosa Wade, the governor of Tabasco, told me that the damage in his state, which, admittedly, was not as hard hit as Chiapas, was less than the earliest estimates suggested.

BOTH BY GUILLERMO ALDANA E.

Damnificados, *damaged ones, they are called. Most are Indians of the Zoque tribe, many of whom pastured their cattle on El Chichón's once benign slopes. At one time 40,000 displaced persons crowded emergency shelters in the states of Chiapas and Tabasco—nearly all suffering eye irritation and respiratory ailments caused by inhaling ash.*

A few days after the final eruptions, refugees line up for army food at a shelter in Pichucalco (**right**). *Women and children* (**left**) *constituted the majority of those who still remained in shelters by late June; many of the men were able to find temporary jobs as laborers in nearby towns.*

By mid-August the thousands of homeless had been resettled, and the shelters were closed.

"The ash covered our sugarcane and banana plantations, but we may recover 80 percent of the cane and almost all the bananas," the governor said as we talked in the Tabasco fairgrounds. "Cacao is our main crop; we expected a harvest of 32,000 tons, and we've already recovered 25,000 tons.

"Remember, this volcanic ash is good for the soil. Next year there will be crops as though nothing happened."

In Chiapas, according to Mondragón, the situation was similar. The coffee harvest actually increased over the previous year, and all the cacao crop was saved.

His land-seeking efforts paid off as well. By early August all the refugees had new homes, and the shelters were closed.

But many problems remain. Nobody knows what the ultimate effect of the volcano will be. Even the basic question—will El Chichón erupt again?—is unanswered. Seismic events were still being recorded daily in mid-August, and scientists continue to monitor the mountain closely.

"Look," said Governor Rovirosa, "the volcano is still active. It could erupt in 24 hours or 100 years. We have to get used to living with an active volcano."

On a helicopter tour I was able to see both the devastation and the land beginning to heal itself.

At Francisco León, where geologist Soto and the soldiers had died, the destruction was total. My companions—Ricardo Riva Palacio, a CFE engineer, and Ricardo Gutiérrez Coutiño, an Instituto de Geología structural geologist—described what had happened.

Francisco León lies in a valley, across the Río Magdalena from a group of mountains that includes El Chichón. When the ash and rocks began to pour from the volcano, the red-hot flow was channeled down toward the river between two other hills.

"It had a ski-slope effect, skipping right across the river and ramming into the town," Riva Palacio explained. "At that point it must have been 300 or 350 degrees Celsius."

Since the eruptions more trouble had struck. The ash flows created a dam that blocked the *(Continued on page 684)*

Pulse of life to a pall of doom: *The village of Francisco León, dominated by its church and park* ***(below)****, became El Chichón's grimmest disaster. During the April 3 eruption a gigantic fireball of hot gases and volcanic ash rolled down El Chichón's slopes, spanned the narrow Río Magdalena, and slammed directly into the town. The river, clogged by volcanic debris, now follows a braided course* ***(right)*** *in the newly sculptured countryside. The stark ruin of the church has become the tombstone for a dead town.*

RICARDO MELÉNDEZ URISTA (ABOVE); KENNETH GARRETT

Postmortem clue, *bent reinforcing rods* ***(left)*** *indicate the force and direction of the blast that demolished Francisco León. About half the 1,000 inhabitants reportedly fled before the first eruption, frightened off by several weeks of recurrent earthquakes. Perhaps 40 fell victim to the volcano; some still lie buried under the ash and scattered human reminders* ***(below)****.*

*"**Like talcum powder,** but heavier," said one observer of the ash that covered Palenque—a showcase of Maya antiquity overlooking the Tabasco plain. By late May, after much human effort and prayed-for rains, the great plaza appeared free of ash (**right**), though much remained compacted under the grass. "You couldn't get rid of the stuff," said the author. Within two or three years the ash will work into the soil, increasing fertility.*

MEXICO GREENE ROBERTSON (TOP RIGHT); GUILLERMO ALDANA E.

Essay in erosion, *a photographic sequence taken at Palenque* ***(right)*** *begins in 1974 with limestone carvings smudged by dark fungi, at top. Following the eruptions, the frieze was covered with fine ash; after two months of wind and rain it was spanking clean. Sadly, the ash and rain had combined to produce a scouring effect that eroded the painted surface. Also suffering the effects of acid rain, Palenque faces abrasive times.*

river, forming an artificial lake. When the rainy season began, the dam broke, burying the site for a time under several meters of muddy water.

The town's ruined church had been a substantial concrete-and-stone structure, about 65 meters long, but only the base of its walls remained now. Elsewhere in the village we found the flotsam and jetsam of everyday life: a tortilla roller, a few ladles, pots and pans, empty beer bottles, bits of clothing.

"Look," Riva Palacio called from within the church. Poking around in the ash, he had found a piece of cloth. "The priest's robe."

In Nicapa most houses remained standing, though virtually none had roofs. The ground was gray, but two people were repairing the roof of a large building, and I saw a few cattle and mules. The trees around the village were green.

A Few Glimmers Among the Ashes

At Palenque newly hired workers shoveled ash off the world-famed Maya ruins. Then they took a pump and a large hose and washed off more.

I visited the ruins after several days of rain; little ash was visible. Though its abrasive action had erased much of the priceless ancient paint—"as if a giant had scrubbed them with scouring powder," in art historian Merle Greene Robertson's words—the ruins survived this as they had survived the previous 12 centuries. They were still beautiful.

It is natural to look for a few hopeful signs in a story like this, and that is one of them. Here are others:

In San Cristóbal and Pichucalco everyone marveled over the way people joined to help clear the ash away. "I saw a man give a shovel to his worst enemy," said one local resident.

In Villahermosa, Patricia Camacho, a reporter for the newspaper *Avance* who covered the volcano story around the clock for two weeks, has a pet duck strutting on her patio. She had found it near death, suffocating on ash, so she took it home and nursed it back to health.

In Chapultenango, people were starting to rebuild their homes. Alfonso, Guillermo, Pedro, and I rode past residents returning home, carrying rolls of sheet metal for new roofs on their backs.

And as we walked back from a visit to the volcano that night, we heard a dog barking across the valley. Pedro whistled, and the dog came to join us. It was Pedro's dog, missing since the first eruption two months earlier.

"I was sure he was dead," Pedro kept saying as he hugged the dog.

Can it be that the area around El Chichón is not as dead as it seemed? Will it, like Pedro's dog, come back too? □

GUILLERMO ALDANA E.

Unbowed *by outrageous fortune, residents return to Chapultenango with a new roof, ready for a fresh start. While geologists monitor El Chichón's every pulse and meteorologists try to interpret the effects of its spring outburst, the people nearby must learn to live with an active volcano.*

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Where is the Bell System going?

Nothing has done so much to change the world we live in as the telephone.

Yet the basic operating principles of the Bell System itself have changed very little over the past hundred years.

It was all because we had a single overriding goal: universal service. Dependable service at reasonable rates for everyone who wanted it.

And in order to achieve this goal, telephone exchanges were established as exclusive franchises and were permitted to operate without competition. But the government strictly regulated our rates and profits.

Today, 96% of the nation's homes have phone service.

So now America and the Bell System can change old goals for new ones.

The regulators and legislators in this country are looking more to the marketplace and competition—rather than regulation—to decide who will provide competitive services and equipment and how they will be priced.

The biggest force behind this change has been new technology, which has changed the very nature of telecommunications.

We are on the threshold of a new era: the Information Age. The technology of communications has gradually merged with that of computers. And the marriage of these two technologies offers the potential for an impressive array of new customer services.

However, the blending of these two technologies has also blurred the boundaries between a traditionally regulated business—communications—and the unregulated data-processing industry.

This circumstance has led to some major rethinking of public policies on telecommunications.

Policies to which the Bell System must conform. And in order to conform, the Bell System must change.

To begin with, the Bell telephone companies will have to be separated from their parent company, AT&T. Among other things, these local operating companies will continue to provide basic service under state regulation, and they'll serve as the gateway to the new Information Age.

Because it is being thrust into a marketplace that is intensely competitive, AT&T—the parent company—is also going to change. The task of bringing these changes about is enormous. But we are determined to make the transition a smooth one.

AT&T will continue to create and provide new products and services to meet your changing needs. And Western Electric, Bell Labs and Long Lines will continue to remain vital parts of AT&T.

We want to keep our customers, shareowners and employees informed every step of the way. So along with your local Bell telephone company, we'll be talking with you in ads like this about varying aspects of the coming changes.

It's all part of the "Let's Talk" program set up by the Bell System.

Each ad will have a number to call: 1 800 555-5000.

There'll be somebody to talk to. Somebody to help you. Somebody to answer your questions. Somebody to get you information.

So call us. And we'll be talking with you.

Let's talk.

Bell System

South Shore Conservatory, Hingham, Mass. Shot with a 28-80 zoom lens at f/5.6 at 1/125 sec. © Eastman Kodak Company, 1982

The less you can count on light, the more you need Kodacolor 400 film.

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Members Forum

FLORIDA

I enjoyed your article on Florida (August 1982). But I must take umbrage at the statement that "Florida, like Hawaii, is one of only two states in the nation with tropical weather." Not so. The "Valley" in southern Texas has tropical weather, palms, poincianas, and ruby-red grapefruit, the best grapefruit in the world.

Dianne Runyon
St. Thomas, U. S. Virgin Islands

Technically, only two U. S. states enjoy truly tropical climate—Hawaii and the southern tip of Florida. However, plants and animals that flourish there can also be found in other states.

As one of the "pilgrims to a shrine of winter warmth," I was surprised, and not a little hurt, by the beginning of the story about Florida. So far, being in our early and late 60s, we have yet to "shuffle." We do wear shorts and polo shirts, as we certainly didn't retire to Florida to wear woolies and ski boots.

Sylvia F. Jewell
Marathon, Florida

Referring to page 215, please explain how water can drop more than four feet and expose "boat tracks." How do boat tracks get into the mud? Does this mean that if the Atlantic Ocean dries up tomorrow, we would see boat tracks?

John J. Garzi
Pasadena, Maryland

The tracks were caused by boat keels or propellers gouging the lake bottom as the water receded in the drought.

In the Florida article the reference to the arthritis medicine of Brooks Campbell says, "Bottled under his own label, the liniment is licensed by the state government for sale in Florida." Is it possible for non-Florida residents to purchase it?

Reg Campin
Blaine, Washington

Mr. Campbell has not submitted his liniment for testing by the U. S. Food and Drug Administration, and it is currently available only in Florida. We are unable to supply Mr. Campbell's address for the many who have requested it. It is the policy of NATIONAL GEOGRAPHIC *to avoid recommending any medicinal product.*

After reading "Florida: A Time for Reckoning," I was disappointed. In terms of economic future, Florida has one of the best in the country. I have lived in Memphis, Chicago, Atlanta, but Orlando is the city that has captured my heart. Out of the ten million Floridians it would be hard for you to find one displeased resident.

David Brown
Orlando, Florida

CARRARA MARBLE

I just finished reading Irving Stone's *The Agony and the Ecstasy*, which recounted Michelangelo's titanic task of quarrying marble from Mount Altissimo, when my July 1982 issue arrived containing the Carrara article. Having been to Italy to see the works of such a master, I can agree with Michelangelo's belief that marble is "alive." Thus the crystals of the "Pietà" must be in "ecstasy," while those of the present-day "Thumbs" and "Fiats" must be in "agony."

Milton Parent
Burnaby, British Columbia

SINDBAD

Reading the article "In the Wake of Sindbad" (July 1982), I felt I was living a mythical legend come true. It was as if I had been transported and was myself struggling against the sea, involved in that same teamwork and comradeship. It was great to read and beautiful to experience.

Leonel A. Oliveira
Berkeley, California

In your article "In the Wake of Sindbad," you mention "the golden age of Arab sail between the 8th and 11th centuries." You also mention the *kamal* as a navigation instrument used in conjunction with the North Star to determine position. The star Polaris, however, was not in the proper position to be used as a North Star prior to around the year 1200. The sudden improvement in navigation that occurred in both Arabic and Western cultures around that time probably coincided with the discovery of how to use Polaris to determine true north.

Fred C. Davis, Jr.
Baltimore, Maryland

Polaris has changed position over the centuries, but only a few degrees between A.D. 800 and 1200. Both Arab and European sailors used it as the North Star by the ninth century. The advent of the magnetic compass in the 12th century greatly increased the accuracy of navigation.

We were appalled at how lightly hydrogen sulfide gas was treated by Tim Severin in his story "In the Wake of Sindbad." Hydrogen sulfide gas is very flammable and extremely poisonous in very small quantities.

Louis A. Jankoski
Piscataway, New Jersey

OLDEST MAYA

In "Unearthing the Oldest Known Maya" in the July 1982 issue, the author writes: "Maize originated in the arid highlands of central Mexico." Most unlikely. No major food crop ever originated in arid lands. Additionally I believe that the origin for maize would be the southern and not the central part of Mexico.

Louis J. Mihalyi
Forest Ranch, California

Present archaeological and botanical evidence suggests that inhabitants of a harsh region were more apt to begin food cultivation than those in a region with abundant wild foods. The earliest traces of maize cultivation come from the dry highlands of south-central Mexico.

WILLA CATHER

This is a note of gratitude for the delightful insight into the life and times of Willa Cather (July 1982). Today there was not a single copy of a Cather book in our public library, which is usually so well stocked. I am sure that the paucity is the result of GEOGRAPHIC influence.

Mary Margaret Mayfield
Jefferson City, Missouri

We enjoyed the Willa Cather article, but in regard to Willa's Virginia birthplace—which my father owns—the house is hardly the "abandoned shell" your writer describes. During the past several years it has been occupied by a succession of tenants and has fared about as well as have many old houses of its sort. It has stood for nearly 200 years, and bids fair to stand some few years more.

Charles T. Brill, Jr.
Gore, Virginia

In the July 1982 issue the caption of a picture of Willa Cather states: "she took a spin on a railroad handcar." According to the lexicon of the Southern Pacific, along whose lines I grew up, Miss Cather is astride what was called either a "speeder" or "velocipede."

Charles A. Bond
Lacey, Washington

The Association of American Railroads confirms that both velocipede and speeder can be called handcars, a term more familiar to most readers.

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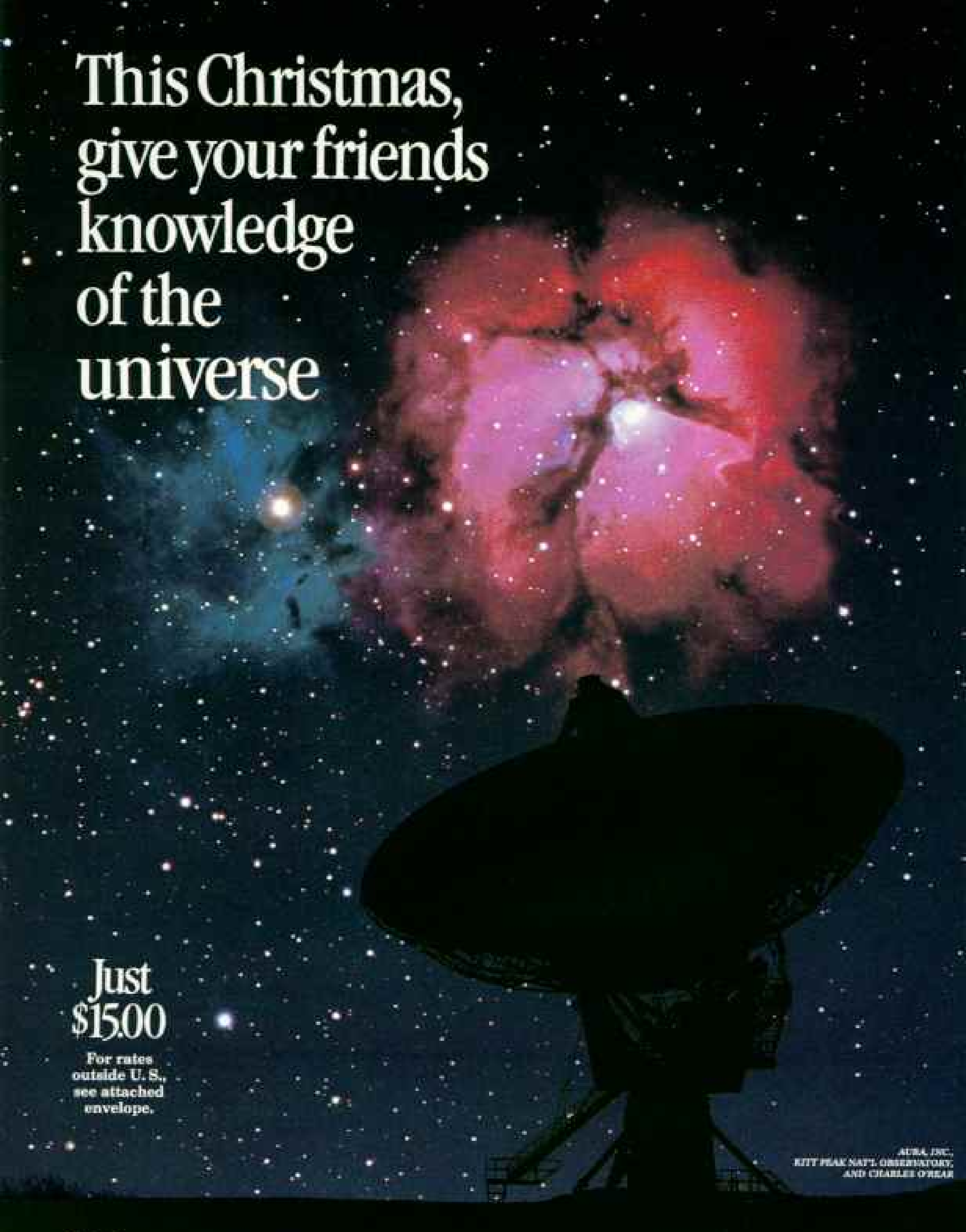

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IVORY COAST

I enjoyed your article on the Ivory Coast (July 1982) but was annoyed to read "Language: French, some 60 African dialects." The habit of referring to non-Western languages as "dialects" is an incorrect use of the term.

Joseph McCloskey, Jr.
North Haledon, New Jersey

Perhaps it would have been more accurate to say "languages and dialects," as does the official atlas of the Ivory Coast. Standard references use "dialects" alone, as we did in the interest of brevity.

Michael and Aubine Kirtley, authors of the Ivory Coast story, seem unaware that animal intestines and knives with blood reservoirs in the hilt are known in numerous tribal initiation and healing rituals. The drama being enacted is likely to be good psychologically for the esprit de corps of the tribe, but need not be taken literally.

Ataniel Annyn Noël
Ramona, California

ARMADILLO

I have just finished reading your most interesting article on the armadillo in the June 1982 issue. It does not mention the medicine Avlosulfon, which is now widely used in the treatment of leprosy. This medicine will almost always arrest the disease, if administered in the early stages.

Maynard Ketcham
Springfield, Missouri

Avlosulfon is a trade name for dapsone, a drug mentioned in the article.

EAGLE VS. TURKEY

In the June issue your editor, Wilbur E. Garrett, left unmentioned other consequences that might have occurred had the turkey been named our national symbol. Think how uninspiring it would have been to hear Neil Armstrong announce from the moon, "Houston. The *Turkey* has landed." Turkey Scouts are a minor embarrassment in comparison.

Steve R. Graham
Goodfellow Air Force Base
San Angelo, Texas

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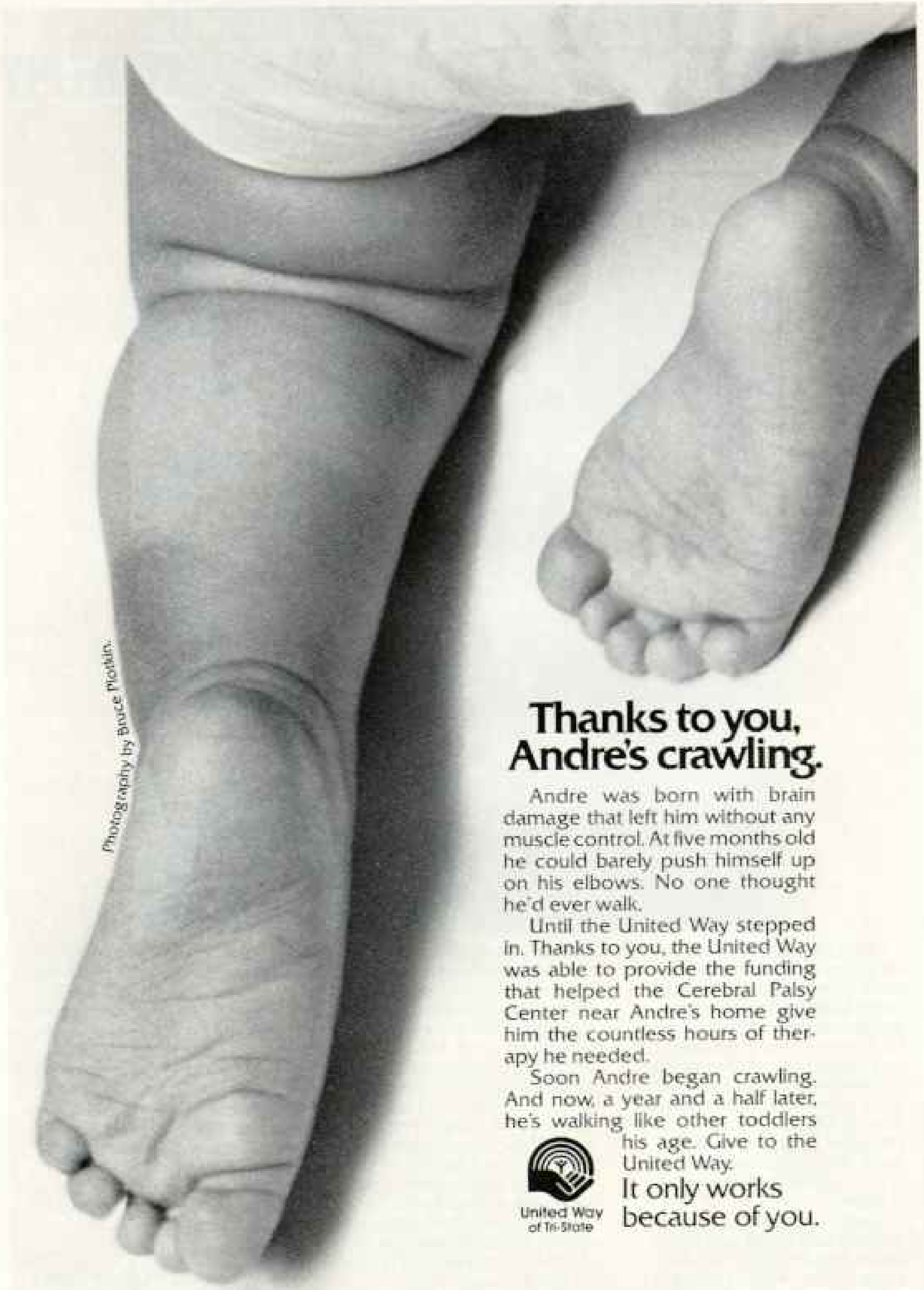

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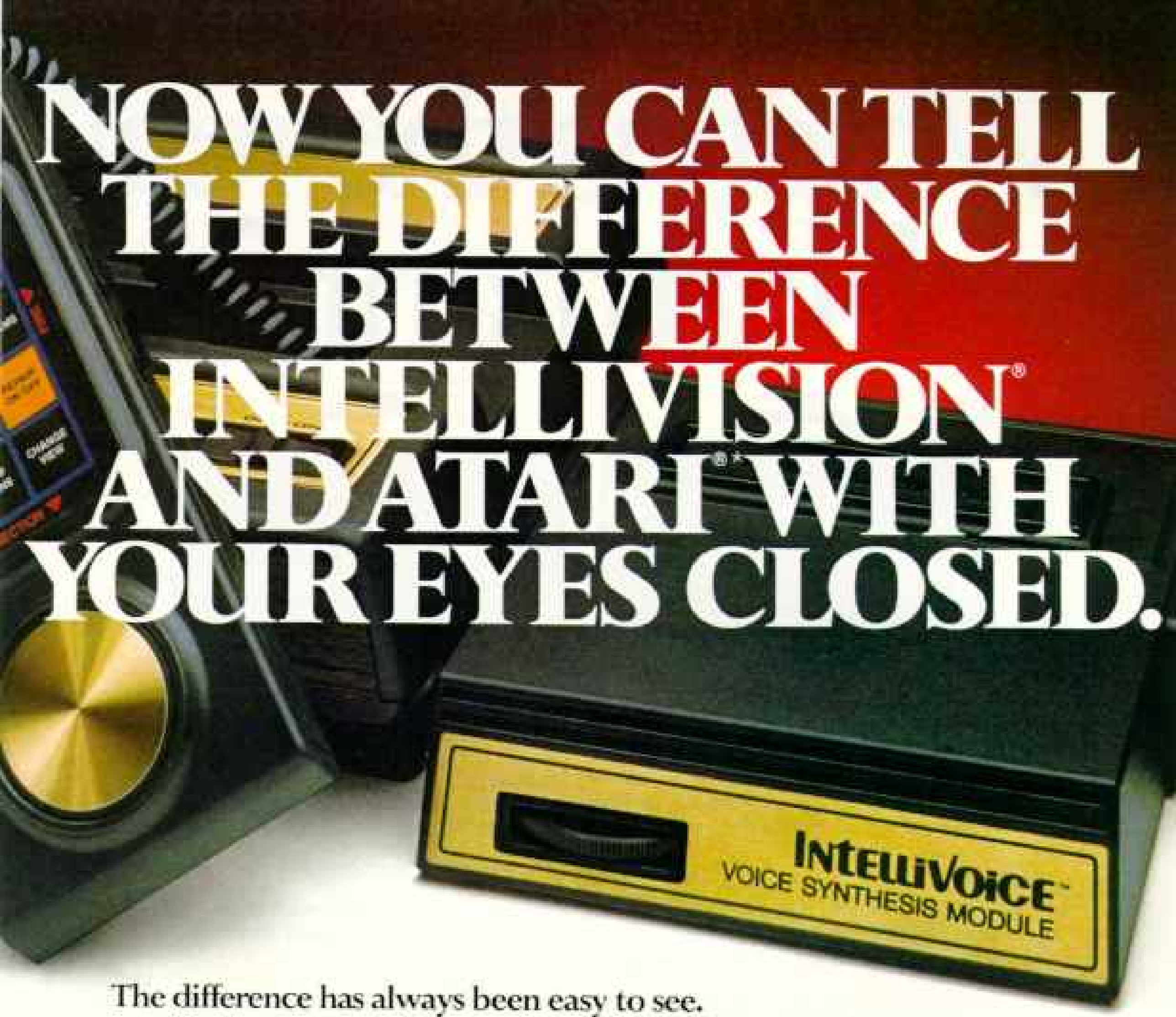

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Photographed by Tupper A. Blake. *Peregrine Falcon: Genus: Falco Species: peregrinus Adult size: Average 38–53cm long with 99–114cm wingspread Adult weight: Average 510–708g male and 850–1,134g female Habitat: Open country, near rivers and along coasts; nests on high cliffs Surviving number: About 100 pairs nesting in contiguous U.S.A. 2,000–3,000 pairs in the rest of North America, other populations found around the world, many also endangered*

Wildlife as Canon sees it: A photographic heritage for all generations.

Imagine the peregrine falcon as it takes its prey. Turning over on its back like an acrobat to strike from below or swooping down in its breathtaking power dive at 100mph or more, it is an awe-inspiring display of speed and precision. The peregrine is a cosmopolitan species, but in North America, where it once could be found even in cities, it has disappeared in large areas of its original range.

The peregrine could never be brought back should it vanish completely. And while photography can record it for posterity, more importantly photography can help save it and the rest of wildlife.

Through intensive conservation efforts, the peregrine is actually at the point of making a comeback in North America. And in the continuing drive to reestablish it, photography serves as an important aid to research.

In addition, photography can help us all to appreciate the peregrine. Looking at those powerful wings raised, one could start to understand just what it is that makes this daring bird one of nature's swiftest.

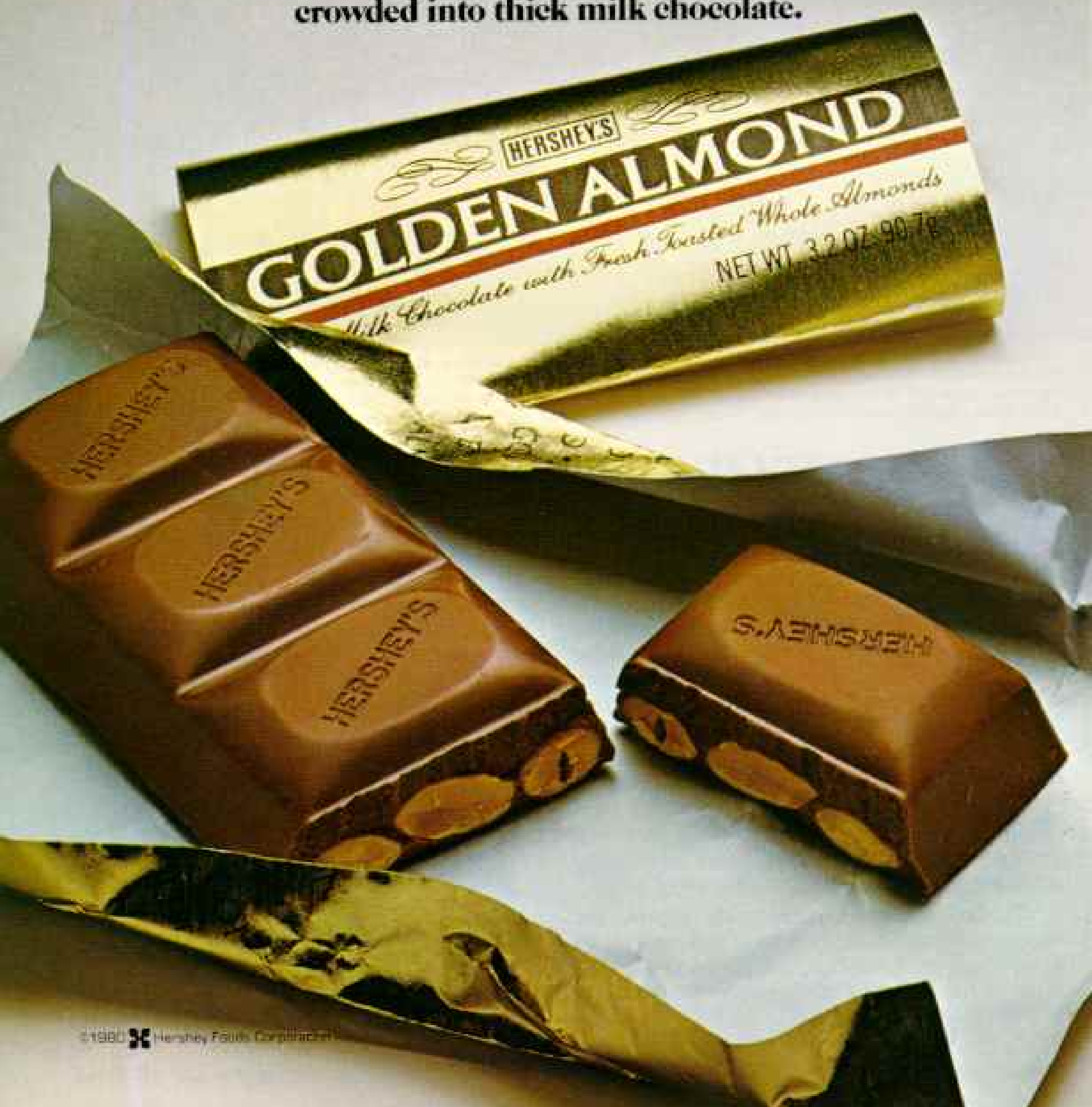
And understanding is perhaps the single most important factor in saving the peregrine falcon and all of wildlife.

Canon

Images for all time

A chocolatier's tribute to almond lovers everywhere.

Whole toasted almonds crowded into thick milk chocolate.



On Assignment

WHETHER DINING ON RAT or carving a pig with a Stone Age implement, senior writer ***Thomas Y. Canby*** always finds a way to get personally involved in his science stories.

His culinary adventure occurred on assignment for a July 1977 article on rats. "They were plump, rice-fed critters captured by Philippine harvesters," Canby recalls, "and were delicious, almost like squirrels."

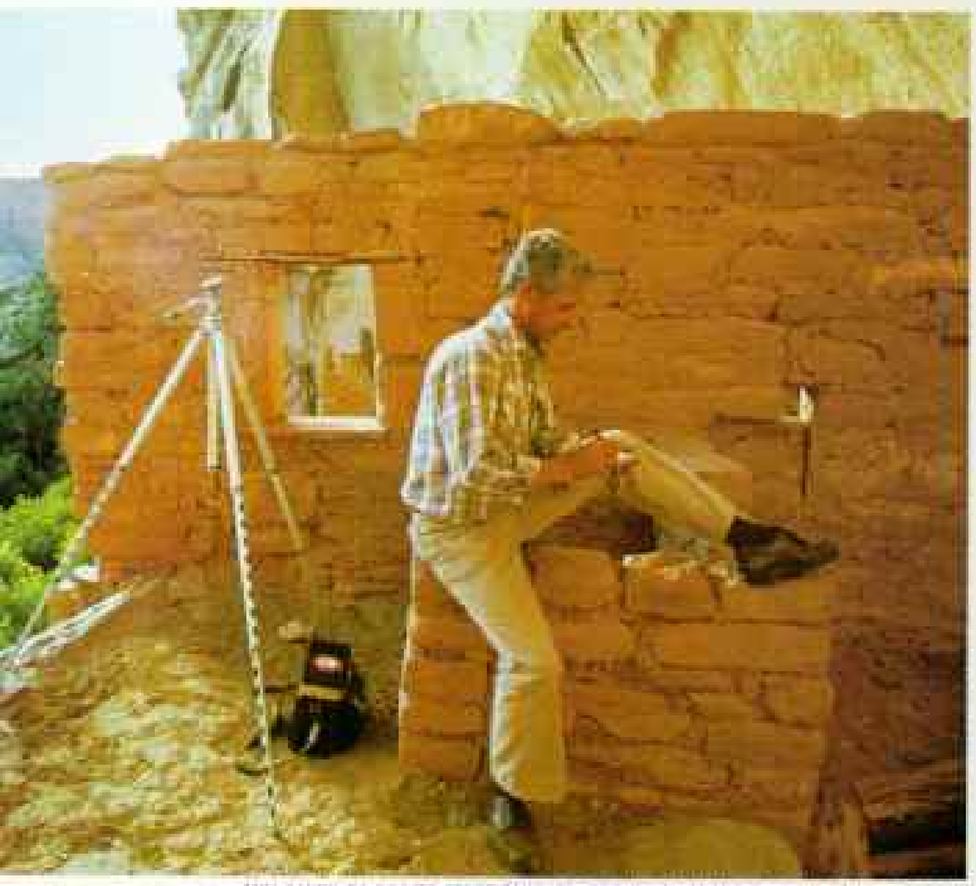
Tom wielded stone blades, made on the spot, for his September 1979 story on early man in America; it won him the prestigious American Association for the Advancement of Science-Westinghouse Award. "The blades did a great job, but dulled quickly," he says. "That probably explains why there is such a profusion of stone flakes from early times."

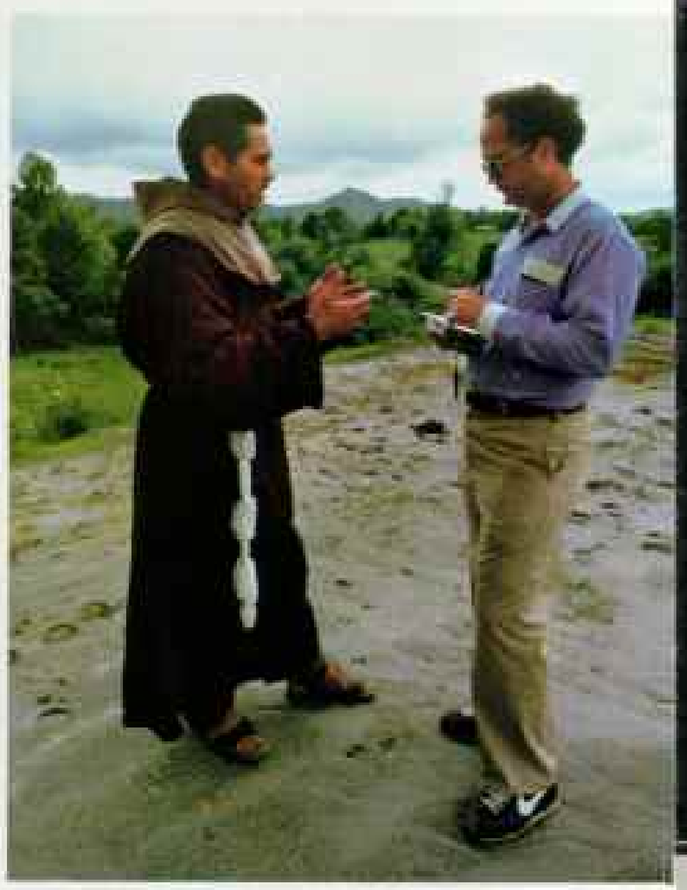
Tracing the prehistoric Anasazi of the Southwest for this issue, Canby thinks he may have discovered unknown roads of this ancient culture. He invited an archaeologist and two experts in aerial reconnaissance to search near ruins in southwest Colorado. "We flew when the sun's angle might help reveal traces, and suddenly saw distinct lines," Tom relates. "But we still need to locate them on the ground. Someday soon archaeologists will return and try positively to identify them."

"THE PHYSICAL DAMAGE was overwhelming, but I'll never forget the faces of the survivors of Mexico's El Chichón volcano," says ***Boris Weintraub,*** a 21-year newspaper veteran now on the National Geographic Society's News Service staff.

Last spring's blast rivaled Mount St. Helens' and killed an undetermined number of people, yet was little reported in the United States. Gathering eyewitness accounts, Weintraub met a priest who told him that many of his parishioners believed it was the end of the world.

The trip was not without humor, Weintraub says. Camping only a few miles from the steaming crater with photographer ***Guillermo Aldana E.,*** Weintraub dozed fitfully during a midnight thunderstorm. "A sudden thunderclap nearby brought the sound-asleep Aldana bolt upright. He shouted, 'It's erupting!' and reached for his cameras. 'Calm down,' I said, 'it's only thunder and lightning.'"





TOM CANBY BY DEWITT JONES (ABOVE); BORIS WEINTRAUB BY GUILLERMO ALDANA E.

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    d. ☐ Fall (Nov.-Dec.)
12. When are you likely to visit Alaska?
    a. ☐ 1983 b. ☐ 1984 c. ☐ 1985
13. Your Age _____
14. Level of Education completed:
    a. ☐ Grade School b. ☐ High School
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16. How many in your party? _____
17. Have you taken a foreign vacation in the past three years? a. ☐ Yes b. ☐ No
18. Have you been to Alaska before?
    a. ☐ Yes b. ☐ No
19. If yes, how many times? _____
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26

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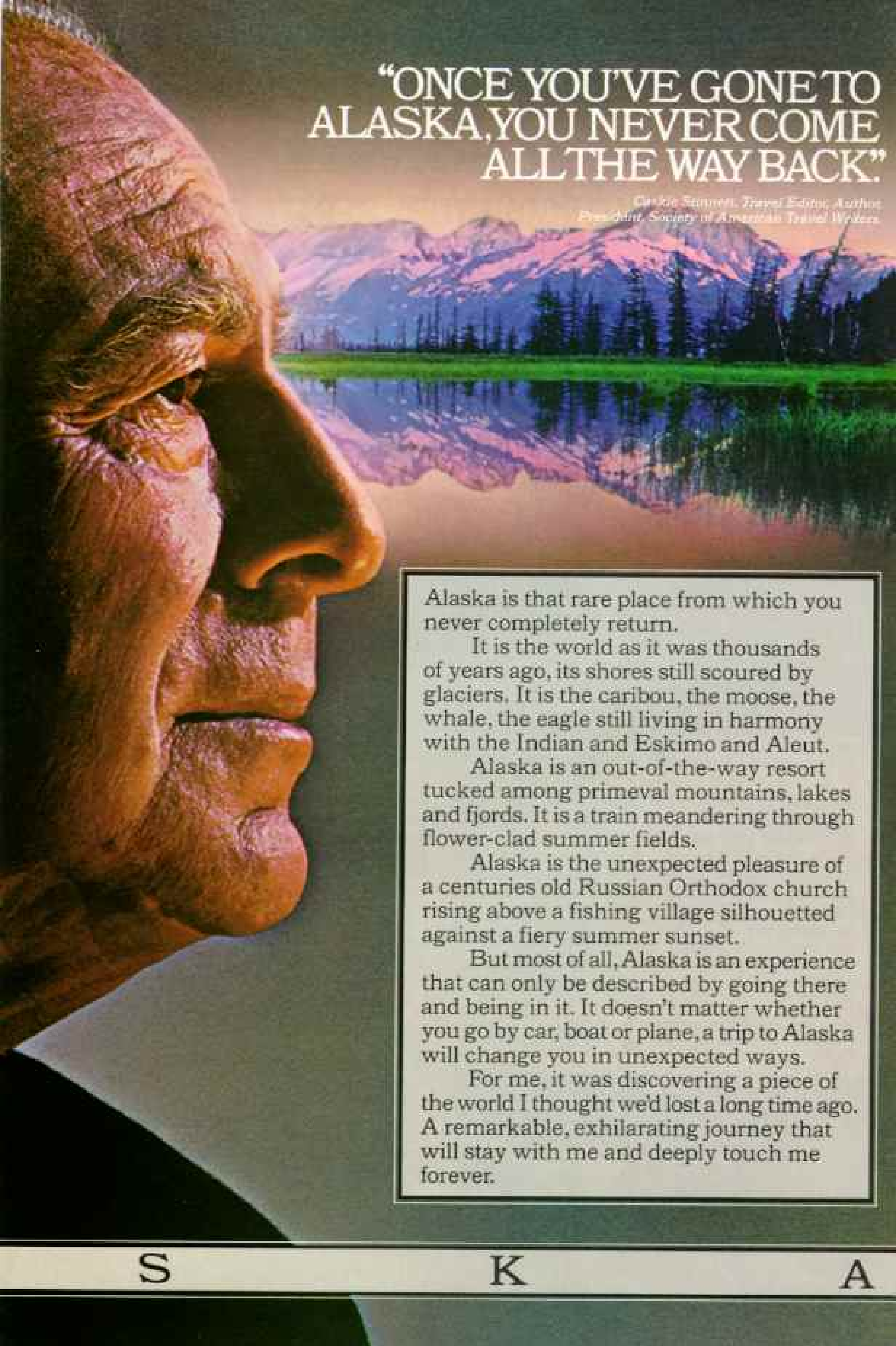
ALASKA


"ONCE YOU'VE GONE TO ALASKA, YOU NEVER COME ALL THE WAY BACK."
Alaska is that rare place from which you never completely return.
It is the world as it was thousands of years ago, its shores still scoured by glaciers. It is the caribou, the moose, the whale, the eagle still living in harmony with the Indian and Eskimo and Aleut.
Alaska is an out-of-the-way resort tucked among primeval mountains, lakes and fjords. It is a train meandering through flower-clad summer fields.
Alaska is the unexpected pleasure of a centuries old Russian Orthodox church rising above a fishing village silhouetted against a fiery summer sunset.
But most of all, Alaska is an experience that can only be described by going there and being in it. It doesn't matter whether you go by car, boat or plane, a trip to Alaska will change you in unexpected ways.
For me, it was discovering a piece of the world I thought we'd lost a long time ago. A remarkable, exhilarating journey that will stay with me and deeply touch me forever.
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Your best opportunity to get any new 1983 Ramcharger may be right now. Use the $1000 introductory rebate towards your down payment or keep the cash.**

Like its 4x4 running mate, Ramcharger Two† is built Ram Tough top to bottom. Unlike Ford or Chevy, Ramcharger has an all-steel roof integrated with the body to eliminate water, dust leaks and reduce wind noise. And Ramcharger has 416 square feet of rust-fighting galvanized steel, more than twice as much as Ford and Chevy combined.

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Ramcharger Two gives you the pulling power you need for just about anything you've got to tow—plus more cargo space than Ford or Chevy. And power steering and 3-speed automatic transmission, along with the practicality of 2-wheel drive, let you cover those long hauling miles with comfort and remarkable ease.

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Mileage	20 est. hwy [1] EPA est. mpg*
Range	700 est. hwy [35] EPA est*
Steering	Standard integral power steering
Interior	Width: 62.3" Height: 41.7" Front seat to liftgate: 70.0" Width btw. wheelhousings: 51.6"

*Use EPA est. mpg for comparison. Your mileage may vary depending on speed, distance and weather. Actual hwy. mileage probably less. Range equals EPA est. × tank capacity.

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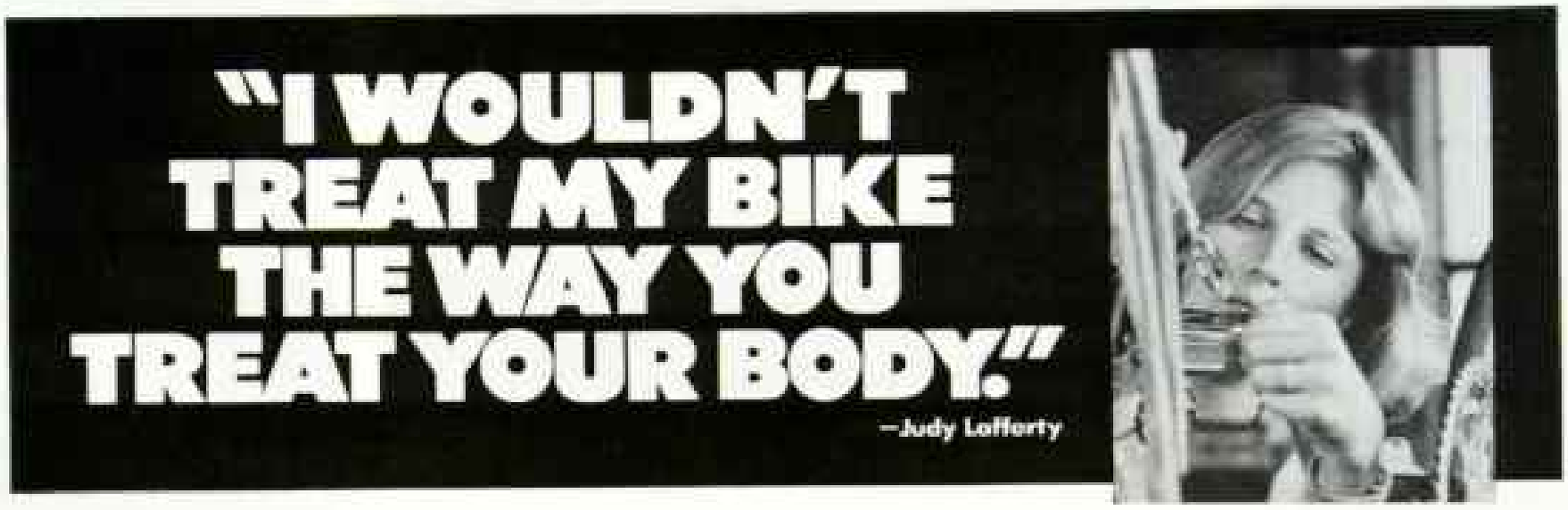

When Judy Lafferty prepares for a race like the annual cross-Iowa run, she makes sure her bike is in perfect shape.

She inspects and adjusts every part. She tunes and balances the whole machine, so it can go the distance.

Because she treats her body the same way, she discovered a lump in her breast a few years ago.

She discovered it early. And these days, 85% of early breast cancers can be treated successfully.

Judy has since had reconstructive surgery, too, and she feels like herself again. Alive, vibrant, ready to get on her bike and take on the world.

Judy Lafferty is just one example of the kind of progress we're making against cancer in its many forms.

The American Cancer Society takes some credit for that progress. But credit won't finance our work.

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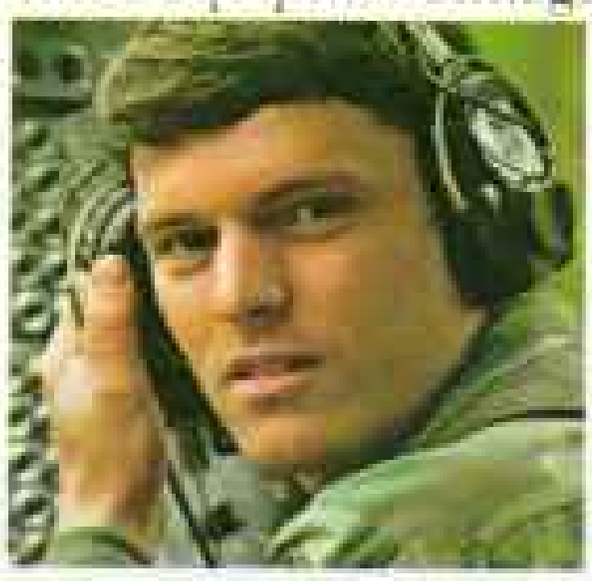

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Realistically, few of us can afford the best of everything. Most must settle for the best we can afford. And live with the compromises.

But for something as important in day-to-day life as a television set, there is a strong temptation to indulge oneself in

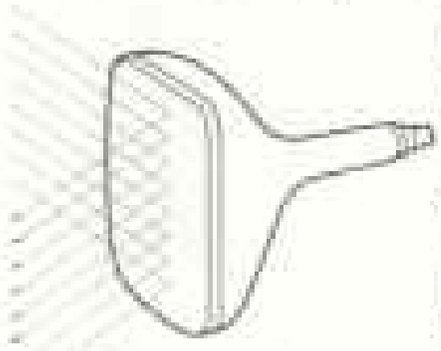
the best. Which makes a Mitsubishi TV well worth your consideration.

An elegant example is this model CK-2582 25-inch diagonal measure Mitsubishi color console with full-function wireless remote, state of the art random access tuning, and complete built-in cable reception capability.

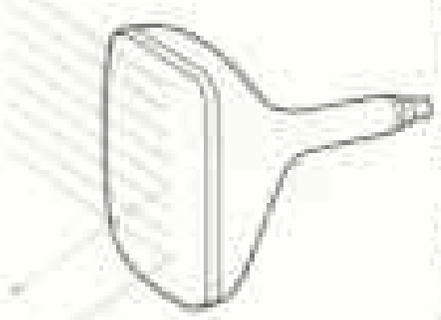
It features a cabinet made not of genuine oak-grain plastic, but of genuine oak-grain oak. It also features one of the two most important innovations in color television tubes ever: Diamond Vision.™ (The other was the black matrix screen developed in the early 1970's.)

UP TO 40% WIDER COLOR RANGE WITH DIAMOND VISION.

Diamond Vision was developed initially to solve the problem of sun glare on our outdoor electronic scoreboards. Our solution was a special glass treatment that actually absorbs sunlight rather than reflecting it. Incorporated into our home picture tubes, it has the same effect on the sunlight or other ambient light you may have in your TV viewing room.



Conventional screen reflects most ambient light.

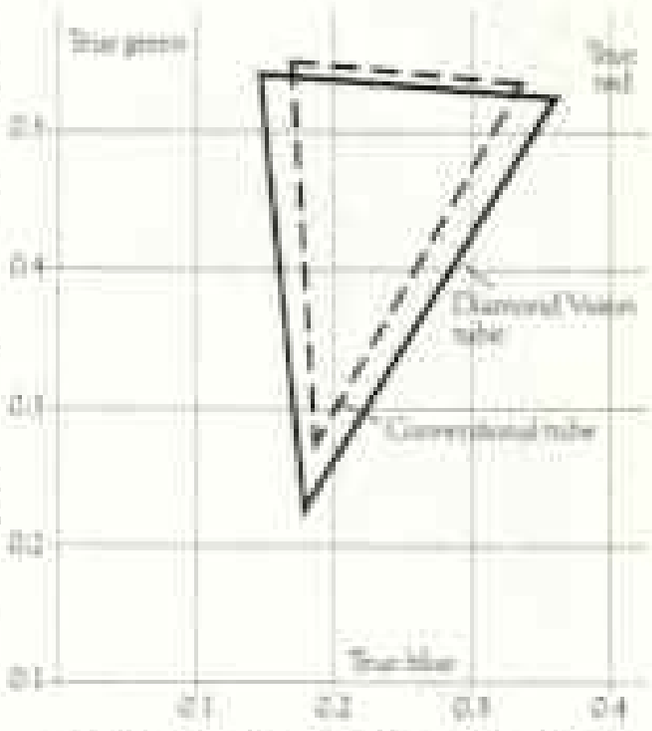


Diamond Vision absorbs most ambient light.

Further experimentation led to other treatments designed to filter out the undesirable light elements from those emitted by the phosphors of the picture tube itself.

The result was not only a picture relatively unaffected by ambient light, but a dramatically improved picture overall. A picture with better, richer, truer colors. Blacker blacks. Bluer blues. Greener greens.

Compared to the conventional TV tube, the range of colors that can be reproduced is wider by 15% to 40%, depending on the amount of ambient light present. For example, crimson rose can be reproduced exactly, something no other television can do. Marine blue, sky blue and green are also truer.



Comparison of the color range reproduced by Diamond Vision and conventional TV tubes under ambient light.

And since the colors themselves are more accurately reproduced, the various shades are differentiated as well. So instead of the flat, homogenized picture you're used to, you get one that's more three dimensional.

Speaking of which, there's yet another dimension to this Mitsubishi color console, one your ears will enjoy:

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And there you will find that while you may never have the best of everything in this world, you can at least have the best of television.

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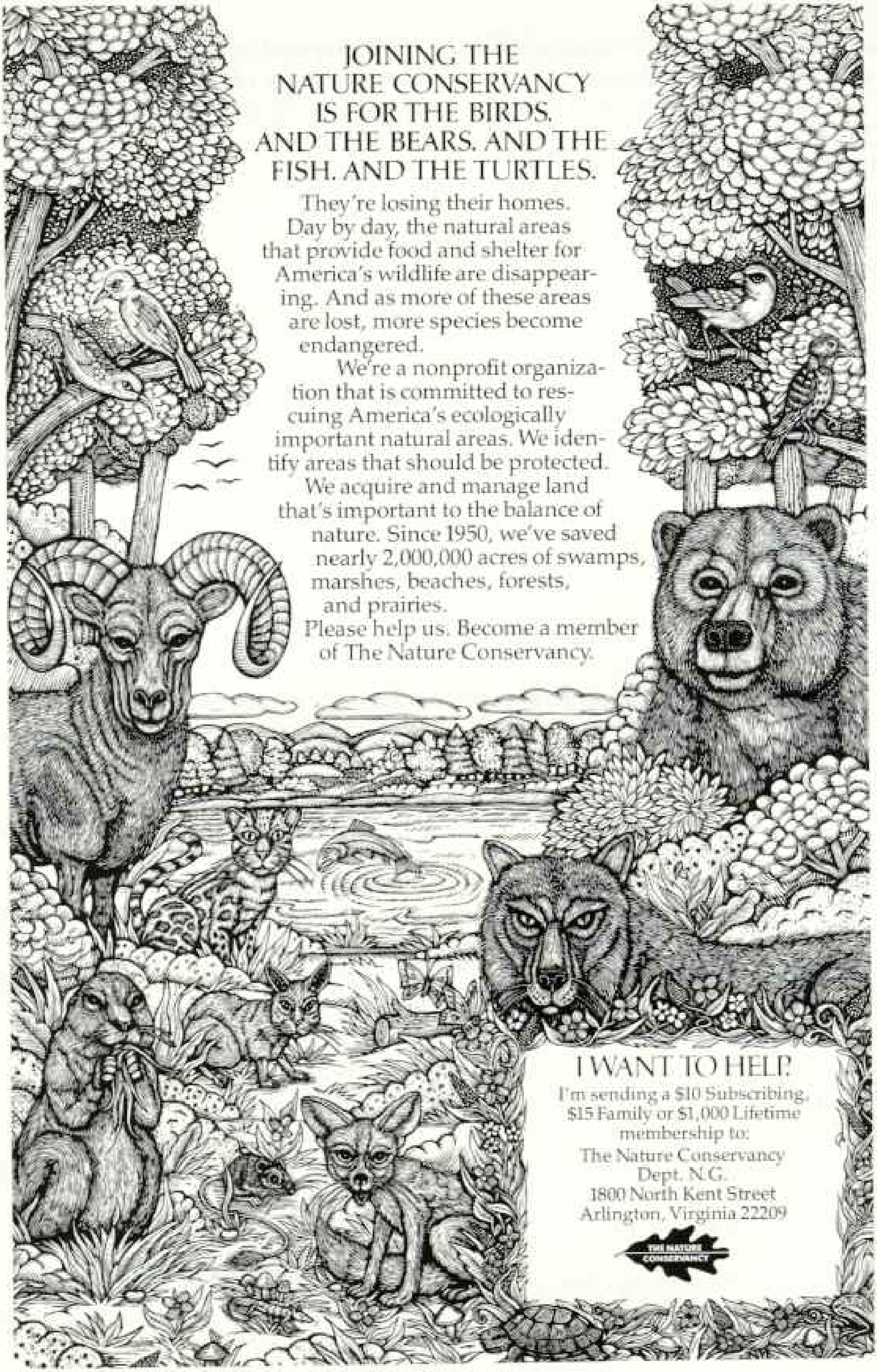

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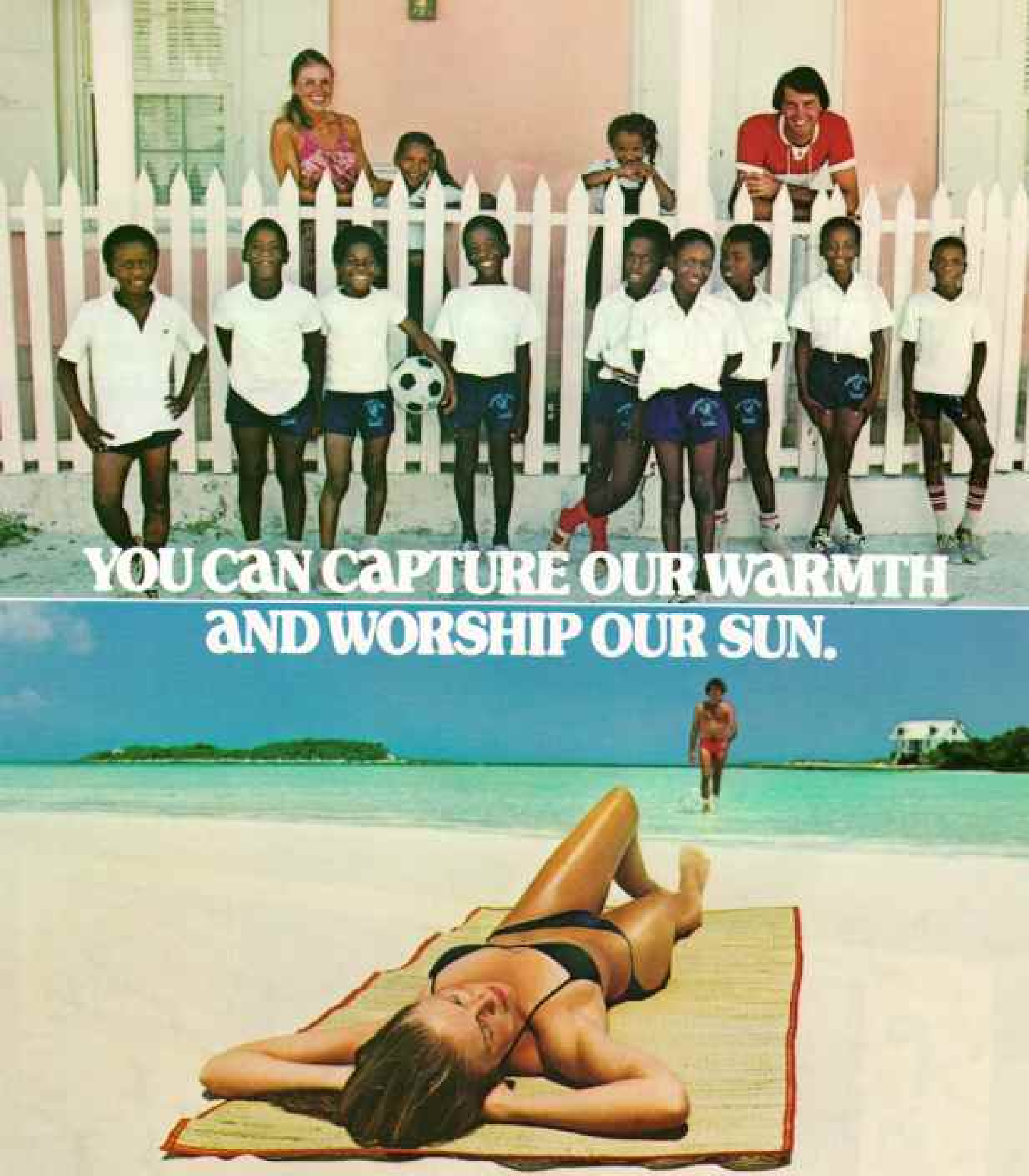

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