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First space walk from a shuttle

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

AS A CHILD, I was fascinated by the futuristic, Buck Rogersish portrayals that grew out of the 1939 New York World's Fair theme "Building the World of Tomorrow." That was the world I would be growing into. Rockets would propel us between megalopolises where highways in the sky threaded among and even through soaring skyscrapers. Personal helicopters would swarm like bees to vertical hives.

Unnoticed and unmissed by most of us was that nary a classical, Romanesque, or colonial structure ever marred these pristine scenes. Also missing from these brave new worlds were ghettos, slums, and blighted inner cities, all too common in the world I've now grown up in.

In this issue we feature the reincarnation of Washington's Old Post Office, once considered so ugly and useless that it was ordered erased from the landscape like a mistake on a child's tablet to make way for a "new" Pennsylvania Avenue.

This month, all gussied up with shops, restaurants, and a set of new bells in its clock tower, the Old Post Office reopens to the public. More than a building saved, it's a symbol to a different type of visionary—the preservationist who sees the restoration of such cultural assets as a way to unblight and revitalize our decaying cities.

I first heard of the project through my work on the board of Partners for Livable Places, an international coalition of some 500 civic groups, corporations, municipal governments, and individuals in a dozen nations. "Partners" was started by Robert McNulty in 1977 with the goal of "making our cities more livable, not by razing them but by building on and around the best of our heritage."

Today, in projects similar to the Post Office restoration, Partners is helping 40 cities turn what seemed to be liabilities into economic and artistic assets. McNulty's inspiration and blessing came from his former boss, the then chairman of the National Endowment for the Arts and guiding hand in saving the Old Post Office from the wrecker's ball. In her memory, Congress named the new Old Post Office the Nancy Hanks Center.

Wilbur E. Garrett

EDITOR

NATIONAL GEOGRAPHIC

THE NATIONAL GEOGRAPHIC MAGAZINE VOL. 164, NO. 3

September 1983

Satellites That Serve Us 281

They can spot ancient river systems under deserts, scout ocean floors, beam television into remote valleys, monitor crops, link operating rooms, probe the universe, keep track of, and even hunt—and kill—each other. Science writer Thomas Y. Canby reports on the current and future tasks of orbiting spaceware.

Spacelab 1 301

Above earth's atmosphere, six men in a shuttle-based laboratory will conduct more than 70 international experiments. By Michael E. Long.

The Aleutians: Alaska's Far-out Islands 336

Born of volcanoes, blasted by storms, the thousand-mile chain spans hemispheres, continents, and cultures. Lael Morgan and photographer Steven C. Wilson report on the nation's westernmost tip.

Living Sands of the Namib 364

Fed on little more than fog, plant scraps, and each other, creatures of Africa's southwest desert coast develop ultimate survival tactics. William J. Hamilton III and photographers Carol and David Hughes chronicle a bizarre desert world.

High-Flying Tulsa 378

Big oil, big evangelism, and big ideas helped build Oklahoma's high-tech, down-home boomer city and inland port. Robert Paul Jordan and photographer Annie Griffiths assess its progress.

Washington's Old Post Office 407

The former home of the nation's postal service escapes the wrecker and reopens to pealing of bells as a center for lively arts and commerce. By Wolf Von Eckardt, with photographs by Volkmar Wentzel.

COVER: *Wearing life-sustaining backpacks, astronauts hover weightlessly in the space shuttle Challenger's cargo bay. Photograph by NASA.*

Satellites
THAT SERVE US

By THOMAS Y. CANBY
NATIONAL GEOGRAPHIC SENIOR WRITER

THEY DWELL IN THE DARK HEAVENS in growing legions, silently circling like swarms of small moons. They are the ingenious spacefarers we call satellites, doing our bidding in ways that enrich the lives of virtually all of us.

Squinting through electronic eyes from hundreds of miles overhead, they lead prospectors to mineral deposits invisible on earth's surface. Relaying communications at the speed of light, they shrink the planet until its most distant peoples are only a split second apart. They beam sweeping vistas of world weather to our living-room TV and guide ships through darkness and storm. Swooping low over areas of possible hostility, spies in the sky maintain a surveillance that helps keep peace in a volatile world.

How many objects, exactly, are orbiting out there?

"Today's count is 4,914," responded Lt. Col. Terry O'Rourke as we explored the fortified lair of NORAD, the North American Aerospace Defense Command, hidden 1,700 feet inside Cheyenne Mountain near Colorado Springs. "Enough stuff that we have to worry about things banging into one another.

"We track everything in orbit, though four-fifths of it's junk spewed into space with satellite launches—rocket bodies, nose cones, spent fuel containers. And by watching them as they fall from orbit, we can spot what *shouldn't* be there, such as enemy missiles."

I examined NORAD's catalog, a record of hardware shot into space since the Soviet Union's stunning launch of Sputnik 1 in 1957. It tallied more than 14,000 man-made objects, two-thirds of which have since fallen back into earth's atmosphere and burned up, including that first Sputnik.

Oddly, no one is quite sure how many of these orbiting objects are active, performing missions for mankind. For the best estimate I turned to the National Aeronautics and Space Administration, the agency that guides the United States' satellite effort.

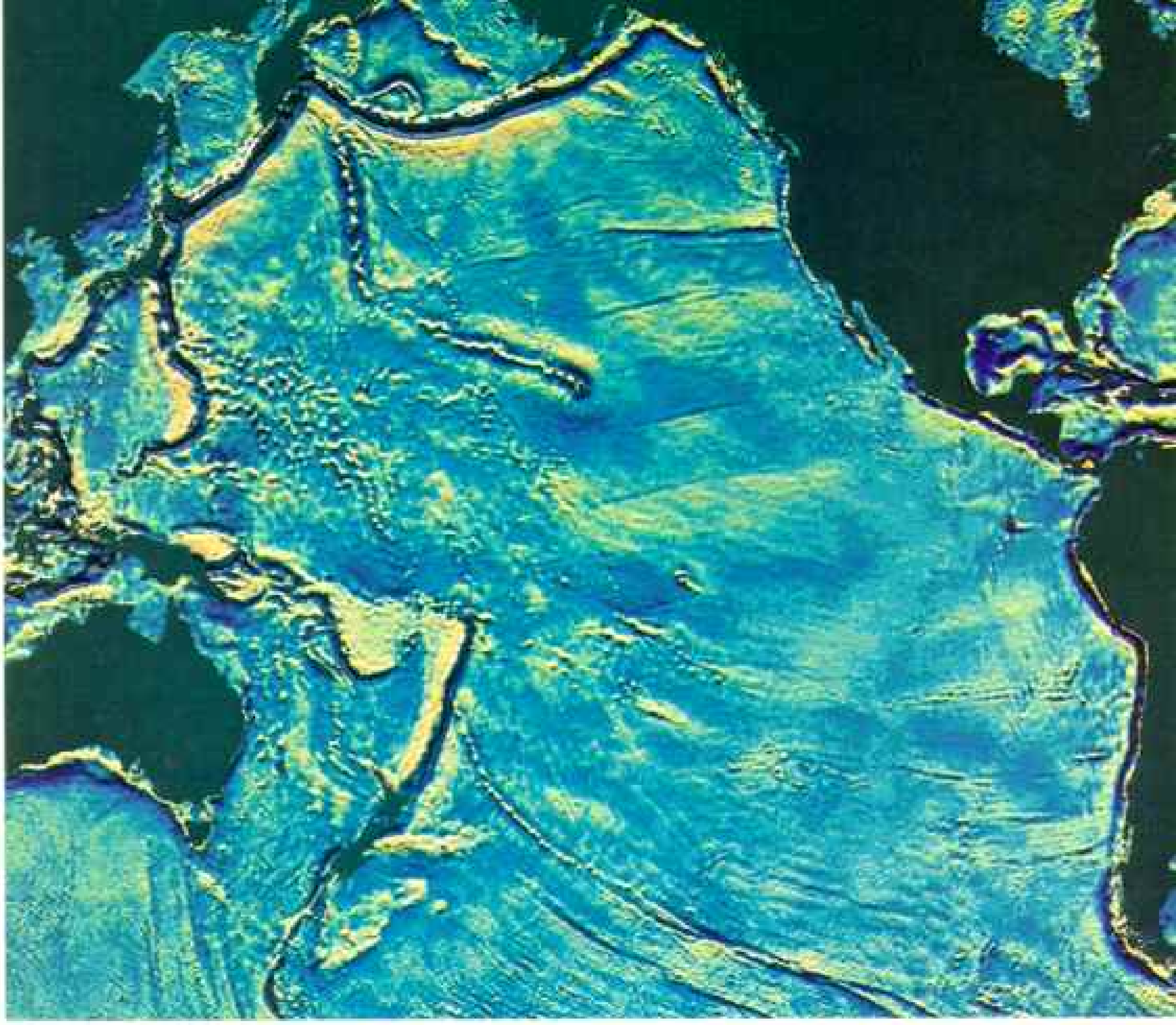
"We count about 290 operable spacecraft at the moment," said Robert Vostreys of NASA's National Space Science Data Center in Greenbelt, Maryland. "Some 180 belong to the United States, and another hundred or so are Soviet. Japan, Canada, Indonesia, India, China, Australia, and 13 European nations own the rest. But the

***Handymen** of the heavens, earth satellites transmit communications at the speed of light, serve as sentries for the military, and explore the universe itself.*

*During its June flight, the shuttle Challenger became a mother ship and launched a West German satellite that took the first ship-to-ship photograph of a shuttle flying free in space (**facing page**) as it drifted over the Mozambique Channel.*

Challenger later retrieved the satellite and returned it to earth, opening a new era of capability in the deployment, repair, and protection of satellites.

NASA, SHUTTLE MISSION 7



Millions of measurements *by a radar altimeter were used to produce a relief map showing variations in the ocean surface. Installed on an oceanographic satellite called Seasat, the altimeter, built at the Jet Propulsion Laboratory in Pasadena, California, recorded the distance*

numbers change almost daily; anything can happen to satellites."

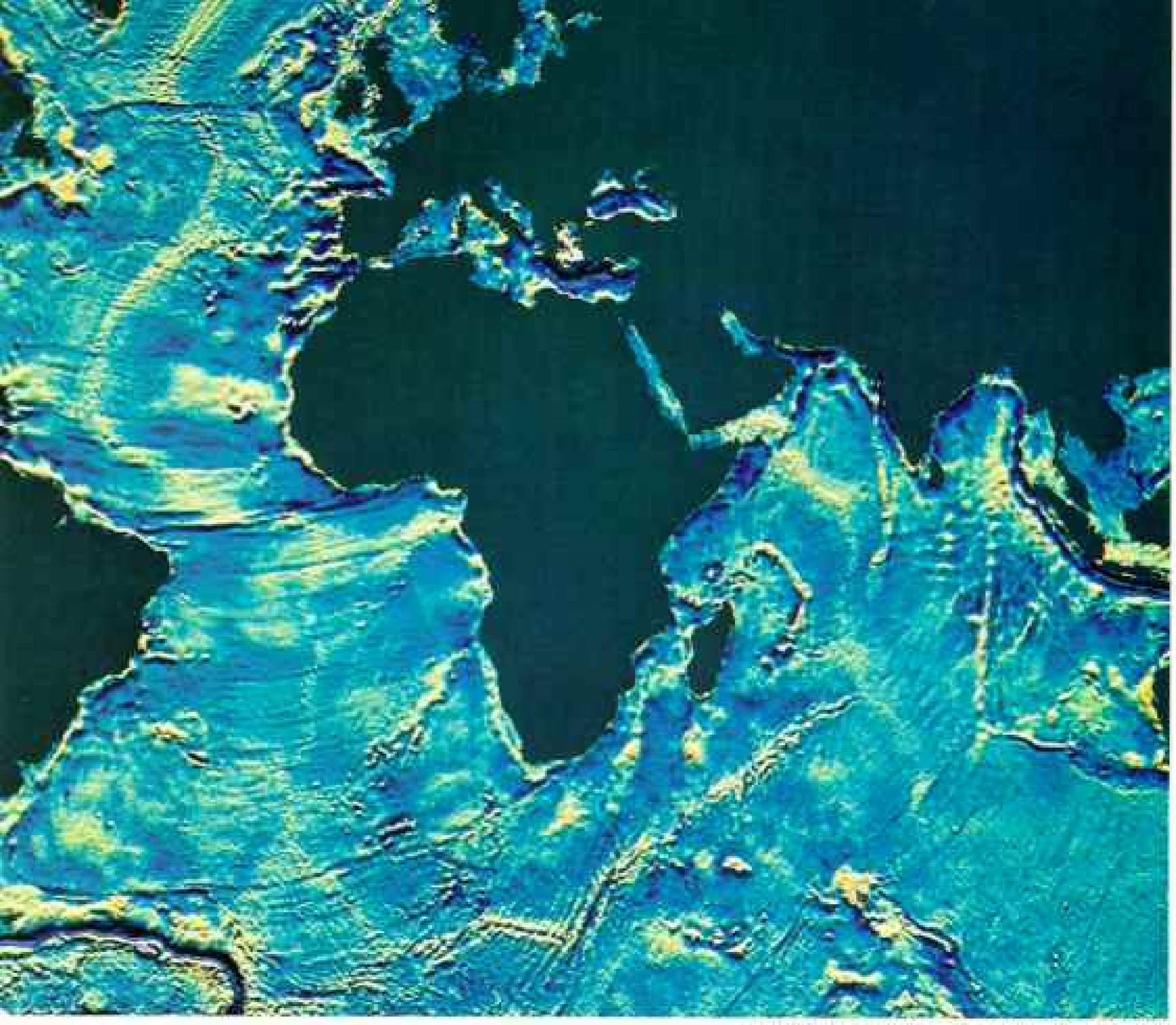
How true. For life in space is no picnic, even for a bunch of unfeeling machines.

Their perils begin with launch, which in the U. S. takes place at Cape Canaveral in Florida, NASA's Wallops Flight Center in Virginia, or, for polar orbiters, Vandenberg Air Force Base in California. One satellite in 20 is crippled by the jolt of lift-off, perishes in the inferno of a defective rocket blast, or is thrust into improper orbit. A few simply vanish into the immensity of space.

When a satellite emerges from the rocket's protective shroud, radiotelemetry regularly reports on its health to round-the-clock crews of ground controllers. They watch over the temperatures and voltages of the craft's electronic nervous system and other vital organs, always critical with machines whose sunward side may be 300 degrees hotter than the shaded part.

Once a satellite achieves orbit—that delicate condition in which the pull of earth's gravity is matched by the outward fling of the craft's speed—subtle pressures conspire to lure it astray. Solar flares buffet the traveler, pushing it out of orbit. Wisps of outer atmosphere drag down its speed. Like strands of a celestial spiderweb, gravity fields of the earth, moon, and sun tug at the orbiting spacefarer. Even the sunshine's soft caress exerts a gentle nudge.

Should a satellite begin to wander, ground crews fire small fuel jets that steer it back on course. This is done sparingly, for exhaustion of these gases ends a craft's useful career.



WILLIAM R. HAMBY, LAMONT-DOHERTY GEOLOGICAL OBSERVATORY

from the spacecraft to the ocean surface. Because of gravity, sea-surface topography reflects that of the seafloor and has been found to vary as much as 600 feet in elevation. Thus the deep trenches rimming the Pacific are clearly visible, as well as details of the Mid-Ocean Ridge and its fracture zones.

Under such stresses, many satellites enjoy life expectancies of only a few years. When death is imminent, controllers may command the craft to jump into a higher orbit, so it will move up away from earth, keeping orbital paths from becoming too cluttered. Others become ensnarled in the gravity web; slowly they are drawn into gravitational eddies that serve as space graveyards. Ultimately, most satellites fall toward earth and burn up in the atmosphere. But flaming fragments of a few reach the surface, and these have caused one known fatality—a Cuban cow.

Space scientists recognized early the promise of satellites for communications. A satellite would become a great antenna tower, hundreds or even thousands of miles above earth, capable of transmitting messages almost instantaneously across oceans and continents.

Around the world, eyes turned upward in 1960 to watch a new "star" glide across the night sky. It was Echo 1, the world's first communications satellite, and one of the largest man-made bodies ever orbited. Big as a ten-story building, Echo was a great balloon made of Mylar, only half the thickness of cellophane. A thin coating of aluminum reflected radio signals from coast to coast and gave Echo its starlike luster.

Two years later Telstar set a pattern for all communications satellites that followed. Unlike Echo 1, which passively bounced back signals, the Bell System's Telstar carried transponders. These amplified the strength of radio signals thousands of times before *(Continued on page 290)*

Satellites on parade

THESE tireless servants have in a few short years become indispensable tools in the service of communications, science, and defense.

1 ***Sputnik 1*** *(1957, U.S.S.R.) beeped for 21 days and extended man's horizon to space.*

2 ***Explorer 1*** *(1958, U. S.) discovered the existence of a radiation belt around the earth.*

3 ***TIROS 1*** *(1960, U. S.) took and transmitted 22,952 images of earth's weather.*

4 ***Echo 1*** *(1960, U. S.) relayed radio and TV.*

5 ***Telstar 1*** *(1962, U. S.), the first communications satellite to transmit TV programs overseas.*

6 ***Syncom 2*** *(1963, U. S.) achieved the first synchronous orbit above the earth.*

7 ***OAO 2*** *—Orbiting Astronomical Observatory*

(1968, U. S.) turned its 11 telescopes to the stars.

8 ***Vela 6*** *(1970, U. S.), orbiting as high as 70,000 miles, designed to detect nuclear explosions.*

9 ***Intelsat IV*** *(1971), owned and operated by the International Telecommunications Satellite Organization, relays telephone calls and television programs.*

10 ***ATS-6*** *— Applications Technology Satellite (1974, U. S.) brought TV to isolated communities.*

11 ***LAGEOS*** *— Laser Geodynamics Satellite (1976, U. S.) plotted the movement of tectonic plates.*

12 ***IUE*** *— International Ultraviolet Explorer (1978, U. S., U. K., European Space Agency) peered deep into space to investigate black holes and quasars.*

13 ***OSCAR 8*** *— Orbiting Satellite Carrying Amateur Radio (1978, U. S.) relayed the signals of ham operators.*

14 ***Landsat 4*** *(1982, U. S.) images earth's surface for geology, agriculture, bathymetry, and land use.*

15 ***TDRS*** *— Tracking and Data Relay Satellite (1983, U. S.) is designed to relay data between satellites and earth stations as fast as 300 million bits per second.*

16 ***Spacelab 1*** *(1983, U. S.) will provide a laboratory for experiments in micro-gravity.*

17 ***Space Telescope*** *(1986, U. S.) will extend scientists' eyes to the fringes of the universe.*

18 ***COBE*** *— Cosmic Background Explorer (1987, U. S.) will analyze the radiation sources of the universe to try to determine its early structure.*

19 ***GPS*** *— Global Positioning System, or NavStar (1988, U. S.). This 18-satellite system will afford precise navigational data for the military.*

20 ***UARS*** *— Upper Atmosphere Research Satellite (1989, U. S.) will study how the atmosphere influences earth's weather.*

21 ***OPEN*** *— Origins of Plasmas in the Earth's Neighborhood (1989, U. S.) will study ionized gases.*

PAINTING BY DAVIS MELTZER; SIZES, ORBITS, AND ALTITUDES OF SATELLITES ARE NOT TO SCALE

THE CELESTIAL FLEET

TDRS System

Retrieval and Repair of SOLAR MAX

TMS

Teleoperator Maneuvering System

VLA Very Large Assemblies

OTV Orbital Transfer Vehicle

SPACE STATION

NASA

United States

BALLUTE

1985-1989 Average: 24 shuttle flights/year

100 KM tether

TETHERED PROBE

Ground Station

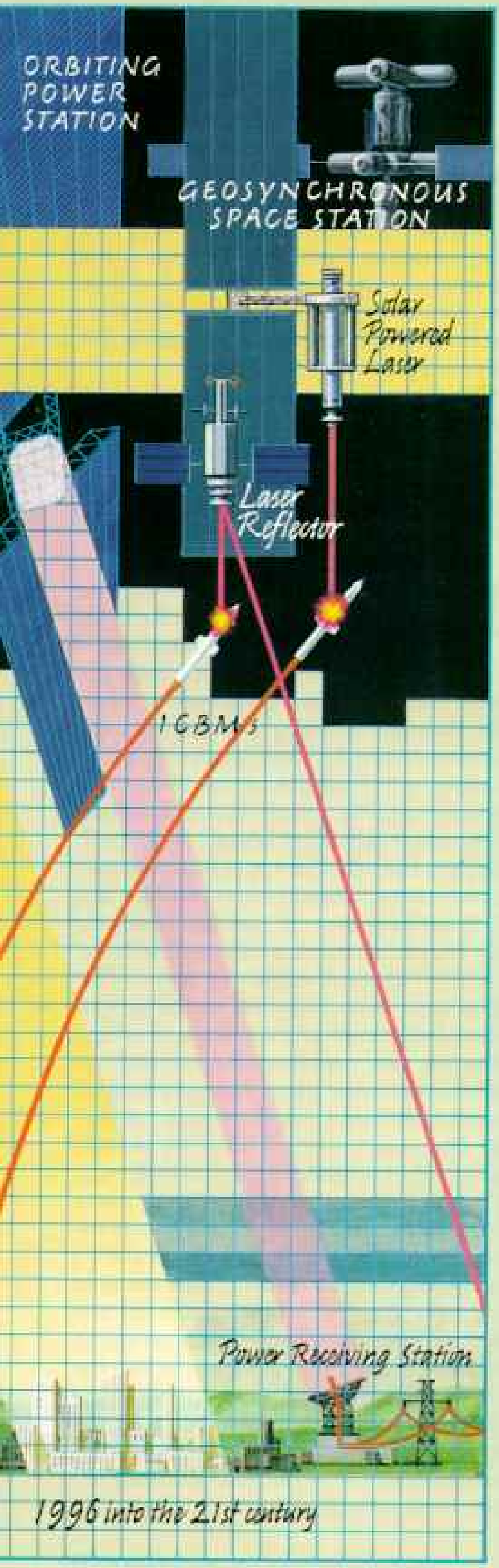
1990-1996 Average: 40 shuttle flights/year

Aft cargo carrier

Unmanned cargo shuttle

The near future - before 1990

1990 - 1996



The final frontier

STAR-TREKKING ARRAY of NASA spaceware delivered to orbit by the shuttle from the present to the 21st century tells an exciting tale of the possible.

Like a fisherman, an upside-down shuttle at far left trolls a tethered satellite through the upper atmosphere to study its composition and dynamics. With a model of a hypersonic spacecraft on the tether, the ionosphere would function as a giant wind tunnel.

With a pancake-like body and mechanical arms, the teleoperator maneuvering system retrieves balky satellites and returns them to the shuttle for repair. To the left of the TMS, an astronaut retrieves the malfunctioning Solar Max spacecraft—designed to study electromagnetic events on the sun—for return to the shuttle, a mission planned for next year.

Hovering immediately above is a covey of TDRSs, supercommunicators of space. Nearby the Celestial Fleet serenely sails—an array of satellites whose sensors, including the Space Telescope and the Gamma Ray Observatory, will explore the universe.

With expanded payloads by the 1990s, very large assemblies are constructed. This one, featuring a huge antenna, transmits signals to the ground strong enough to be picked up by a miniature receiver, such as a wrist radio. A manned space station for research and experimentation in micro-gravity serves as a space base. To its right an orbital transfer vehicle (OTV) lifts a scientific payload to deep space. Grazing the atmosphere as it returns to low orbit, it is shielded from heat by a balloon-like parachute called a ballute, which also acts as a brake.

Twenty-first century feasibilities include an orbiting mirror reflecting sufficient sunlight to light an entire city at night. Above it a gigantic power station collects the sun's energy, converts it into electricity, and beams it to a ground station via microwaves.

Below, lasers destroy nuclear missiles early in their ballistic arcs. A geosynchronous space station (GSS) 22,300 miles high serves as a repair facility for communications satellites. The GSS may do further duty as a launch site for solar and planetary missions and might even function as the Cape Canaveral in space for man's ultimate journey—a mission to another galaxy.

PAINTING BY NATIONAL GEOGRAPHIC ARTIST WILLIAM R. BOND

(Continued from page 283) relaying them to their destination.

But Telstar could relay messages only when its orbit placed it between the sender and the intended receiver. If only a satellite would hang stationary overhead, always in relaying position. . . .

A means for achieving this had been suggested by science writer Arthur C. Clarke as early as 1945. If a satellite traveled 22,300 miles above the Equator, with an orbital period of 24 hours, it would remain stationary above a fixed point on earth's surface—an orbit known as geostationary. Today the geostationary belt is recognized as the most important orbital region around earth.

In 1965 an 85-pound fledgling known as Early Bird soared aloft from Cape Canaveral to stake man's claim on the geostationary frontier. Parked over the equatorial Atlantic, it relayed as many as 240 telephone calls at once between North America and Europe —more than six times as many as the Atlantic cable, laboriously completed nine years earlier. It also carried a TV channel. Through Early Bird, television viewers watching events an ocean away came to accept the startling words Live Via Satellite.

Early Bird had been built with a life expectancy of 18 months. Four years after launch, when a successor satellite failed, the Bird was brought out of retirement to broadcast the investiture of Great Britain's Prince of Wales to 500 million people.

Early Bird also provided the initial space link for a remarkable venture known as the International Telecommunications Satellite Organization, or Intelsat.

Today 15 satellites unite 109 Intelsat member nations in a communications brotherhood that sets a unique example of international cooperation. For the U. S. the participating agency is Comsat—the Communications Satellite Corporation. Immensely profitable to its members, Intelsat also has reduced the cost of worldwide telecommunications. Today costs are only one-eighteenth what they were before 1965.

Technologically, Intelsat's satellites are marvels of engineering.

In an ultraclean assembly room at Ford Aerospace & Communications Corporation in Palo Alto, California, Sam Eveleth inspected my white smock, my white gauze cap, the gauze bootees covering my shoes. Approving, he said, "Duck inside."

Stooping, I straightened up within a desk-size vehicle whose panel walls bristled with some 38,000 sensitive electronic parts.

"This is an Intelsat V, one of 15 we're turning out," said Mr. Eveleth. "They're the fifth generation, after Early Bird. Instead of 240 voice circuits, this one has twelve *thousand*, plus two color TV channels. But these birds are expensive—about 34 million dollars apiece.

"That's because everything's customized. For reliability, thousands of parts are made of exotic materials. See that nut?" He pointed to a small blue fastener surely worth only pennies. "It's made of titanium and costs $25.75. That's what I mean, *expensive*."

ALMOST EVERY MONTH another communications satellite parks in the geostationary belt: satellites called Westars, to service Western Union and companies who lease its transponders; Comstars, flagships of mighty Comsat; Satcoms, built and owned by RCA; powerful Aniks, sent aloft by Canada to form the world's first domestic satellite system. Indonesia unites its thousand inhabited islands with satellites; Japan and the European Space Agency own orbiting communications stations; and a U. S. military network parallels Intelsat's. Most Soviet communications satellites travel highly inclined orbits to cover that nation's northern latitudes, or the geostationary belt would be even more crowded.

Despite this proliferation, demand for satellite communications outraces supply. Explained Robert C. Hall, president of Satellite Business Systems (SBS), "We are witnessing a shift of tidal proportions in the way we handle information, in the way we move it from place to place. And satellites are superb information handlers." A typical SBS satellite channel can relay "talk" between computers about 160 times faster than is practical over landlines—fast enough to transmit Tolstoy's *War and Peace* across the U. S. in a few seconds.

Similar strides are taking place in the booming field of teleconferencing. This innovation grew out of the heartwarming exploits of a versatile experimental satellite

labeled ATS-6, and known as the Teacher in the Sky.

Soon after launching the Teacher in 1974, NASA ground controllers trained its antenna on Appalachia. There it brought evening college classes to schoolteachers whose isolation denied opportunity for advancement.

When the day's classes ended in the East, controllers shifted the satellite's beam to the Rocky Mountain region. There it broadcast vocational courses to junior high students.

By then evening had reached the West Coast, and controllers tilted the Teacher again for the day's final task—delivering medical help to the Northwest and Alaska. In this region, where distances are vast and medical assistance sparse, the burly machine became an angel of mercy.

"For the medical experiments we used two-way television," recalled Wasyl Lew, former ATS program manager. "Once, in Alaska, an Athapaskan Indian working at a remote construction site had his face horribly torn—the cheek ripped open from mouth to temple. The wound froze right away, but when people took him inside to help him, it thawed, and he began to bleed to death.

"A health aide used ATS-6 to contact a doctor in Anchorage and showed him the cut over television. Right away he had her sewing up the wound, directing every stitch over TV. The patient did fine."

After a year controllers drifted the Teacher eastward, to within beaming range of India. There officials already had begun construction of 2,400 chicken-wire antennas in as many villages.

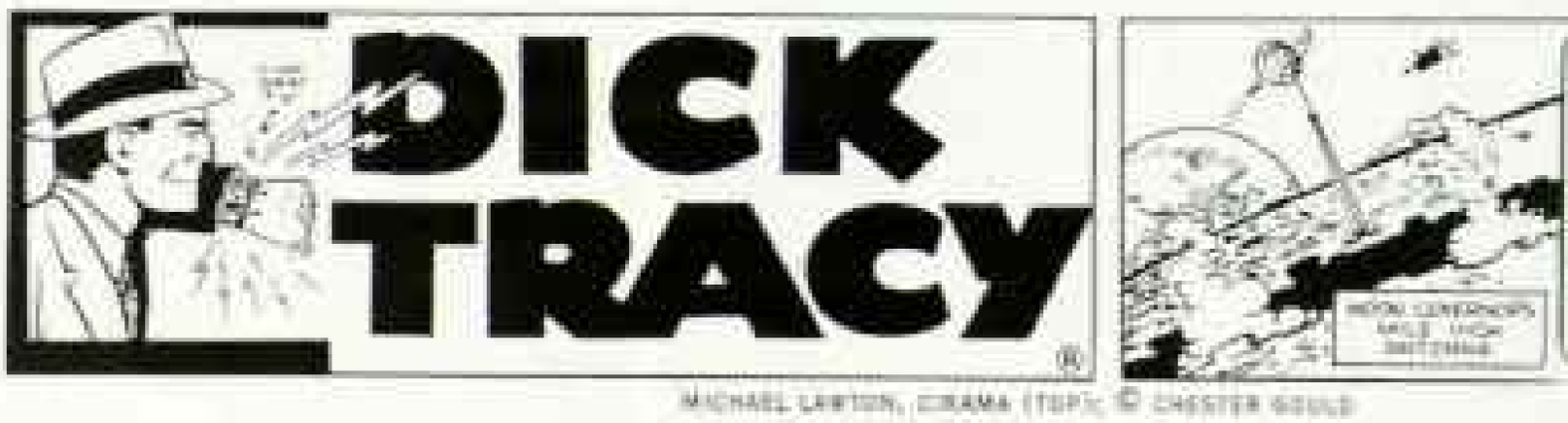
Each evening after the men came in from the fields, the satellite sent down programs on agriculture, health, and family planning to throngs who never before had seen television. This success launched India on her own satellite program.

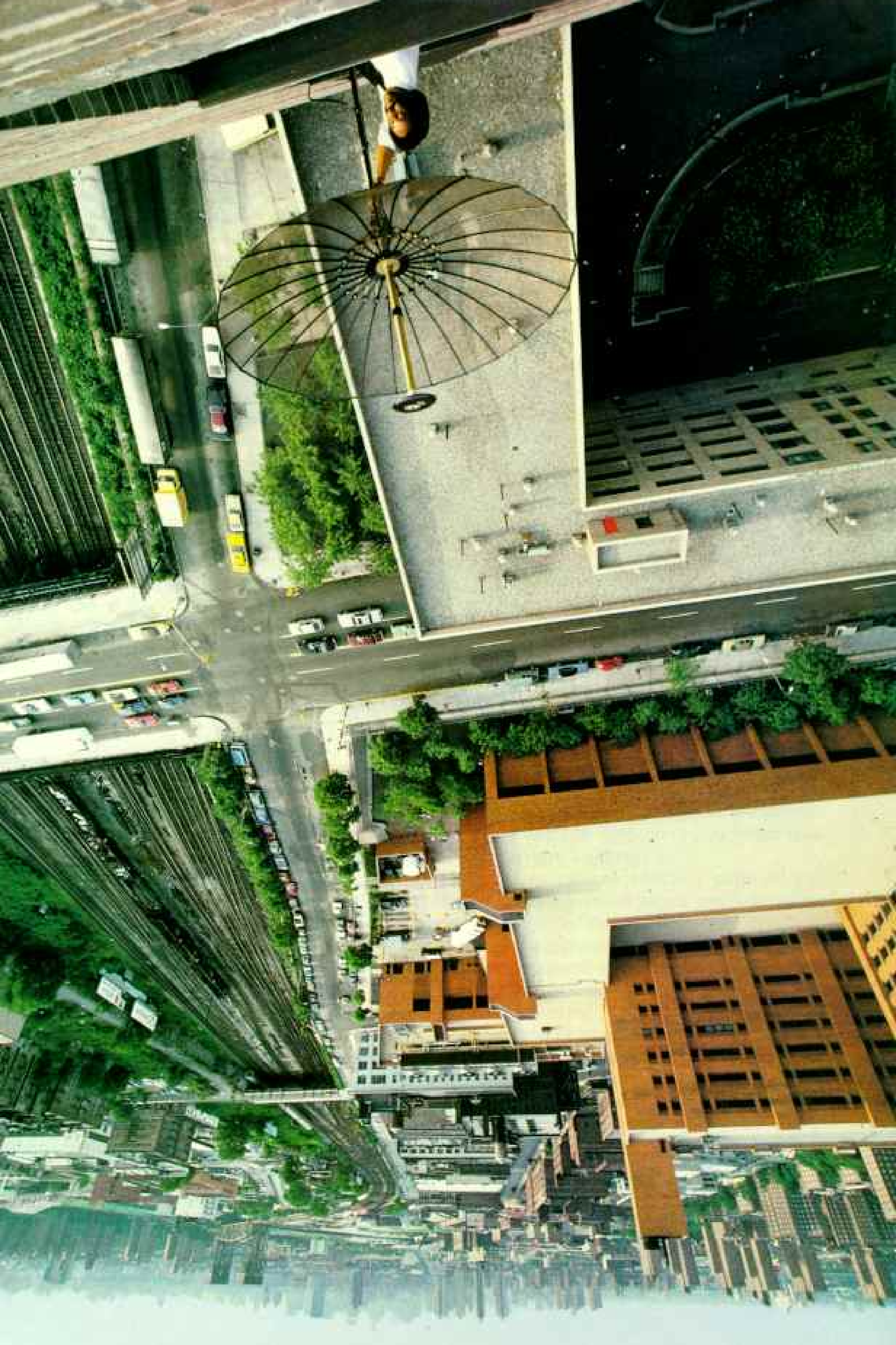
By now it was 1976. As NASA controllers guided the Teacher's slow return westward, it helped celebrate our Bicentennial by carrying the story of space benefits to Asia,

Visionary genius, *artist Chester Gould anticipated the feats of the space age with élan, if not exactitude. In the 1940s, when many astronauts were still in diapers, Gould's superdetective Dick Tracy and his scientist cohort, Diet Smith, roamed the universe in an atomic-powered Space Coupe and used lasers to process gold on the moon.*

*Tracy first employed his two-way wrist radio in the service of justice on January 20, 1946. A more advanced version also included a TV receiver (**below**), used by Tracy to communicate with authorities on the moon.*

Gould's imagination still outstrips current technology. From his retirement home in Woodstock, Illinois, he says, "I still think that getting around the universe will be a simple thing someday."





Like an oversize umbrella, *Mark Gordon's foldable dish antenna* ***(left)*** *affords him a 300-channel menu of satellite TV from his New York City apartment. Gordon built a stand on rollers to deploy the eight-foot-wide, 19-pound antenna, manufactured by Luly Telecommunications of San Bernardino, California.*

The antenna and associated electronic gear cost Gordon $2,000. "I roll it to the window at 5:30 p.m.," he says, "and back to the bedroom at 11. So you don't really need a backyard in order to put up an earth station to receive satellite TV."

From Our Lady of the Angels Monastery in Irondale, Alabama, Mother Angelica ***(right)*** *beams the word of the Lord via satellite. A few years ago when a local TV station broadcast a movie she considered objectionable, the nun "got angry" and founded the Eternal Word Network,*

FRED WARD, BLACK STAR

which now reaches 1.3 million homes.

In frigid Shungnak, Alaska, 300 miles northwest of Fairbanks, teacher Bonnie Bless helps her Eskimo students ***(below)*** *videotape a program on "How to Harness Your Dog." The students also taped local Thanksgiving and Christmas celebrations and broadcast the programs to the townspeople from an earth station.*

MICHAEL LEWTON, CINAMA (LEFT); KENNY SMITH

Africa, Europe, and South America. Back home again, ATS-6 diligently resumed its good works over Appalachia, the Rocky Mountain region, and the Northwest. By 1980, its steering thrusters spent, the Teacher was granted a well-earned retirement.

Its legacy of teleconferencing was born of the Teacher's lesson that distant individuals can react with intimacy when brought together by satellite-borne TV. Today a growing number of professions are abandoning costly travels to a common meeting place, and instead meet "face-to-face" through television.

Scan the office-building rooftops in your hometown and count the dish antennas, turned like sunflowers to the heavens. Many form the connecting link between communications satellites and one of their major customers, the nation's more than 5,600 cable-television franchises.

A few years ago cable television lolled in the doldrums, a poor relation to the mighty broadcast networks that blanket the nation using telephone lines and microwave towers. Then satellites vaulted community antenna television (CATV) into dazzling visibility. Home Box Office (HBO) persuaded cable companies to erect dishes to relay recent movies to home TV. About the same time another satellite venture blasted off—the inspiration of an audacious Atlanta entrepreneur.

"It came to me while I was reading a magazine story about satellites," said Ted Turner, as he adjusted a large tobacco chew. "I owned a television studio; towns all across the country had cable-TV systems; and in the sky hung a satellite that could bring us together. Throw in a system of earth stations, and I'd have a nationwide cable system able to take on the national networks that are bringing us so much trash."

Ejecting his quid of Red Man, Mr. Turner lit a large, dark cigar. "Now a satellite carries my superstation WTBS to 26 million households across the nation, and we're challenging the networks. By 1985 cable TV will be in half our homes."

The burgeoning of cable television has inspired a tandem boom in earth antenna stations. Scientific-Atlanta, Inc. (S-A), the world's largest antenna manufacturer, was riding high on this wave of the future when

Paul Bunyan's earphone, *the 380-ton antenna at the Andover, Maine, earth station (**above**) went into service in 1962. Known as Big Horn, the giant antenna linked the United States with Europe "live via satellite" through the famous Early Bird.*

With the miniaturization revolution of the 1970s, Big Horn was deactivated, only to be resurrected for the Defense Department last year to provide telecommunications with the island of Diego Garcia in the Indian Ocean.

*Modern dish antennas at Fucino, Italy (**right**), perform tests of newly launched Intelsat satellites, as well as telemetry, tracking, and command functions.*

BOTH AT FIELD MARK, BLACK STAR

Chatting at light speed

WHEN YOU TELEPHONE London, telex Moscow, or send computer data to Tokyo, the odds are two out of three that you are using an Intelsat satellite—only a third of international tele-traffic goes by cable laid beneath the oceans.

*Transmitting communications at the speed of light, Intelsat's 15 satellites unite 109 member nations of the International Telecommunications Satellite Organization, with headquarters in Washington, D. C. Here, in Intelsat's operations center (**above**), technicians are in contact with earth stations around the world.*

*Scheduled for launch in 1986, Intelsat VI (**right**), the organization's newest satellite, will juggle at least 30,000 telephone calls and several television programs at the same time. After deployment in orbit 22,300 miles from earth, the 3.6-meter-wide satellite extends to its full height of 11.7 meters (38 feet). Intelsat plans to orbit at least five of the 3,918-pound giants.*

Organized in 1964, Intelsat had established global coverage for just a week when it scooped the world in 1969 with television pictures of Neil Armstrong's first step on the moon, a broadcast seen by half a billion people. The organization estimates that two billion people—nearly half of the world's population—will view next year's summer Olympic Games in Los Angeles.

MICHAEL CARTON, CIRAMA

After positioning in orbit, left, Intelsat VI extends like a telescope to expose additional panels on its skin for solar power. Then the communications satellite, one of the world's most complex, deploys its antennas and reflectors.

PAINTING BY LLOYD K. TOWNSEND (ASTRONAUT SHOWN TO SCALE)

I came calling at its plant in Georgia.

"We have made more than 10,000 dishes," said John Feight as he showed me S-A's anthill of electronics activity. "You used to need an antenna about 30 feet in diameter that cost $100,000. Today a ten-footer gives good reception, and mass production reduces the cost to around $6,000—cheap enough to park in the backyard."

Backyard users are responding—both those who live beyond reach of regular TV and those who delight in aiming an antenna toward a distant satellite and harvesting scores of programs free for the taking.

But what is the legality and morality of collecting TV signals intended only for paying customers? "Piracy!" charge pay-TV networks such as HBO; and as home dishes spread, they plan to scramble their signals so unauthorized users can't decipher them. Home antenna owners counter that what they do in their backyards is their own business, although many would pay if billed.

The issue could become more complex with the impending arrival of a new generation of television, known as direct broadcast satellite, or DBS. Here, powerful satellites would beam TV directly to miniaturized rooftop antennas costing only a few hundred dollars.

For mariners, satellites can mean life itself. When the liner *Titanic* smashed into an Atlantic iceberg in 1912, another ship sailed nearby but had turned off its radio and did not hear the *Titanic*'s frantic calls. As a result, 1,517 persons died. The tragedy spurred 24-hour radio watch, although interference still plagued communications.

Radio reliability was revolutionized with the birth of a marine satellite system now known as Inmarsat, the International Maritime Satellite Organization. Today three internationally operated satellites provide instantaneous communication for a fast-growing fleet of nearly 2,000 ships that carry Inmarsat equipment.

MORE THAN a decade ago NASA launched a satellite whose electronic eyes were designed to examine the planet's surface from 570 miles above. The spacecraft, known today as Landsat, had its skeptics: What could a machine at high altitude tell us that a person couldn't see better on the ground?

Landsat 1 and three successor satellites responded with some of the most exciting rewards of man's venture into space. Guided by their imagery, analysts have:

- Located scores of lakes that show on no

maps and hundreds of unknown geologic features, including great crustal fractures.
• Found oil in Sudan, tin in Brazil, and uranium in Australia.
• Discovered a new islet off Canada's Atlantic coast (named Landsat Island) and an uncharted reef in the Indian Ocean.
• Mapped routes for railroads, pipelines, and electric power rights-of-way.

Racing around the planet 14 times a day, Landsat peers down on 115-mile-wide swaths of earth's surface with two very different eyes. One, a television camera, distinguishes objects about the size of a football field. The other, called a multispectral scanner, numerically records the reflectivity of earth objects with a sensitivity to color far greater than that of a human eye.

Landsat 4 had rounded the North Pole and was streaking south over the Canadian Arctic when I entered the control room at NASA's Goddard Space Flight Center in Maryland.

It came into range of Goddard's antenna, and the big dish began a slow pivot, tracking the hurtling spacecraft and receiving its view of the world below.

From Goddard the data were retransmitted to an RCA communications satellite for relay to the Earth Resources Observation Systems (EROS) program, housed on rolling prairie outside Sioux Falls, South Dakota. There at the EROS Data Center the satellite signals would be converted into films and magnetic tapes for distribution.

Orders and inquiries pour into the center at a rate of nearly 60,000 a year: from federal and state agencies, from oil and mineral companies, from universities, and from nations around the world.

Of Landsat's many customers, developing countries especially find the satellite a gift from the heavens.

"Maps of poorer countries often are sketchy at best," observed Douglas Carter, a Landsat specialist who recently retired from the U. S. Geological Survey. "Lakes and rivers appear out of place or running the wrong direction, soils and vegetation are poorly understood, natural resources unknown. Few of these nations have the budgets to make costly surface surveys. Used correctly, Landsat can do much of this, as Carlos Brockmann showed in Bolivia."

I arrived in Bolivia too late to find Dr. Brockmann at his customary post. Months earlier the 189th of Bolivia's coups had ousted him as director of the nation's satellite natural resources program. But the energetic innovator *(Continued on page 308)*

More than meets the eye: *During cataract surgery at the St. Louis University School of Medicine (**left**), the entire operation is recorded on videotape. Later a television program, known as Eyesat, is prepared and sent to a control room (**right**) of the Bonneville Satellite Corporation in Salt Lake City, which beams it to a satellite. Eye specialists around the country tune in to get credit from participating state medical agencies, part of the physicians' annual relicensing process.*

Eyesat was begun by Dr. Francis E. O'Donnell, Jr., of St. Louis University, who reasoned that, "If such programs work for religion, they ought to work for medicine." They have. Soon to come are: Medsat, Surgsat, and Pedsat, for internists, surgeons, and pediatricians.

BOTH BY LOWELL GEORGIA

NASA, SHUTTLE MISSION 9

"We're going scientific"

AS ASTRONAUTS Dr. Story Musgrave and Donald H. Peterson maneuvered along the shuttle Challenger last April **(above)**, *its empty cargo bay seemed an invitation to the tons of scientific apparatus that will occupy another shuttle's bay during the first flight of Spacelab, a nine-day mission scheduled for launch September 30.*

This international scientific adventure, sponsored jointly by the European Space Agency (ESA) and NASA, will involve scientists from Canada, Japan, the U. S., and 11 European countries.

More than 70 experiments will probe special aspects of astronomy, biology, earth observation, materials processing, and solar, atmospheric, and space-plasma physics.

An important element is the virtual absence of gravity. Spacelab makes it possible to perform experiments that can be done only in the weightlessness of space.

"We're going scientific all the way," says Dr. Richard Chappell of NASA's Marshall Space Flight Center. "We'll orbit instruments as large as a piano and bring them back. Then we'll do it again."

OPPOSITE PAGES FOLD OUT ▶

COLUMBIA

Spacelab 1

By MICHAEL E. LONG
NATIONAL GEOGRAPHIC SENIOR STAFF

PICTURE a day aboard Columbia and its piggyback scientific center, Spacelab. On the flight deck, pilot Brewster H. Shaw, Jr., wafts weightlessly to relieve shuttle commander John W. Young.

Leaving the laboratory module aft, Robert A. R. Parker, a NASA astronaut trained to operate and maintain Spacelab hardware, drifts through a tunnel leading to the crew's quarters. Meanwhile, Ulf Merbold, with a clipboard, sends a change-of-shift status report back to earth.

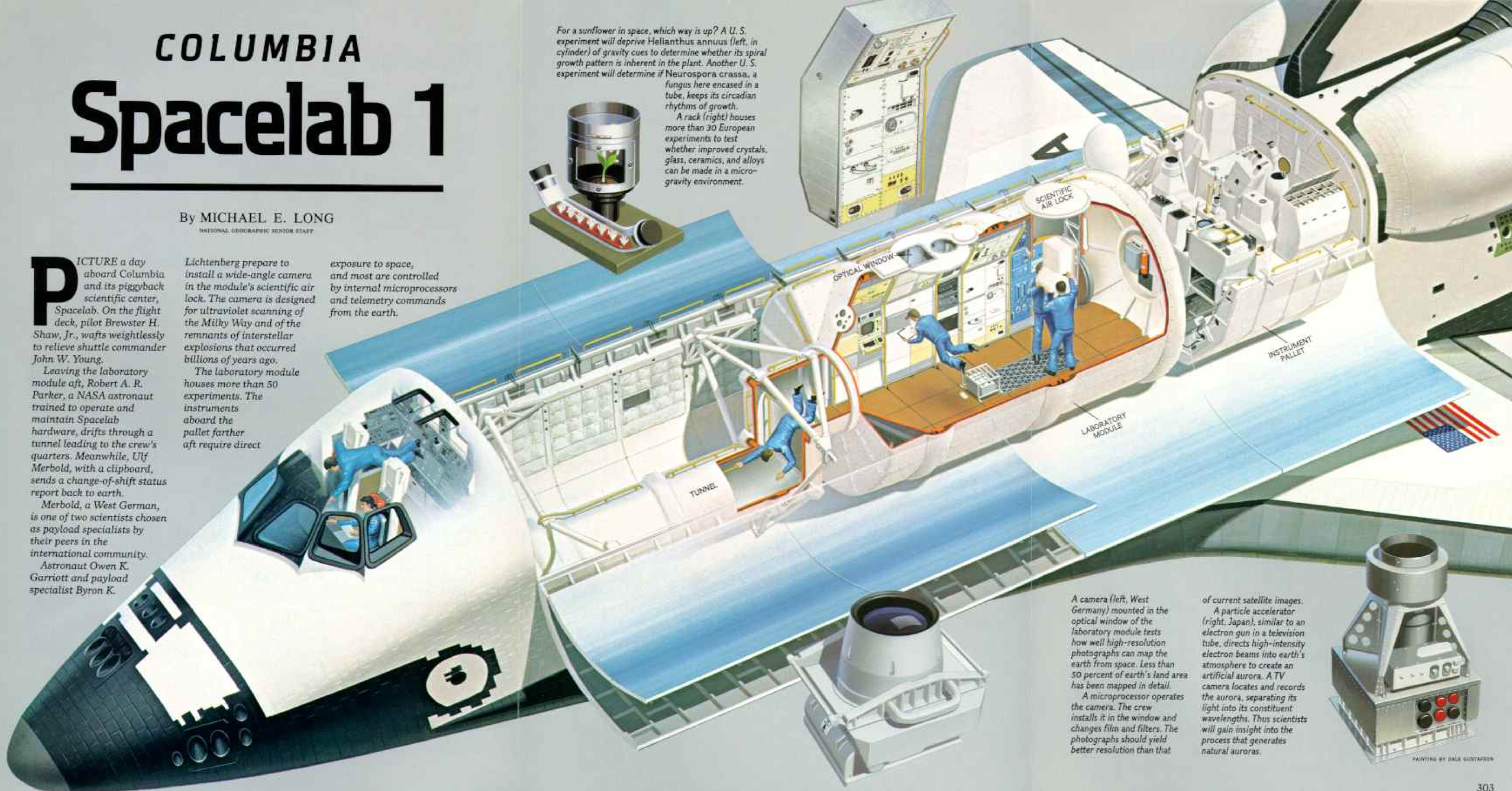
Merbold, a West German, is one of two scientists chosen as payload specialists by their peers in the international community.

Astronaut Owen K. Garriott and payload specialist Byron K. Lichtenberg prepare to install a wide-angle camera in the module's scientific air lock. The camera is designed for ultraviolet scanning of the Milky Way and of the remnants of interstellar explosions that occurred billions of years ago.

The laboratory module houses more than 50 experiments. The instruments aboard the pallet farther aft require direct exposure to space, and most are controlled by internal microprocessors and telemetry commands from the earth.

For a sunflower in space, which way is up? A U. S. experiment will deprive Helianthus annuus (left, in cylinder) of gravity cues to determine whether its spiral growth pattern is inherent in the plant. Another U. S. experiment will determine if Neurospora crassa, a fungus here encased in a tube, keeps its circadian rhythms of growth.

A rack (right) houses more than 30 European experiments to test whether improved crystals, glass, ceramics, and alloys can be made in a microgravity environment.



A camera (left, West Germany) mounted in the optical window of the laboratory module tests how well high-resolution photographs can map the earth from space. Less than 50 percent of earth's land area has been mapped in detail.

A microprocessor operates the camera. The crew installs it in the window and changes film and filters. The photographs should yield better resolution than that of current satellite images.

A particle accelerator (right, Japan), similar to an electron gun in a television tube, directs high-intensity electron beams into earth's atmosphere to create an artificial aurora. A TV camera locates and records the aurora, separating its light into its constituent wavelengths. Thus scientists will gain insight into the process that generates natural auroras.

PAINTING BY DALE GUSTAFSON

Space partners: ESA and NASA

A CASCADE of electrons streams down earth's magnetic field past the shuttle to cause earth's auroras. A detector (**West Germany**) measures their numbers, speeds, and directions.

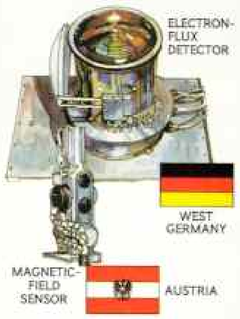
In a corollary experiment (**Austria**), a sensor defines the intensity and direction of earth's magnetic field in the vicinity of the shuttle.

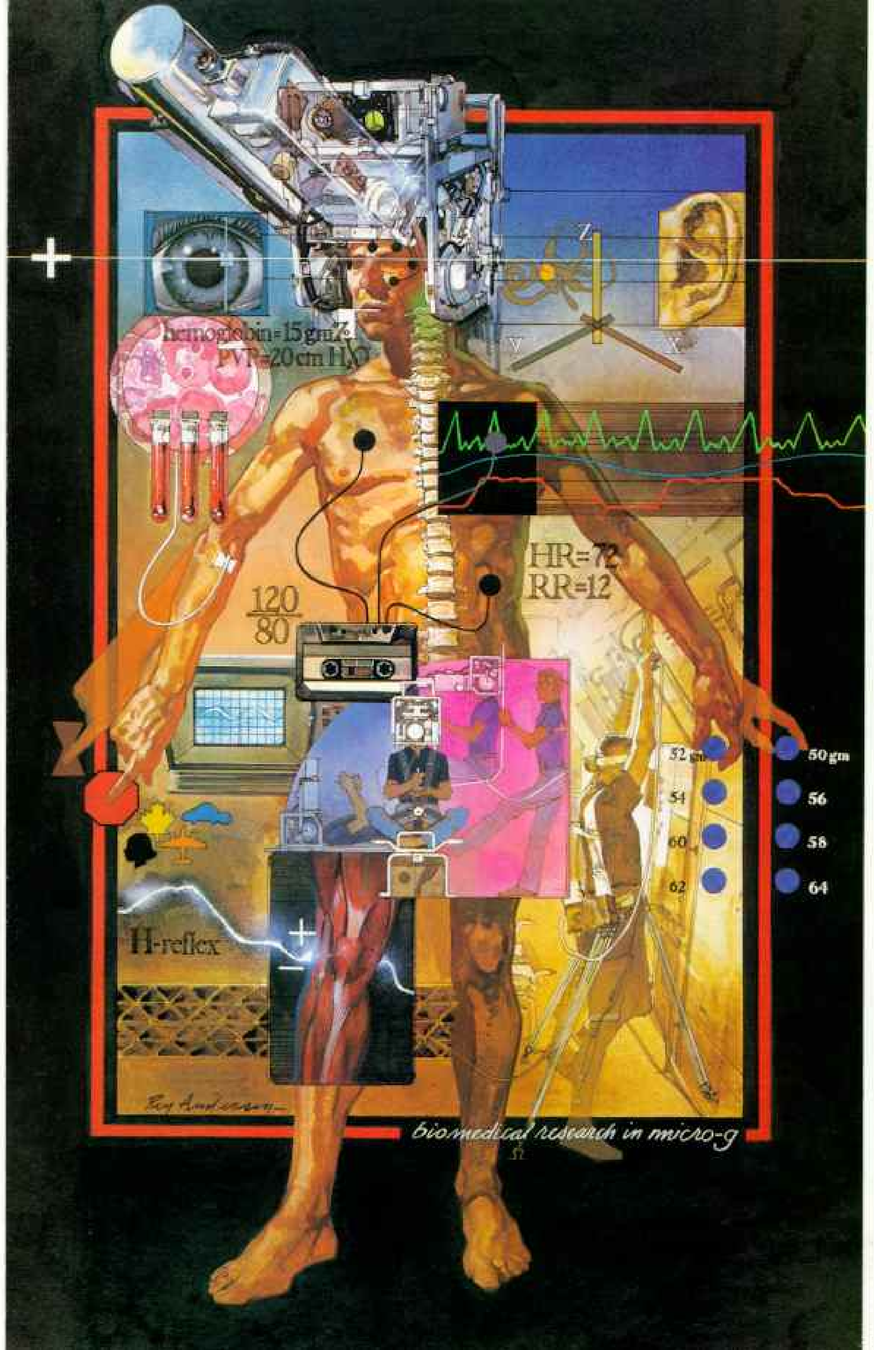
Like newspapers, X rays emitted by astrophysical events—from exploding supernovae to pulsars—carry the stories of the events, because the processes that caused them label the rays with discrete frequencies. A spectrometer (**European Space Agency**) edits the copy from such reporters as colliding stars and black holes to produce a paper that astronomers will read with interest.

Viewed from shuttle altitude, the atmosphere acts like a giant television screen, containing faint optical emissions produced by high-velocity winds, electric fields, and other phenomena. After a low-light TV camera (**United States**) records these images, earthbound scientists can tune in at their leisure.

The sun's radiant energy—long known as the solar constant—pummels our atmosphere, contributing to the equations that govern atmospheric circulation, and hence earth's climate. With recent discoveries that the solar constant actually varies a bit, scientists ask, how much? The question can only be answered from a spacecraft, since the atmosphere filters out some of the sun's energy before it reaches earth. A radiance sensor (**Belgium**) will help determine the variability of the solar constant.

A sister experiment (**France**) views a narrower slice of the sun's energy output, from ultraviolet to infrared—spectral bands that deposit energy at various levels of the atmosphere.





Physiology

HIMSELF a satellite of sorts in space, man has exhibited curious dysfunctions during prolonged flight. An experienced former test pilot becomes nauseated. His heart alters in rhythm. He loses red blood cells. Why?

A TV camera of very high resolution mounted on a crew member's head (**left**) will record the movement of his eyes while he is strapped in a metal frame, center, and pushed about by another crew member. Erratic eye movements are a key index to subtle changes in the body's delicate balance system.

At another time, he will be asked to study the location of common shapes and, with eyes closed, point to each.

A hemoglobin monitor records changes in red-blood-cell production, and a medical tape recorder, through electrodes shown in black, monitors his heart, brain, and eyes.

In another experiment he picks up a pair of metal balls and tries to judge which is heavier. There are 24 balls to choose from, all the same size but differing subtly in mass.

A slight electric shock applied to the tibial nerve behind the knee will yield data about a little-known field of reflex behavior during sustained weightlessness.

Most of these experiments will also be conducted before and after the flight.

John W. Young
Commander

A former naval aviator and experimental test pilot, Young, 53, commanded the shuttle during its first orbital test flight in 1981. The veteran of two Gemini and two Apollo missions spent more than 71 hours on the moon's surface.

Brewster H. Shaw, Jr.
Pilot

As an Air Force fighter pilot, Shaw, 38, won the coveted Top Gun award twice and logged 644 combat hours flying F-100s and F-4s in Vietnam. Before becoming an astronaut in 1978, he was a test-pilot instructor at Edwards Air Force Base.

Dr. Owen K. Garriott
Mission Specialist

Garriott, 52, served as science pilot on the second Skylab crew in 1973. A specialist in ionospheric physics, he received his doctorate from Stanford University in 1960.

Dr. Robert A. R. Parker
Mission Specialist

A former associate professor of astronomy at the University of Wisconsin, Parker, 46, received his doctorate in that subject from the California Institute of Technology in 1962.

Dr. Byron K. Lichtenberg
Payload Specialist

A specialist in biomedical engineering, Lichtenberg, 35, has degrees from Brown University and the Massachusetts Institute of Technology.

Dr. Ulf Merbold
Payload Specialist

Merbold, 42, a citizen of West Germany, graduated from Stuttgart University and researched low-temperature physics and crystal-lattice defects at the Max Planck Institute for Metals Research.

ALL PAINTINGS BY ROY ANDERSEN

TDRS Spacelab's link to earth

*LAUNCHED by uncoiling springs, a Tracking and Data Relay Satellite inches away from the shuttle on April 4, 1983 (**right**). Its ability to relay hordes of data is vital to Spacelab's mission.*

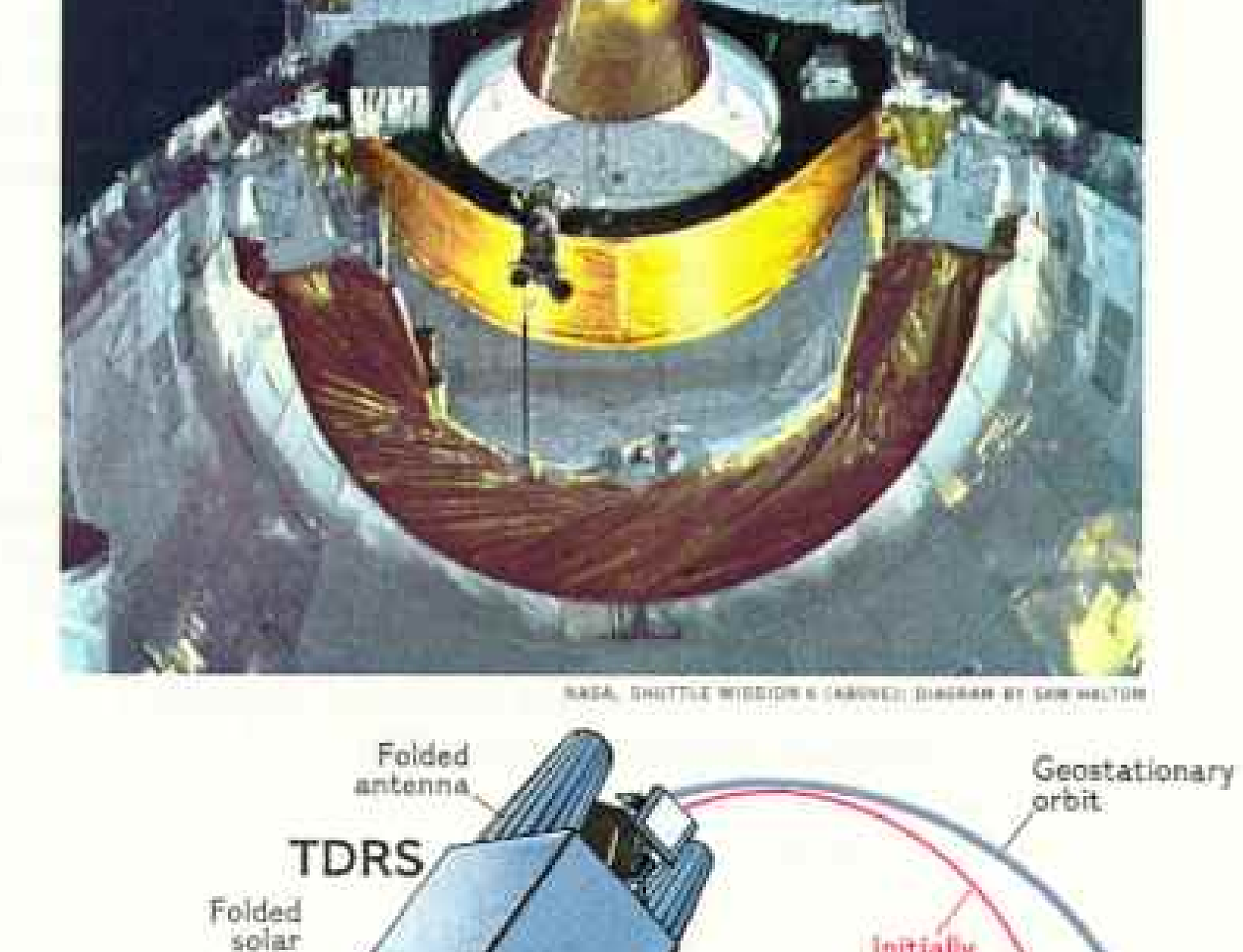
*Six hours later, the inertial upper stage (IUS) (**bottom**), designed to propel TDRS to orbit, malfunctioned. Suddenly, the satellite and its booster tumbled through space like a thrown dagger. As the tumble continued at 30 rotations per minute, the vital telemetry link with the ground was interrupted.*

"We couldn't talk to it, and we couldn't hear it," recalls Ronald K. Browning, NASA's project manager for the TDRS System. Browning's staff made frenzied calculations. Could the satellite and booster be deployed? Would TDRS come apart? "It was three hours of pure hell," says Browning.

*Meanwhile, a telemetry command got through and TDRS separated. On its own, it stopped tumbling and responded to commands. But Browning faced a new challenge: how to nudge the satellite from its egg-shaped orbit (**right**, in red) to the desired path, shown in blue.*

After nearly a month of analyses and computer simulations, NASA began firing TDRS's tiny thrusters and achieved the goal by the end of June.

NASA. SHUTTLE MISSION 6 (ABOVE); DIAGRAM BY SAM HILTON



(Continued from page 299) still was free to show me the remote-sensing laboratory he had created with assistance from the United Nations and the U. S. Agency for International Development.

"With few roads, we use a lot of bush planes," said Dr. Brockmann. "But poor maps were causing more than 400 crashes a year—pilots looking for incorrectly mapped villages and running out of gas, or slamming at night into mountains that weren't supposed to be there. Landsat permitted us to correct our maps and reduce the crashes."

Training a small staff, Dr. Brockmann harnessed Landsat for other down-to-earth tasks: to map an economical gas pipeline route across forested Bolivia, to guide engineers building a railroad through an almost impassable swamp. Analyzing imagery of an immense salt flat known as the Salar de Uyuni, he and Douglas Carter located what may be the planet's greatest concentration of lithium, vital for fusion power—perhaps the energy successor to oil.

In Santa Cruz, in eastern Bolivia, I found a team of Bolivian and British geologists mapping an assault on the forbidding Huanchaca plateau, a wilderness known to few but Indian hunters. Technicians bent over Landsat images, identifying lineaments and rock outcrops that might hold minerals, looking for streams that could bear their canoes into the remote plateau. Here was an ideal use of Landsat: aiding high-technology pioneers in mapping one of earth's most defiant frontiers.

Neighboring Brazil, I discovered, was engaged in a dynamic satellite program. "We opened our Landsat center in 1973, and today it's the second busiest in the world, next to EROS," boasted Dr. Nelson Parada, director of INPE, Brazil's equivalent to NASA. "Satellites are the only practical way to obtain information about so enormous a country. More than 1,300 institutions use our satellite data."

IN THE UNITED STATES, Landsat plays a growing role in the high-stakes search for oil and minerals.

Seeking to observe the companies in their search, illustrations editor Jon Schneeberger and I knocked at a preserve that is tightly guarded. Little wonder: We were asking rival firms to reveal potential oil and ore strikes possibly worth billions of dollars.

Yet three companies—Phillips, Conoco, and Superior—admitted us to their inner sanctums. In darkened rooms crowded with the finest in electronic equipment, we saw geologists poring over satellite imagery that ranged the globe.

"When we search for oil," explained Herbert Tiedemann of Phillips, "we look for geologic structures such as faults, folds, and dome-shaped formations. These can act as oil traps that concentrate deposits."

Much of this secret work still is experimental. But the eyes in space already have guided Chevron geologists to a major strike in Sudan's remote Sudd, a Maine-size swamp bordering the Nile.

I heard a word of caution from H. A. Kuehnert, director of exploration projects for Phillips: "Bear in mind that Landsat can only narrow the search—identify areas worth exploring further and those to be ignored. You still must go in on foot with gravimeters and costly seismic tests, and drill expensive exploration holes before you know you have something."

At Superior Oil in Houston, Stephen Nicolais described the search for minerals. "We often analyze an image for signs of iron oxide, the same reddish brown hillsides sought by the western gold prospector on his donkey. Normally the coloration isn't vivid enough to show up in a regular image, so we digitally enhance color contrasts. We've already discovered indications of new copper deposits in Chile."

In his search for metal deposits, James R. Keighley, a jungle-wise prospector, analyzes Landsat images of remotest Brazil and Bolivia. These have led him to tin deposits worth fortunes.

"The ore often occurs in ancient streambeds and granite outcrops that are invisible even if you walk right on top of them. But Landsat images, enhanced with false colors, distinguish between vegetation growing on normal granite and on tin-bearing granite. Perhaps the metal affects the plants; anyway, that's where we find it."

Mr. Keighley's use of Landsat to distinguish subtle vegetation differences conforms with the original intentions of the satellite's designers. They chose its sensors

Switchboard in space

*CAT'S CRADLE of telemetry provides an electronic link among satellites and earth stations and illustrates the central role of TDRS (**1**), the Tracking and Data Relay Satellite made by TRW, Inc., and launched from the shuttle last April.*

*Landsat (**2**), having established its position from four satellites of the Global Positioning System (**3**, shown in red), directs its imaging apparatus toward earth. Data collected by Landsat are beamed up to TDRS for real-time transmission to an earth station at White Sands, New Mexico (**4**).*

*Without skipping a data byte, TDRS simultaneously receives transmissions from a space shuttle (**5**), as well as from the Space Telescope (**6**) above it.*

*At top left, Satcom (**7**), a communications satellite, relays data from White Sands to the earth station at NASA's Goddard Space Flight Center in Greenbelt, Maryland (**8**), lower right.*

PAINTING BY DAVID MELTZER

USAF SPACE DIVISION

GPS Landmarks in orbit

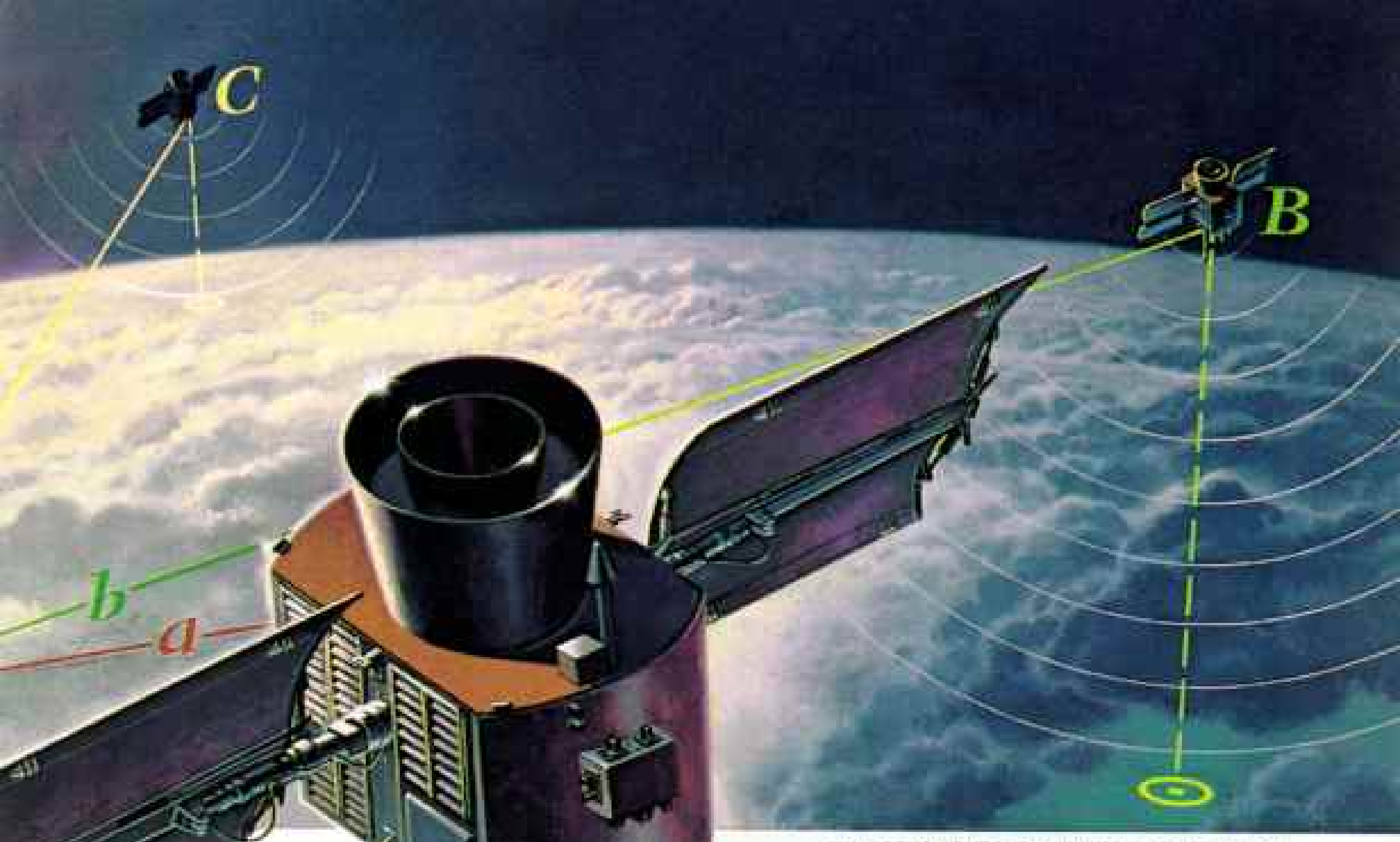
*LIKE ELECTRONS whirring around nucleus earth (**above**), the 18-satellite Global Positioning System, also known as NavStar, will provide U. S. military forces with position and velocity information of unprecedented accuracy.*

*When the full system is operational in 1988, a computer aboard an aircraft such as a B-1 bomber (**top**) receives signals from four GPS satellites—**A** through **D**—orbiting 10,900 nautical miles high.*

*The satellites broadcast their locations as well as the exact time. The distances from the aircraft to the satellites are represented by lines **a** through **d**. These distances also equate to the time it takes for a satellite's broadcast to be received, represented by **a** through **d** on a stylized clock (**above right**).*

Almost instantly, the B-1's computer solves equations that determine latitude, longitude, and altitude within ten meters. It also computes the aircraft's velocity to within one-tenth of a meter per second.

Such information permits extraordinary precision in the delivery of weapons to a target whose coordinates are known. In early tests of the system utilizing four prototype satellites, attack aircraft traveling 450 knots at 10,000 feet put their bombs



PAINTING BY DAVIS MEITZER; FRED WARD, BLACK STAR (BELOW)

*inside a circle about ten meters in diameter, roughly the area of a large living room. A tank (**above middle**) was later placed over craters made by dummy bombs at the U. S. Army proving grounds outside Yuma, Arizona, to illustrate the accuracy.*

*Beneath a model of the space shuttle (**right**), technicians at Rockwell International's facility in Seal Beach, California, work on a GPS satellite. Of 21 satellites to be orbited, three will serve as spares.*

KERBY SMITH (TOP); FRED WARD, BLACK STAR

Search and rescue

*LENDING AN EAR to a pilot in distress (**right**), receivers developed by Canada and France and installed on a U. S. weather satellite pick up emergency signals from the downed aircraft and relay them to a ground station, which pinpoints the location.*

The technique, jointly pioneered last year by the U.S.S.R. with Cospas and the U. S. with Sarsat, has saved the lives of 35 people in 15 incidents involving aircraft and ships.

*With satellite relay, ship-to-shore communication is as easy as picking up the phone. Cdr. T. A. Catesby (**left**) of the Patricia, a British lighthouse tender, illustrates. Shore-to-ship communication is made easier by a 16-inch-wide antenna (**upper left**) made by Radio Research Laboratories of Koganei, Japan.*

primarily for studying growing things, as in making crop forecasts—still an uncertain art in such countries as the Soviet Union, China, and India.

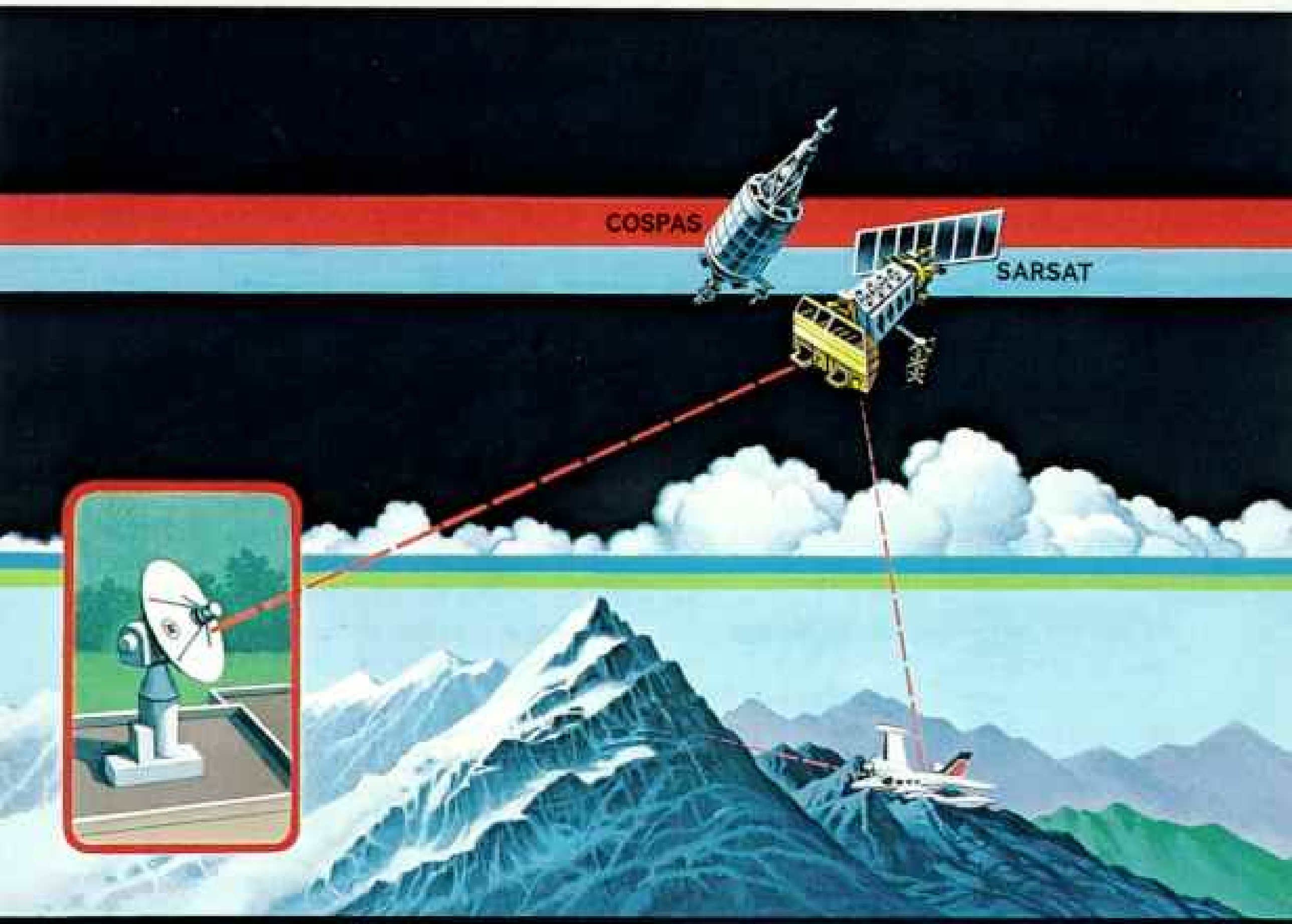
Ironically, as Landsat 1 lifted from its launchpad in 1972, buyers representing the Soviet Union were quietly calling on America's grain dealers. Unknown to U. S. officials, the U.S.S.R. wheat crop had failed disastrously, and the Russians secretly were contracting for some 20 million tons—cheap. The clandestine raid persuaded the U. S. to monitor the Soviet crop annually, and satellites became one means.

The mission has posed a challenge. "One problem is the difficulty in distinguishing by satellite between grains having similar reflectances, or 'signatures,' such as wheat and barley," said Gene Rice, director of the NASA earth resources program at the Johnson Space Center in Texas.

"In addition to Landsat's measurements of crop acreages, we use weather satellites to tell us if crops are stressed by drought or winds. As acreage and moisture measurements improve, so will our forecasts."

Perfected or not, crop forecasting by Landsat was proceeding full tilt a few blocks away from the Johnson Space Center, where the U. S. Department of Agriculture was watching over the fields of major agricultural nations, including the Soviet Union. Curious about the Russians' fickle wheat crop, I entered a darkened room where analyst Pat Ashburn sat before a video image aglow with the red tones Landsat gives to healthy vegetation.

Piloting his magic console, Mr. Ashburn took me on a sweeping Landsat tour across the great Soviet wheat belt: over mammoth fields checkering Kazakhstan, the Volga River Valley (parts of it forbidden to earthbound tourists), and the Ukraine; over small fields in the Crimea and Byelorussia. In



PAINTING BY DAVID MELTZER

most places crops appeared normal, though the season was too young for a final forecast.

Landsat's appeal extends to others who oversee broad acreages. The Bureau of Land Management, guardian of 320 million public acres, uses satellite imagery to tell which remote rangelands are suitable for grazing. The St. Regis Corporation consults Landsat about the health of its 2.3 million acres of southern timber. A growing number of states use the satellites for inventorying natural resources, detecting pollution, monitoring rangeland and wildlife habitat, even spying on "wildcatters" stripping coal from unlicensed areas.

During the Landsat era four satellites have borne the name and served thousands of commercial users. Landsats 1 and 2 expired after sending some 800,000 images to earth, and Landsat 3 is partly defective. Landsat 4, launched last year, carries a new sensor known as a thematic mapper that offers keener vision for crop surveys and mineral exploration. Recently Landsat operations shifted to the National Oceanic and Atmospheric Administration (NOAA).

Despite Landsat's usefulness, revenues fall far behind costs. The Reagan Administration has proposed that this system and the weather satellites be absorbed by the private sector. Should this happen, many fear the United States will surrender this vital role to the French and Japanese, who plan to launch sophisticated earth-resources satellites in mid-decade.

TWIRLING THROUGH SPACE with the Landsats, another family of spacecraft also looks down on earth. These are the hardworking meteorological satellites, known best for their spectacular views of world weather.

Awe greeted a photomosaic produced in 1960 from pictures taken 450 miles out by

the environmental satellite TIROS 1. Through its tiny TV cameras, the satellite carried the human eye into space until man for the first time saw two-thirds of his planet, a sight seen before only on maps. More significantly, it revealed global weather systems, as exposed by clouds riding the backs of invisible winds.

This spawned salvos of bigger and better TIROS satellites, each armed with keener sensors for sharpening our scrutiny of weather and the environment. Since their vigil became routine in 1966, no tropical storm has formed anywhere on earth undetected, and hurricane warnings have saved thousands of lives in the U. S. alone. Supplementing the TIROS observations, two Geostationary Operational Environmental Satellites, known as GOES, send weather pictures from 22,300 miles out, bringing the panoramas you see on TV.

"A great advantage of weather satellites," explained Dr. John Leese, satellite specialist of the World Meteorological Organization, "is that they observe conditions over areas where we lack other information, particularly the oceans."

Thousands of Americans, however, require more specific weather reports. The farmer must calculate when to plant and irrigate and reap; the ski-resort operator, when temperatures favor making snow; the county or city road crew, when to prepare to salt or sand before a blizzard. "Satellite data are indispensable," said Dr. Joel Myers, whose private forecasting firm, AccuWeather, Inc., provides personalized predictions to more than 450 such clients.

When winter's crop-killing frosts creep south toward Florida citrus country, a temperature sensor on a GOES satellite monitors the ominous advance. By indicating when to take action, such as igniting costly burners that will save the fruit, the satellite enables growers to avoid fighting the cold prematurely, saving an estimated 35 million dollars a year.

This same sensor measures temperatures of the surface of the sea—a fact that brought vast satisfaction to Capt. Augustus Genovese when I caught the commercial fisherman on a rare day ashore.

"We know the water temperatures fish prefer," said the ruddy-faced skipper of the purse seiner *White Dove*, out of Cape May, New Jersey. "Mackerel like water at 46°F, bluefin tuna 69°, and so forth. But how to locate these waters? We had no way until NOAA began distributing satellite temperature charts.

"A month ago the chart showed a warm eddy moving into the Hudson Canyon off New York City—perfect conditions for mackerel, squid, and scup. We raced out there and caught as much as 80 tons a day. Now boats from as far as Virginia are working the canyon. Amazing!"

Environmental satellites also strengthen the mariner's hand in the ancient struggle with sea ice. In Canada's treacherous Gulf of St. Lawrence, images from on high help guide 1,500 ships a year through winter ice by improving the efficiency of aerial reconnaissance. Satellite pictures have been used in opening areas of the Great Lakes to year-round navigation.

TIROS satellites shower down their data free for the taking, and more than 120 nations have built ground receiving stations to avail themselves of the bonanza. Observed NOAA's Robert W. Popham, "Anybody with a few hundred dollars and some engineering skill can build a receiver—and already has—universities, high schools, even Boy Scout troops and individual amateurs.

NASA

We know of at least 800 ground stations, and there are probably thousands."

WHEN THE RUSSIANS launched Sputnik 1 in 1957, they little suspected that Americans would quickly translate the satellite's radio signals into the greatest revolution in navigation since the compass.

Listening to those beeps, scientists at the Johns Hopkins University Applied Physics Laboratory in Maryland found they could use them to predict Sputnik's precise orbital position, and thus the location of the listener on earth. Other scientists at the lab thereafter developed the electronic "black box" to automate such a system, and the blessing of satellite navigation was born.

Today a constellation of five navigation satellites, launched originally to guide the Navy's Polaris submarines, serves mariners all over the world. Where an expert navigator using a sextant obtains fixes with an accuracy of one mile (and only at dawn or dusk and when it's not overcast), a satellite navigator can tell his position within a hundred yards, night or day, clear or cloudy.

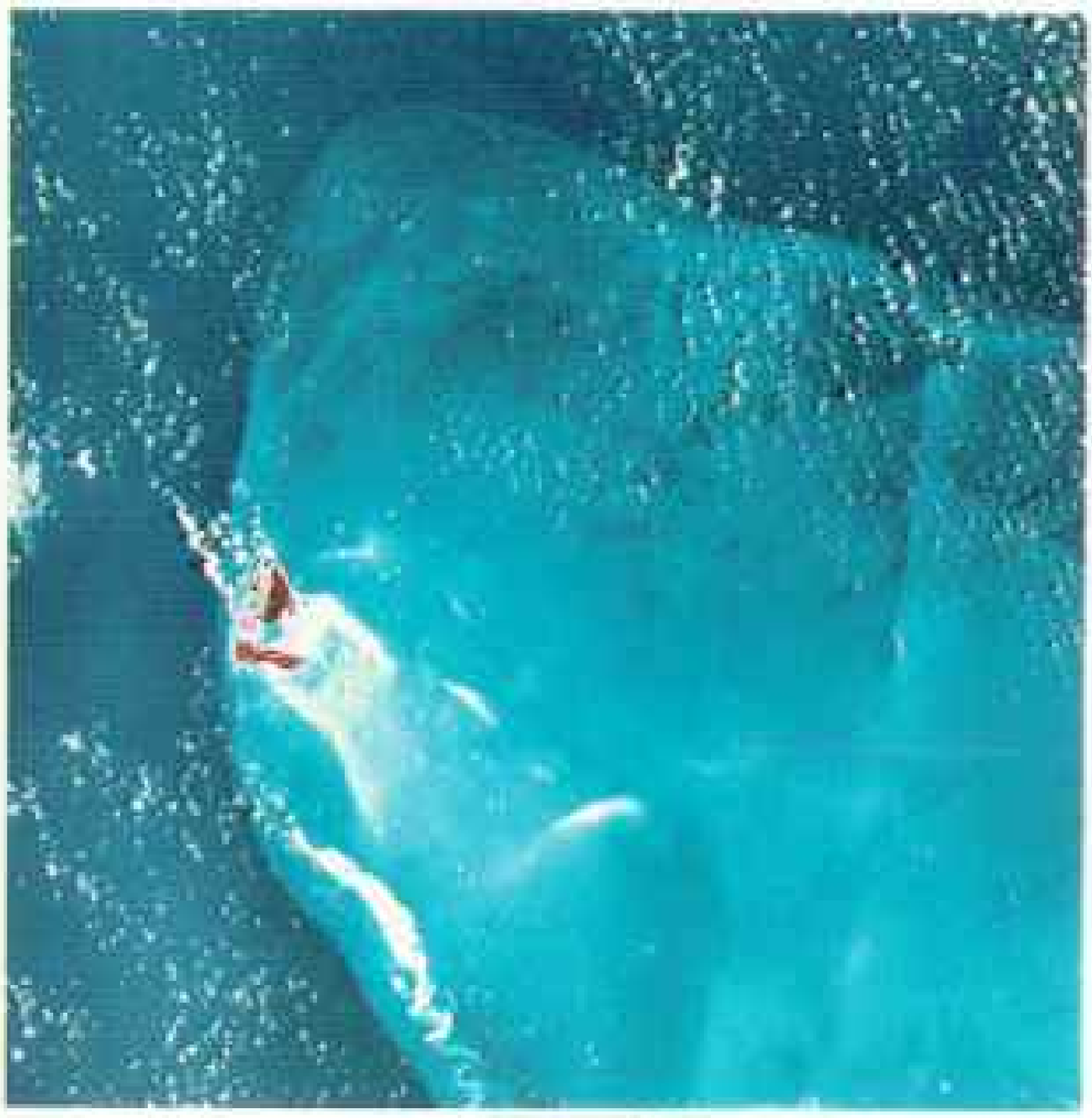
The system has won the loyalty of the tough breed who roam the seas in search of tuna, voyages that may last half a year.

"My only worry," said John Zolezzi, captain of the *Mary Antoinette*, out of San Diego, "is that the satellite system may break down, and we'll have forgotten how to use the sextant. We use 'sat-navs' for everything: finding a fishing ground, staying on it during darkness, and simply setting a straight course from here to there—pretty important when you burn $3,500 worth of fuel a day."

To the surprise of many, the sat-nav system was greeted as enthusiastically on land as on the open sea. Perhaps as many as a thousand land surveyors now carry sat-nav black boxes along with their theodolites. "Surveys that took years now can be done in days," affirmed Richard Peat, deputy of Geodesy and Surveys for the Defense Mapping Agency.

In a few years a new generation of 18 space beacons, known as the Global Positioning System, will give fixes almost instantly within a few yards. Automakers already are testing dashboard navigators that show you where you are, and someday they could use a voice synthesizer to tell you your location and where to turn.

When the tiny Explorer 1 bore American space hopes aloft in 1958, it carried Geiger counters that revealed the existence of a powerful radiation band wrapping the earth—one of *(Continued on page 326)*



***New tricks** with old imagery. A Landsat 1 image (**left**) shows the islands of North and South Bimini off the Florida coast, with the tip of Grand Bahama Island at top. This conventional false-color image, made from the green, red, and infrared bands of the satellite's scanner, gives a minimum of shoal information.*

*A technique devised for the Defense Mapping Agency combines the green and red bands of a similar Landsat image to produce a synthetic blue. Recombining the blue with the green and red restores true color (**right**), defining the extent of the shoal and revealing water depth. This will result in greatly improved nautical charts.*

A PORTFOLIO

Images of earth

*SECRETS OF THE SAHARA, hidden by sand, are revealed by the piercing eyes of radar. A Landsat image (**below**) shows a vast sweep of sand punctuated by hills in northwestern Sudan. The red lines indicate the 50-kilometer-wide swath of the imaging radar carried aboard the space shuttle Columbia in November 1981.*

*Probing the sand to a depth of six meters (20 feet), the shuttle's radar, developed by scientists at the Jet Propulsion Laboratory (JPL), literally fills in the space between the lines to reveal ancient topographical features (**right**).*

The dark region at top has been identified as a river valley as large as that of the present-day Nile. Below it other riverbeds and valleys carve the bedrock. In a similar area in Egypt, scientists dug along a riverbed revealed by radar and discovered arrowheads 100,000 to 200,000 years old.

BOTH NASA JET PROPULSION LABORATORY

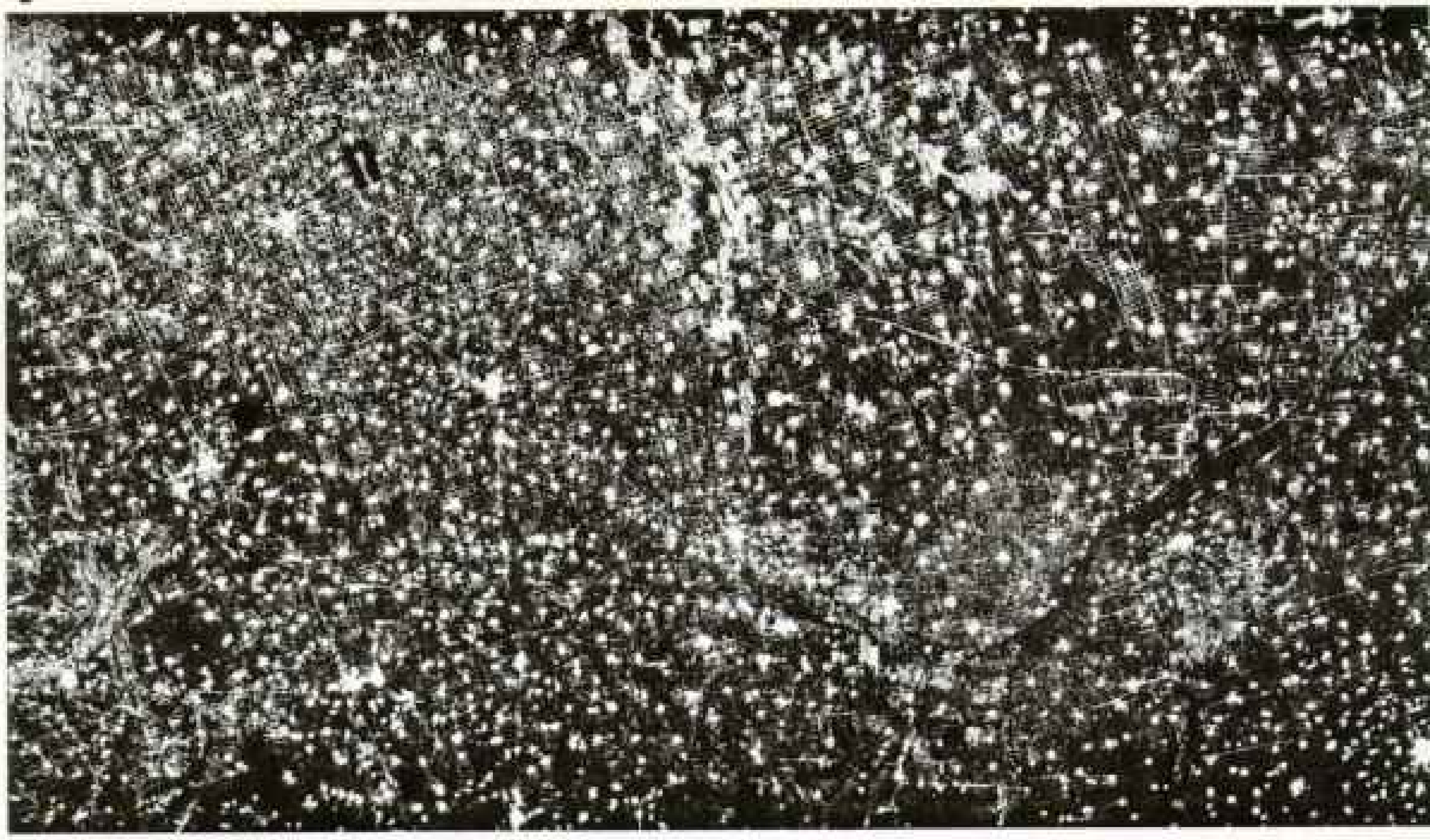
BAS-RELIEF OF TERRAIN imaged by radar in northwest Xinjiang Province, China, an area of intense tectonic activity, shows the shearing of mountains along the perpendicular fault line at left. Sand, pebbles, and boulders spread out in alluvial fans from the ridges at right.

Directed at the earth at an angle from the spacecraft, radar microwaves

NASA JET PROPULSION LABORATORY

penetrate clouds and sand. Encountering features such as boulders, bedrock, mountains, or man-made objects, the waves scatter, or bounce away like tennis balls, in various directions. Those waves that return to the spacecraft are recorded on film or assigned numerical values that are sent back to earth via telemetry. Entered into a computer, the numbers produce an image.

C

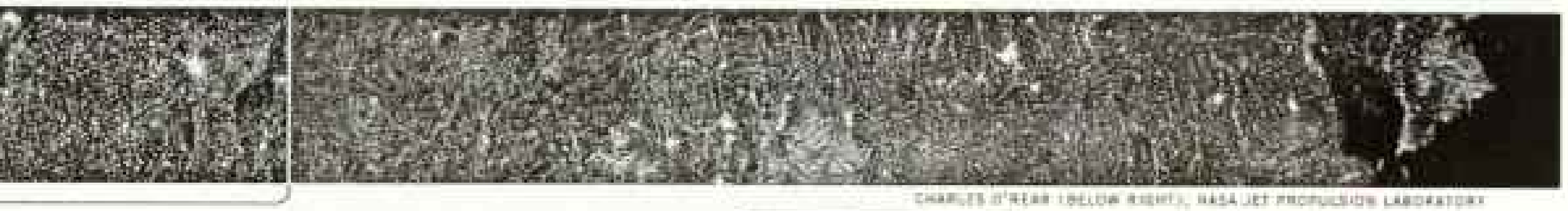


MAN-MADE QUILT *of villages and farms in eastern China reveals a high density of population, about one village every square kilometer* (**top**). *There are some 6,500 villages—as well as the city of Dezhou at upper right—in the photograph, which covers an area 175 kilometers by 50 kilometers. The villages appear as white splotches, the farm boundaries as grid lines.*

The photograph is enlarged from part of an image strip, area C (**above**),

A

B



CHARLES ELACHI (BELOW RIGHT), NASA JET PROPULSION LABORATORY

made by the shuttle's radar in a sweep from the Great Wall to the Yellow Sea.

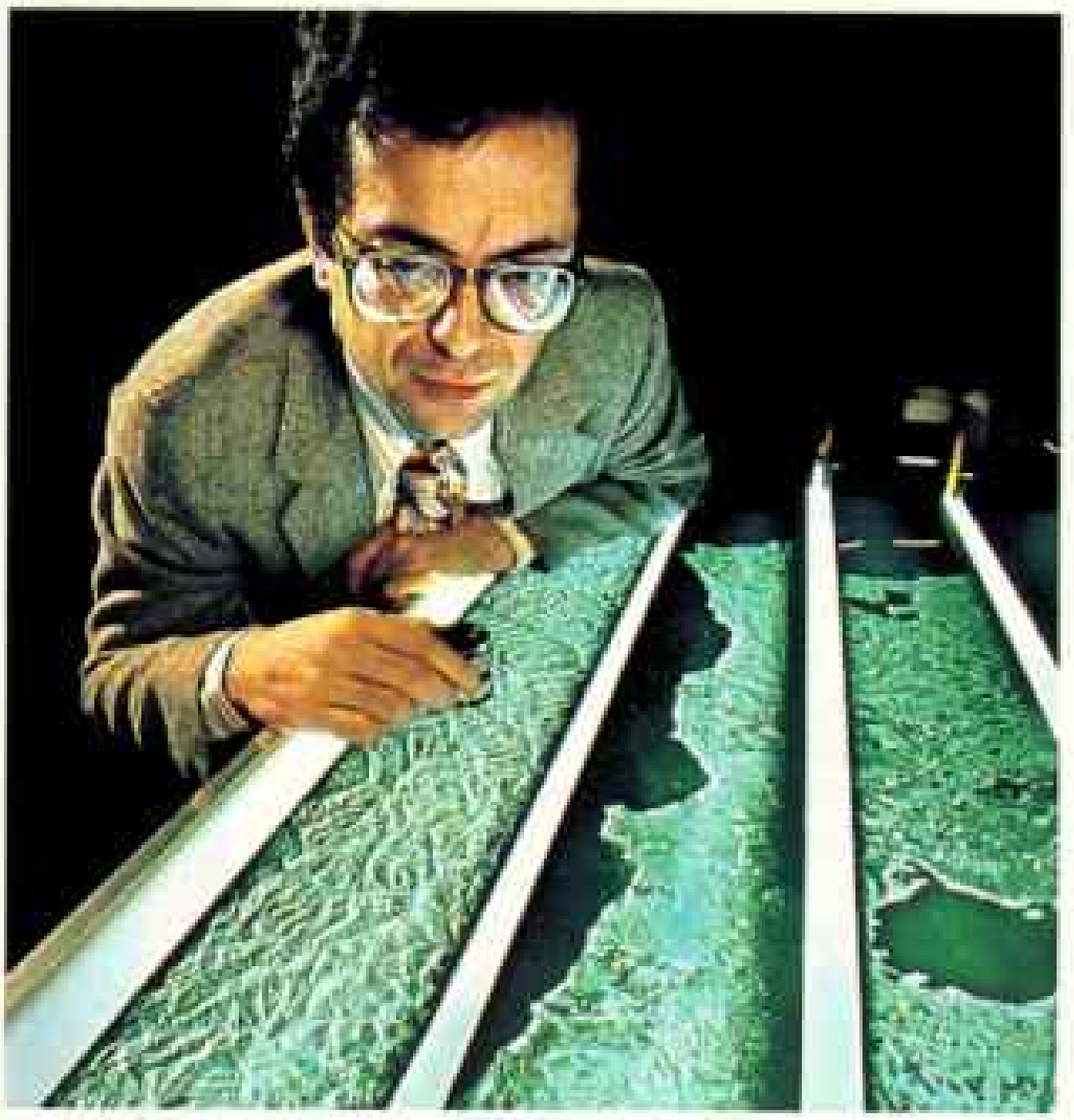
An enlargement (**below, middle**) *of area B shows drainage patterns radiating from the Luya Mountains in Shanxi Province. The mountain peaks are heavily forested and show as bright areas.*

The mountains meet the Mu Us Desert (**bottom left**) *in an enlargement of area A.*

Principal investigator of the team that created the shuttle's radar, Dr. Charles Elachi (**right**) *examines strips of the imagery at JPL. "We knew in theory that radar could penetrate sand," he says, "but this is the first time it has been verified on a large scale."*

From archaeology to geologic mapping, Dr. Elachi sees a bright future for the new imaging process. On a shuttle mission next year, the radar will image Egypt's entire Western Desert. NASA plans to put the radar on a spacecraft bound for Venus in 1988 to create the first map of that cloud-covered planet.

From the Great Wall to the Yellow Sea, the 50-kilometer-wide track of the shuttle's imaging radar traverses deserts, mountains, and agricultural areas.



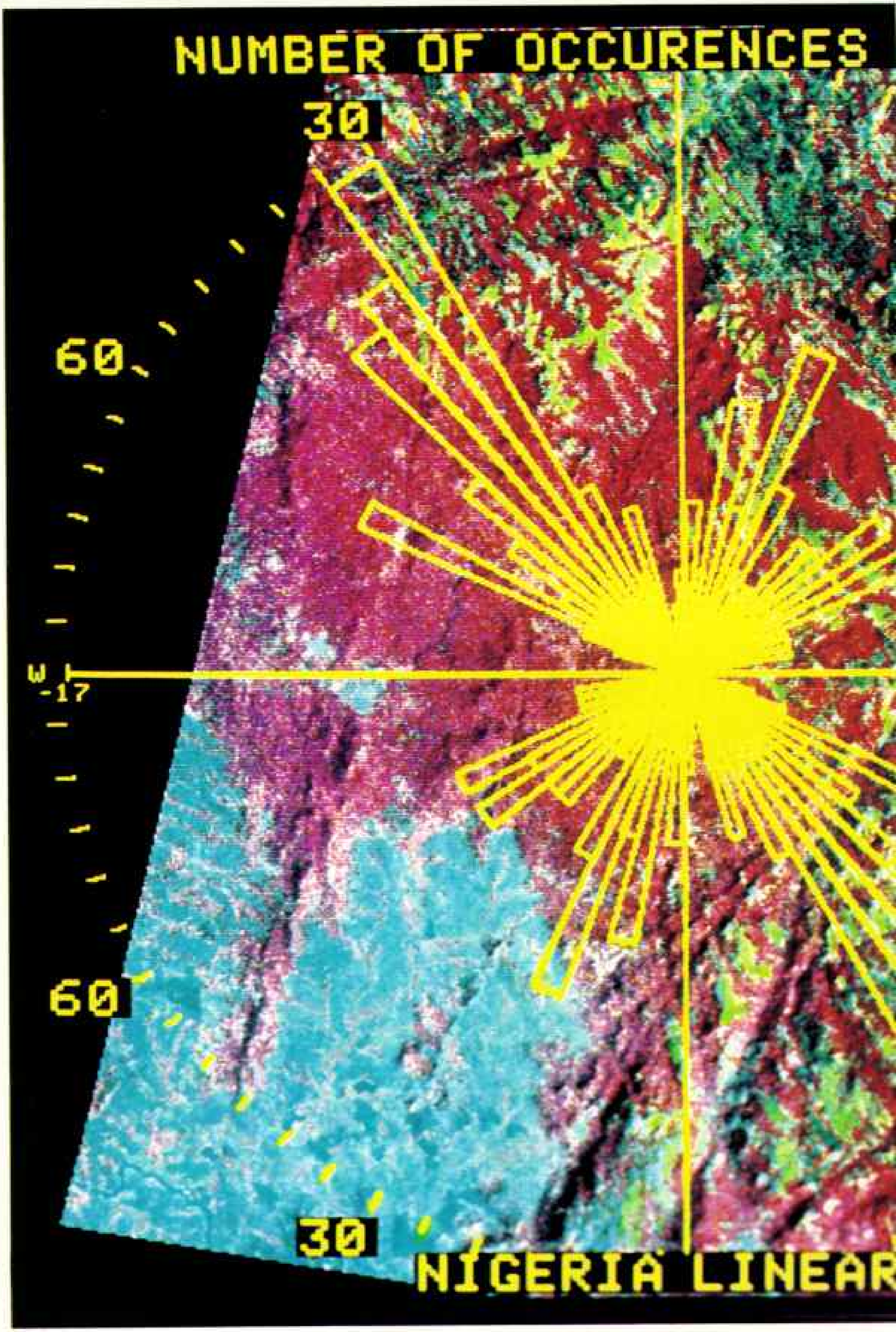
FRED WARD (ABOVE); NASA/EARTH RESOURCES INSTITUTE OF MICHIGAN

SPACE-BORNE MAPPERS, *Landsat 4's imaging systems provide a picture of Detroit, Michigan, and environs (**right**) from an altitude of 440 miles.*

To make this photograph, three of the satellite's seven imaging systems were employed—red and green in the visible-light wavelengths and the near infrared.

Detroit, at upper center, and Windsor, Ontario, are separated by the Detroit River. At left center, Highway 94 skirts the runways of Metropolitan Wayne County Airport and, farther west, threads between Lake Belleville and the runways that appear as spokes in the Willow Run Airport.

*Dr. Alden Colvocoresses (**above**), research cartographer at the U. S. Geological Survey in Reston, Virginia, holds the Dyersburg, Tennessee, image map, the first quadrangle made from Landsat's thematic mapper data. "Now," he says, "it is up to the map users to tell us how useful they find this kind of map."*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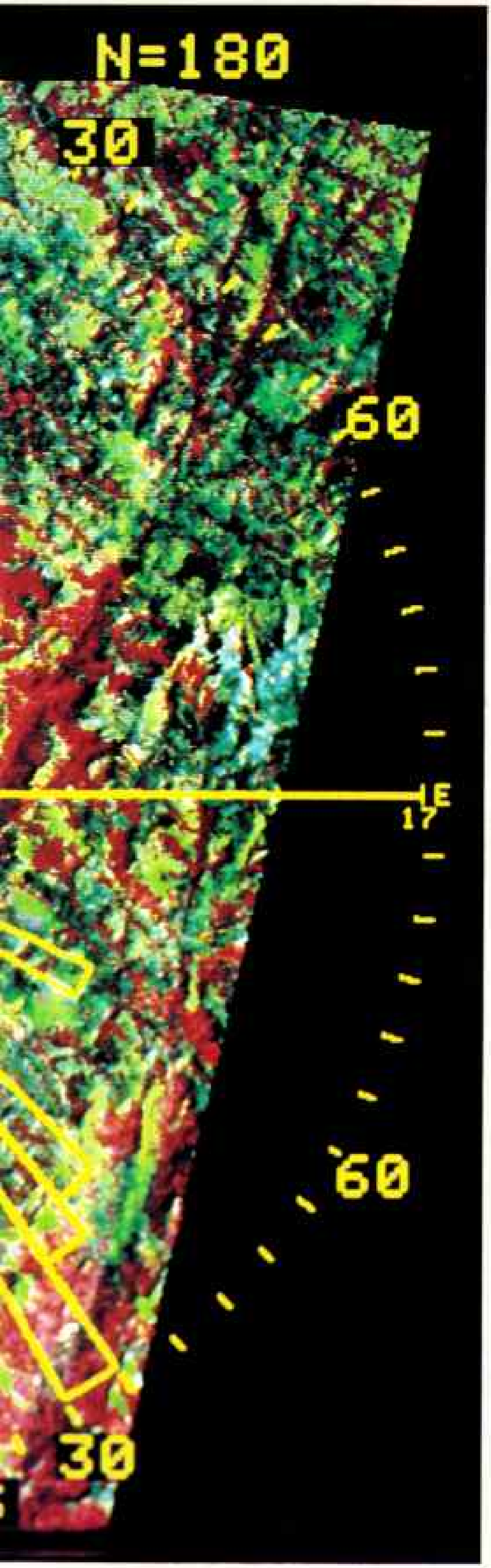
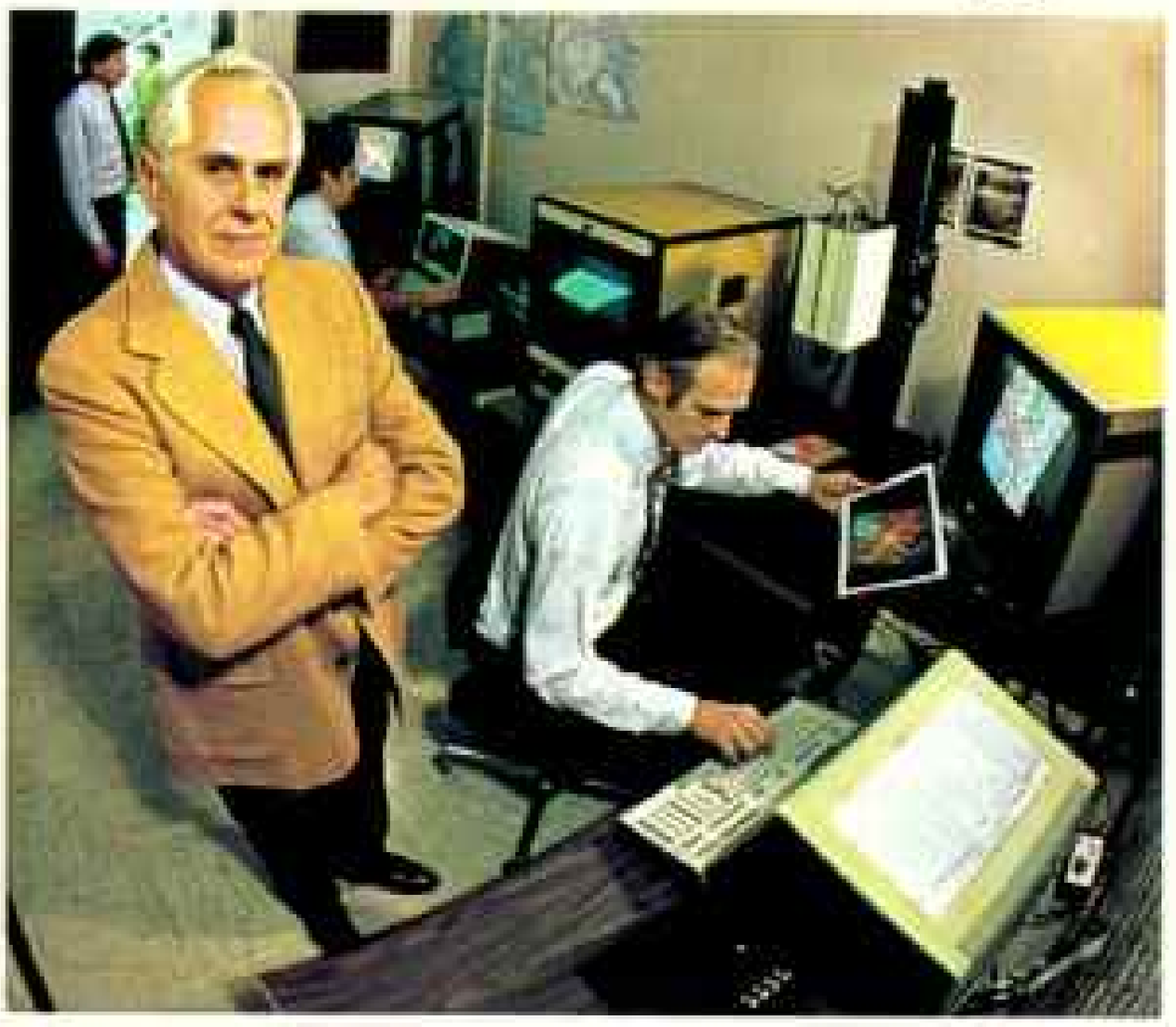


PHILLIPS PETROLEUM (LEFT); KERBY SMITH (BELOW); USDA FOREIGN AGRICULTURAL SERVICE

*LIKE A DART BOARD, lines superimposed on a Landsat image by a computer show the azimuths of faults in a mountainous area of Nigeria (**left**). Such lines help pinpoint likely spots for oil exploration in nearby areas where fault lines are not so visible.*

*"They don't tell us where the oil is," says H. A. Kuehnert (**below,** standing), director of exploration projects for the Phillips Petroleum Company in Bartlesville, Oklahoma, "but they do give us an idea of where to look for it."*

*Landsat imagery near the Black Sea (**above**) gives the U. S. crucial information on the extent of the Soviet wheat crop. Fallow fields appear in blue and white, growing wheat in red.*



(Continued from page 315) the famed Van Allen belts. Since then, at least a quarter of all satellites have been dedicated to science programs, coordinated largely by NASA, the Soviet Union, and the European Space Agency.

Training their sensors on earth's surface, they have mapped its varying magnetic contours, measured the drift of the continents, and showed that the "level" sea actually undulates with great troughs and ridges varying 600 feet in elevation. Studying the atmosphere, they record fluctuations of its ozone content. Carrying astronomers' eyes beyond earth's obscuring atmosphere, they have opened dramatic windows onto the universe, including the discovery of X-ray sources that may indicate the locations of black holes.

SCANNING their green-tinted scopes in March of 1981, radar operators at NORAD detected the ascent of Soviet Cosmos satellite number 1258. Interest quickened as the spacecraft gained on another Soviet satellite, Cosmos 1241.

Two orbits after launch, radar showed Cosmos 1258 closing on its quarry. The rest is classified, but in a likely scenario, the pursuer suddenly vanished—exploded by a signal sent up by Russians on the ground. Its shrapnel smashed into Cosmos 1241. It was the 19th known test of a Soviet hunter-killer satellite, and the ninth simulated kill.

Lt. Gen. Kelly Burke, then chief of research for the U. S. Air Force, told me of U. S. efforts to develop a counterforce. "Soon we'll be demonstrating an antisatellite missile fired from a fighter plane, and it will be better than the Soviet system," said General Burke. "In most areas of space," he added, "we have a clear technological lead."

Will satellites someday become chariots of war, hurling the thunderbolts of lasers and particle beams at cringing earthlings?

International treaties, always fragile, prohibit deployment of weapons of mass destruction in space. But some authorities believe the Soviet Union is developing a satellite-borne laser system that by mid-decade could be capable of destroying U. S. satellites or missiles. The Department of Defense contends that the Soviet laser program is three to five times as large as that of the U. S. Other experts, however, believe that a parallel U. S. program would be disastrously expensive, if not also unfeasible.

"Satellites are ill suited for the role of destruction," said Dr. Harris Mayer, a space and defense scientist. "Equipping them for the massive terrestrial bombardments of *Star Wars* would require orbiting prohibitive amounts of energy and mass. Communications surveillance and navigation—these will be the military tasks of satellites."

In Dr. Mayer's view of space and war:

- Swarms of simple, low-flying communication satellites—too many to knock out—maintain vital command links.
- Powerful navigation satellites, beaming down directional signals through any weather, guide tanks, ships, aircraft, missiles—even foot soldiers wearing tiny wrist receivers.
- Denying the enemy the cover of darkness, space lasers bathe the night battlefield with light invisible to the enemy's unaided eye, but bright as moonlight to friendly forces equipped with special eyeglasses.
- Nuclear-powered satellites emit electric impulses that jam electronic systems, such as those that controlled Argentine air-to-surface missiles that sank a British destroyer during the Falkland Islands conflict.

The satellites, meanwhile, will not be sitting ducks. "Those in geostationary orbit, which include most military spacecraft, are relatively invulnerable," said Lt. Gen. Richard C. Henry (Ret.), former commander of the Air Force Space Division.

"If an A-sat [antisatellite] approaches, we can command a satellite to evade by moving it miles away, then move it back. Satellite circuitry is hardened against the radiation of nuclear explosion, known as an electromagnetic pulse. We provide elaborate defenses against frequency jamming and against tricking a satellite with false commands. And for many military satellites in orbit there's a spare parked nearby, ready to be brought on-line when needed.

"A revolution in missile delivery will come with the new Global Positioning System," continued General Henry. "Guided by these navigational satellites, missiles traveling thousands of miles will be able to pinpoint their targets within hundreds of feet."

Unlike satellite weaponry, spy satellites enjoy international protection. U. S.-Soviet treaties, politely calling the spacecraft "national technical means," permit them for monitoring arms-limitations compliance. They also guard against surprise attack or warn of military buildup in trouble spots around the globe.

Spy satellites possess awesome acuteness of vision. Some watch for the fiery trail of missile launches and the unique blasts of nuclear tests. Lower orbiters record scenes on film that is later released by parachute and snagged in midair by Air Force planes. While the camera resolutions are highly classified, nonofficial accounts say they can reveal Soviet license-plate numbers, and even distinguish uniformed personnel from civilians.

Secrecy shrouds most Soviet space operations. But free-world experts know much of that nation's immense space effort, partly because of the ingenious electronic snooping of Geoffrey Perry, a graying physics teacher at the Kettering Boys School outside London, and founder of the Kettering Group of amateur space observers.

"It's relatively simple to detect Soviet launches," explained Mr. Perry, pointing to a rudimentary school-top antenna. "Eavesdropping on their radio frequencies, my students and I simply wait to hear the chirpings of a newly hatched satellite. If the Russians encode its telemetry signals, we try, often successfully, to break the code."

WHAT DOES THE future hold for satellites?

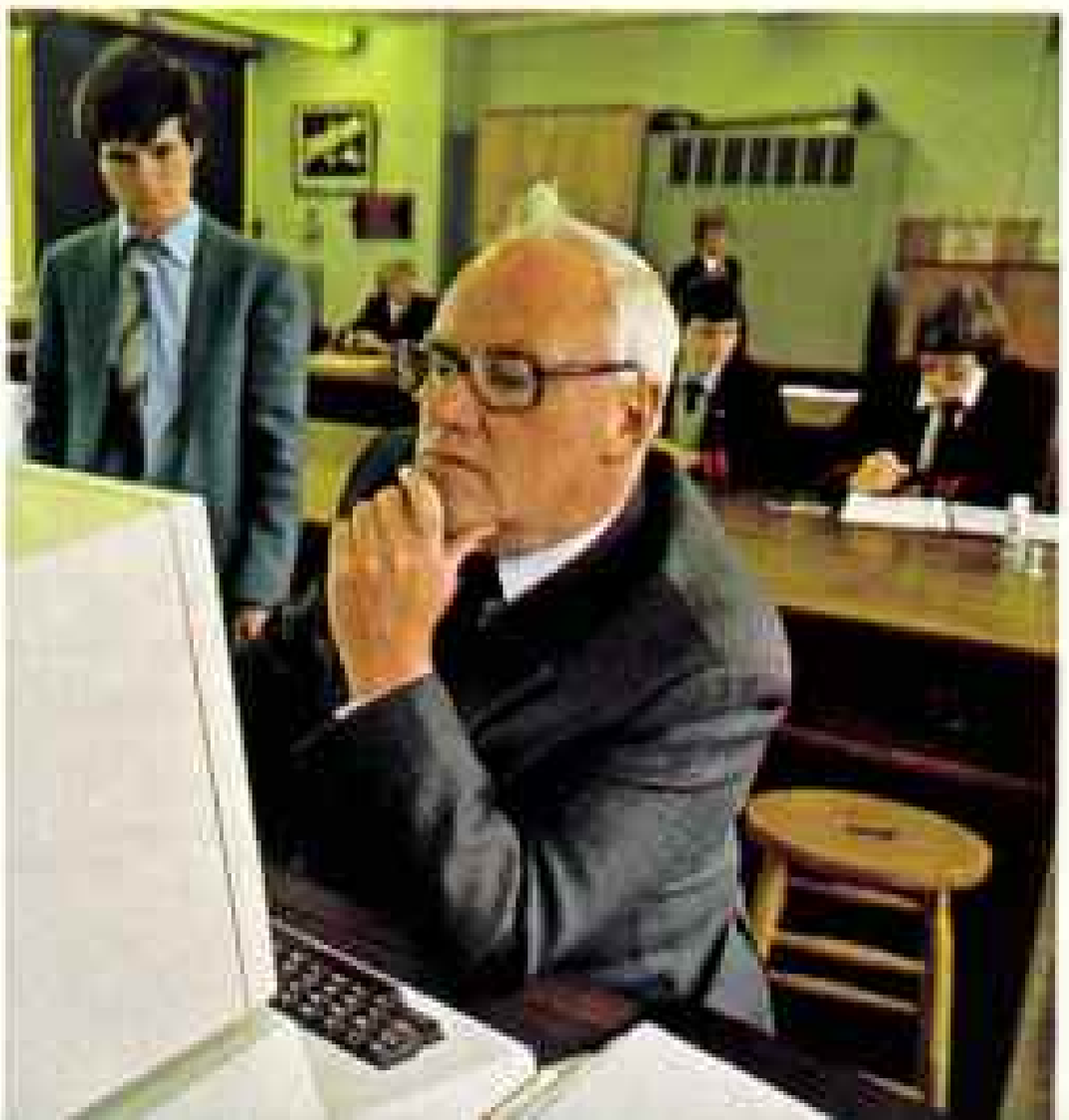
"The technology of satellites is advancing faster than any other," said Abraham Schnapf, RCA's veteran manager of satellite development. "Nowhere is this more evident than in communications. Higher frequency transmissions will permit more satellites to park in the geostationary belt; higher transmission speeds will dramatically multiply each spacecraft's effectiveness.

"Electronic mail by satellite is already becoming a reality. In 15 years satellites will relay alarms of house break-ins to your local police station—and disaster warnings to your wrist radio. And someday shopping services, library books, and perhaps the

BOTH BY O. LOUIS MAZZATENTA, NATIONAL GEOGRAPHIC STAFF

Eavesdropping, *a student at Kettering Boys School north of London tunes in on a broadcast from a Soviet weather satellite* ***(above)****. His 1938 receiver is the kind that was used by the British in World War II to find the frequency of the radio beams directing German bombers to British cities.*

Thus Geoffrey Perry, MBE ***(below)****, head of physics, introduces his students to the art of satellite tracking. "It's all detective work," says Perry, who has logged more than 14,000 satellite passes, "and it's good experience for the boys." In 1966 the space detective revealed to the world that the Russians were using a new launch site.*



Space record scorecard

*WHO'S ahead in the race? Though the Soviet Union has launched twice as many payloads as the U. S. (**right**), numbers don't tell the whole story. Soviet payloads include platforms used to boost satellites to new orbits. Some Soviet satellites have a useful life of only a few weeks, while most U. S. satellites are designed to function longer. Satellites eventually lose momentum, and therefore altitude. About 70 percent of the payloads shown at right have fallen into the atmosphere and burned up.*

Orbits, like satellites, come in different sizes. A satellite in a geostationary orbit stays over the same point on the Equator, a prime spot for weather and communications satellites.

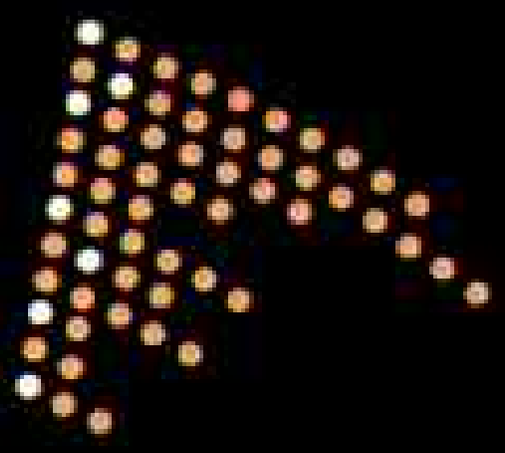
*Satellites tend to remain in an orbital plane defined by the latitude of their launch sites. Thus a satellite launched from an equatorial site, like ESA's Ariane (**above**) rising from French Guiana, will remain in equatorial orbit unless a correction is made. U. S. satellites launched from Cape Canaveral have a lesser inclination, or angle with the Equator, than Soviet satellites launched from higher latitudes.*

An elliptical orbit is useful for making scientific measurements—such as ozone levels—at various altitudes. In polar orbit, a satellite can observe the entire earth as the planet revolves beneath it. A sun-synchronous orbit, inclined a few degrees beyond earth's pole, permits an imaging satellite such as Landsat to make its pictures with the sunlight always striking the earth from the same angle.

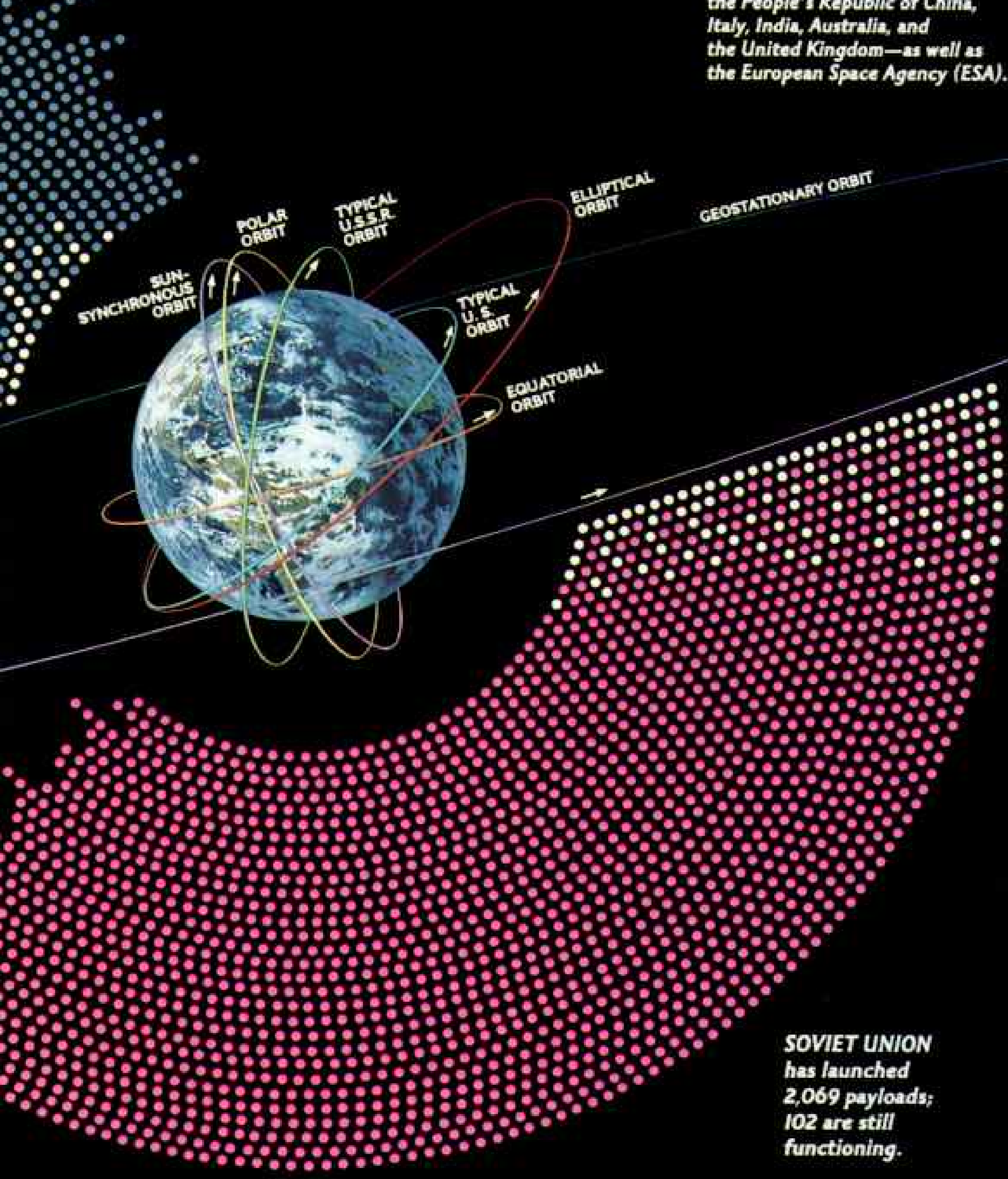
JAMES L. LONG ASSOCIATES (ABOVE); PAINTING BY LLOYD K. TOWNSEND

***UNITED STATES** has launched 997 payloads; 183 are still functioning.*

OTHER NATIONS and ESA have launched 59 payloads; 7 are still functioning.



In this schematic chart, the dots represent payloads launched successfully from 1957 through 1982. White dots show approximately how many are still functioning. In addition to the U. S. and the U.S.S.R., seven other nations have entered space—Japan, France, the People's Republic of China, Italy, India, Australia, and the United Kingdom—as well as the European Space Agency (ESA).



SOVIET UNION has launched 2,069 payloads; 102 are still functioning.

NATIONAL GEOGRAPHIC will arrive via satellite to your home TV."

NASA foresees major benefits from environmental satellites.

"They're invaluable to understanding the complete envelope of the environment—the complex interactions of the oceans, atmosphere, and polar regions," said Dr. David Atlas, chief of NASA's Laboratory for Atmospheric Sciences. "Only satellites can map the annual waxing and waning of the polar ice sheets, which have an immense effect on the atmosphere."

Satellites also will aid in "now-casting"—pinpointing locations of severe storms such as tornadoes before they strike.

NASA's Dr. A. Fritz Hasler, who developed one promising technique, handed me a composite image made from two satellites simultaneously. Peering through special stereoscopic glasses, I saw an ugly curd of clouds. "We call that a 'pig nose,'" said Dr. Hasler. "It's the top of the severe thunderstorm containing the tornado that blasted Wichita Falls, Texas, in 1979, destroying 4,000 homes. Stereo surveillance can help detect these in time to give warning."

Science in space will soar to a new plateau in 1986, when the shuttle hauls aloft a 12-ton orbiting observatory known as the Space Telescope. Big as a boxcar, it will expand man's vision in the heavens sevenfold, possibly to the very edges of the known universe.

Ironically, the technological revolution soon will spell doom for today's familiar, free-flying satellites. "They're too costly to

To attack...

KILLING A SATELLITE, U. S. style. In a system now being tested, an F-15 fighter fires a two-stage missile at its target. With telescopes for eyes, the 50-pound warhead adjusts its flight path for intercept.

Soviet style: a much heavier satellite, known as a hunter-killer, is boosted to the same orbital path as its target, closes in, and explodes. Using their own satellites as targets, the Russians have demonstrated this capability many times.

keep throwing away," said Ivan Bekey, NASA's director of Advanced Programs and Plans, "and too numerous to be serviced by the shuttle. Within two decades they'll be largely obsolete, little dinosaurs in space.

"In their place," he continued, "shuttle crews will assemble large platforms, each clustering many payloads powered by a central utility module. Some will point sensors toward the sun and stars, others will peer down at weather and earth's resources, and still others will provide automated laboratories for making pharmaceuticals, alloys, semiconductors, and other high-value materials best processed in zero gravity."

By 1991, if NASA's plans materialize, these platforms will be joined by a permanent manned space station. One of its prime missions will be to serve as a stepping-stone for massive, economical exploitation of the coveted geostationary zone.

"That's the high ground of space," explained Earl Cole of the space station program at Rockwell International Corporation, one of the eight aerospace firms under NASA contract to help plan missions for the next-generation space system. "The nation that develops the most efficient technology for moving mass into geostationary orbit will dominate space."

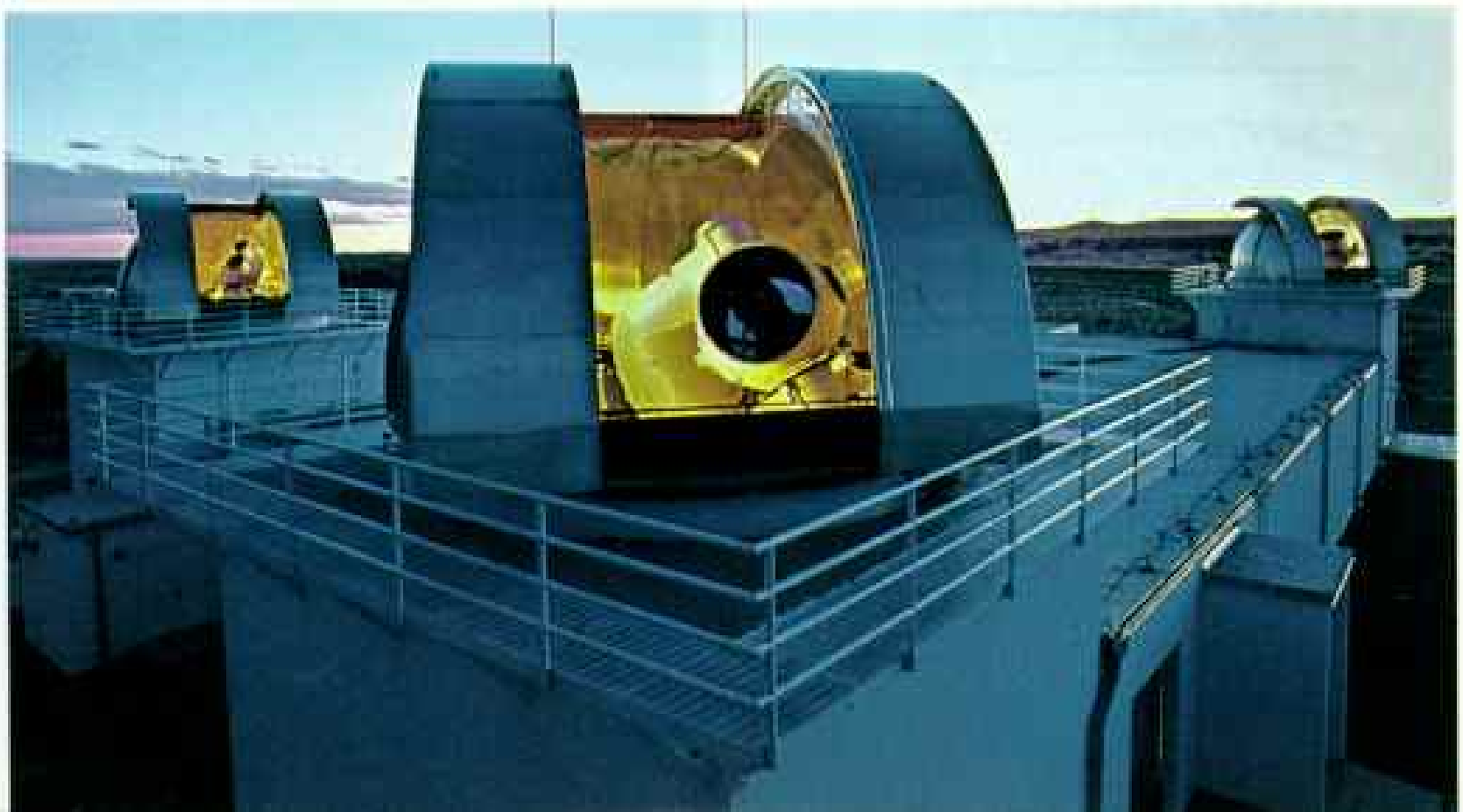
In most of the mission designs, modules destined for a geostationary berth ride the shuttle to the manned station, where they park for an electronic health check and deployment of their fragile antennas. Then the station crew loads the module aboard an

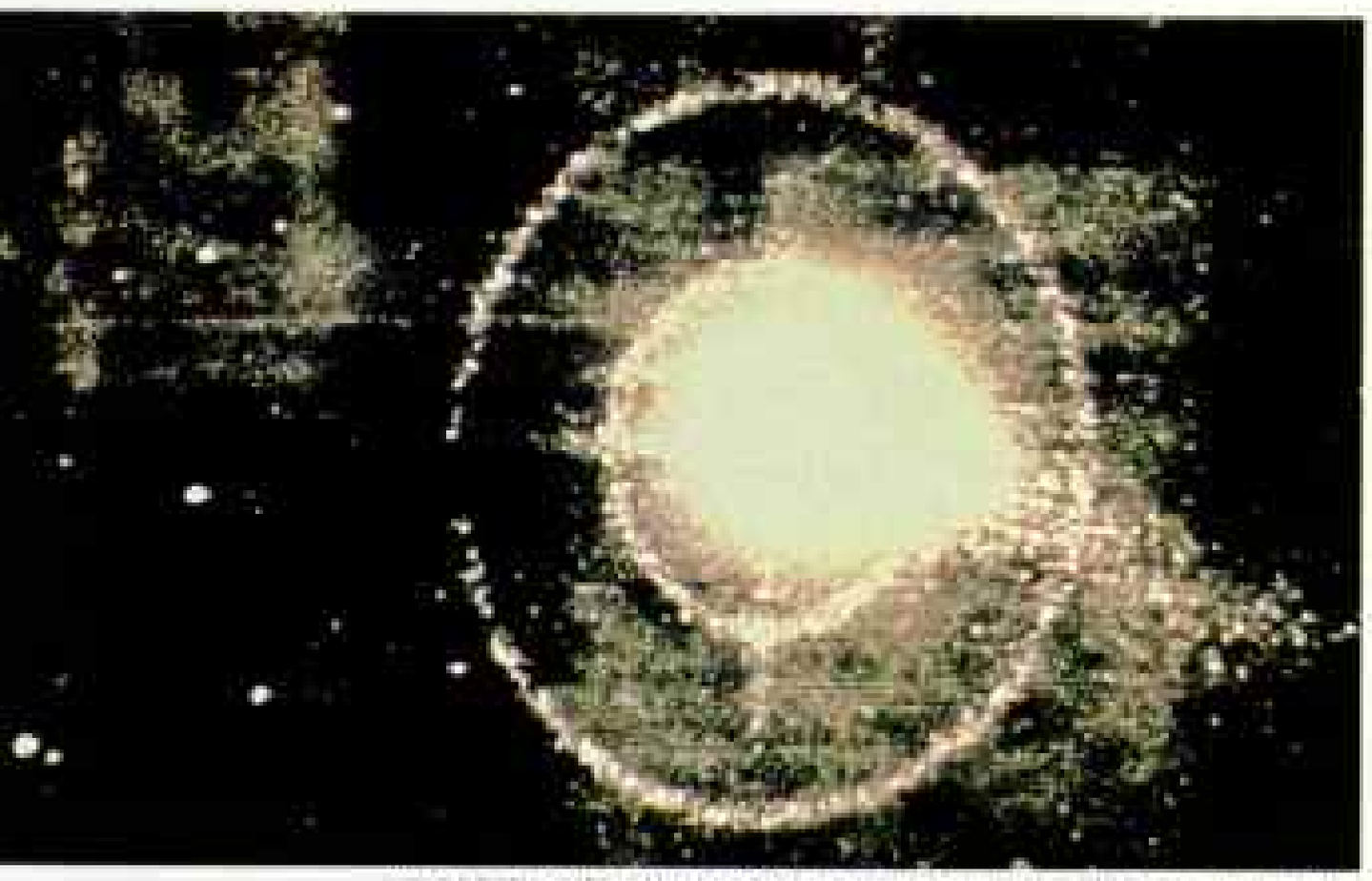
...to defend

FRUSTRATING an attack on its satellite fleet, the U. S. employs several options. Telemetry signals are encrypted and made jam-resistant by varying frequencies and other methods. The satellite's circuitry is hardened against radiation from nuclear blasts.

Using its thrusters, the satellite maneuvers evasively to another orbit, thus presenting its assailant with a new task. If a satellite is hit, a spare can take its place. Covert spares in deep space are also ready for duty.

PAINTINGS BY DAVID MELTZER





USAF NORTH AMERICAN AEROSPACE DEFENSE COMMAND (ABOVE); KERBY SMITH

The ultimate in sentries, *video display terminals* ***(left)*** *of the North American Aerospace Defense Command are cued to show the ultimate in threats, a missile attack on the United States or Canada. Shielded under a third of a mile of granite in NORAD's command center in a mountain near Colorado Springs, the terminals are electronically linked to U. S. defense satellites, optical tracking systems, and ground-based radar stations.*

In addition to this primary mission, NORAD keeps track of man-made objects in space, from spent rocket boosters to orbiting debris. The count as of June 20, 1983: 4,914.

Some 1,400 people staff NORAD's mountain redoubt, a complex of 15 steel-sided buildings mounted on hundreds of steel springs each weighing 1,000 pounds. Shock absorbers under the buildings are designed to minimize vibration from nuclear attack. In an emergency, 25-ton steel doors would slam shut in 30 seconds, and the complex could sustain itself for a month.

*The latest in space surveillance equipment, NORAD cameras at a site in Socorro, New Mexico (**far left, bottom**), can locate and track an object the size of a soccer ball 20,000 miles away. The cameras are a million times more sensitive to light than the human eye.*

*When Cosmos 954 flamed toward earth on January 24, 1978, an optical sensor on Maui in the Hawaiian Islands photographed the stricken Soviet satellite (**left**) a few minutes before impact in Canada's Northwest Territories.*

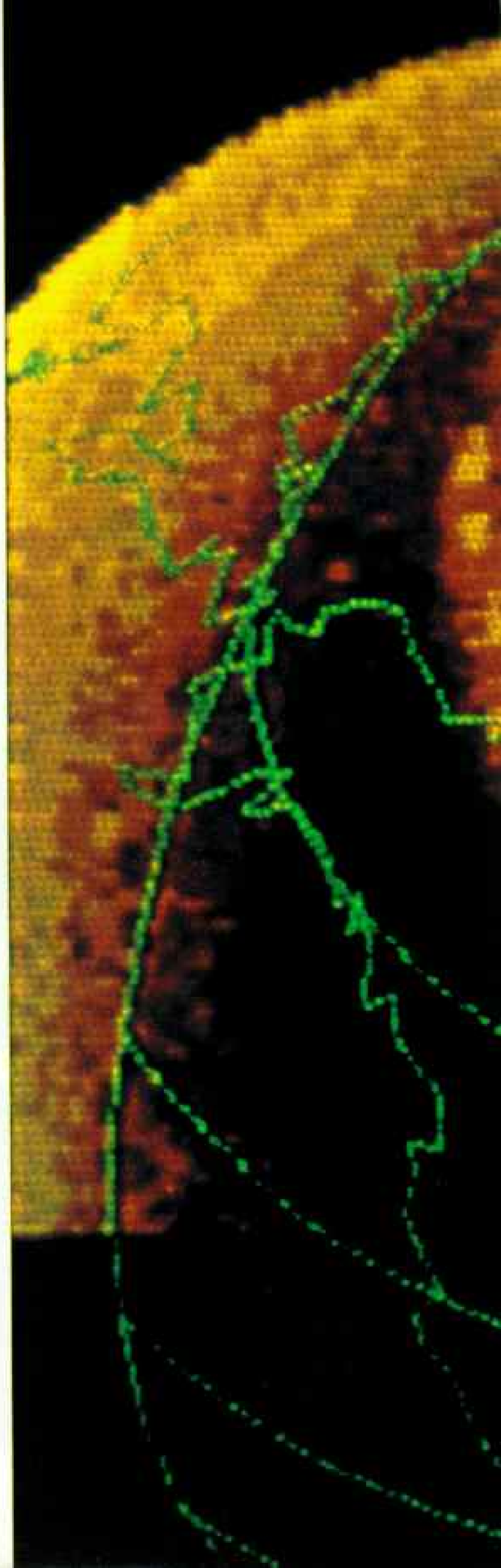
unmanned orbital transfer vehicle (OTV) for relay to a platform abuilding in the geostationary belt. Automatically plugging the module into the platform, the OTV returns to the manned station to be reused, eliminating virtually all of the 30-million-dollar cost of using expendable rockets to boost satellites into higher orbit.

This rush to the geostationary zone comes as no surprise to its farsighted advocate. "Someday," mused Arthur Clarke over coffee and croissants during a United Nations space conference in Vienna, "the zone will be a solid ring of structures, housing thousands of devices to serve mankind. There will be enough radio capacity up there for the whole human race to pair off and talk with itself. As the Russian engineer Yuri Artsutanov prophesied, someday we may ascend to the ring by elevator, riding cables reaching like an Indian rope trick 22,300 miles high."

The scramble to share in the great space rush is reflected in the budding competition to provide launch facilities. The European Space Agency, vying with the space shuttle, has signed up several U. S. satellites to ride its rocket, the Ariane. Several private U. S. corporations, using off-the-shelf rocket components, hope to be able to launch commercial satellites for much less than NASA charges.

There's room for all. Delays in the shuttle and early failures of Ariane have generated a waiting line of satellites that have purchased tickets to space but have seen their flights postponed.

The multi-ring satellite circus is only beginning, and it's a spectacle we on earth can observe. On a clear evening, when darkness settles about your home, go outdoors and peer into the sky. In a few minutes you'll probably notice that one of those tiny golden "stars" is slowly moving. It will be an obedient electronic servant in space, orbiting on high to improve the lives of all of us. □



Earth wears a halo *in this remarkable image of the aurora borealis, the northern lights, made by an ultraviolet camera aboard Dynamics Explorer 1. The bright crescent is a portion of the sunlit side of the planet.*

NASA/L. A. FRANK, UNIVERSITY OF IOWA

ALASKA'S FAR-OUT ISLANDS

The Aleutians

By LAEL MORGAN

Photographs by STEVEN C. WILSON

ENTHEOS

THE SPLENDID wilderness of volcanic peaks ahead was represented on an Alaskan map as an "unknown area," and seas that separated us from the island of Attu were veiled in a rich lace of spindrift.

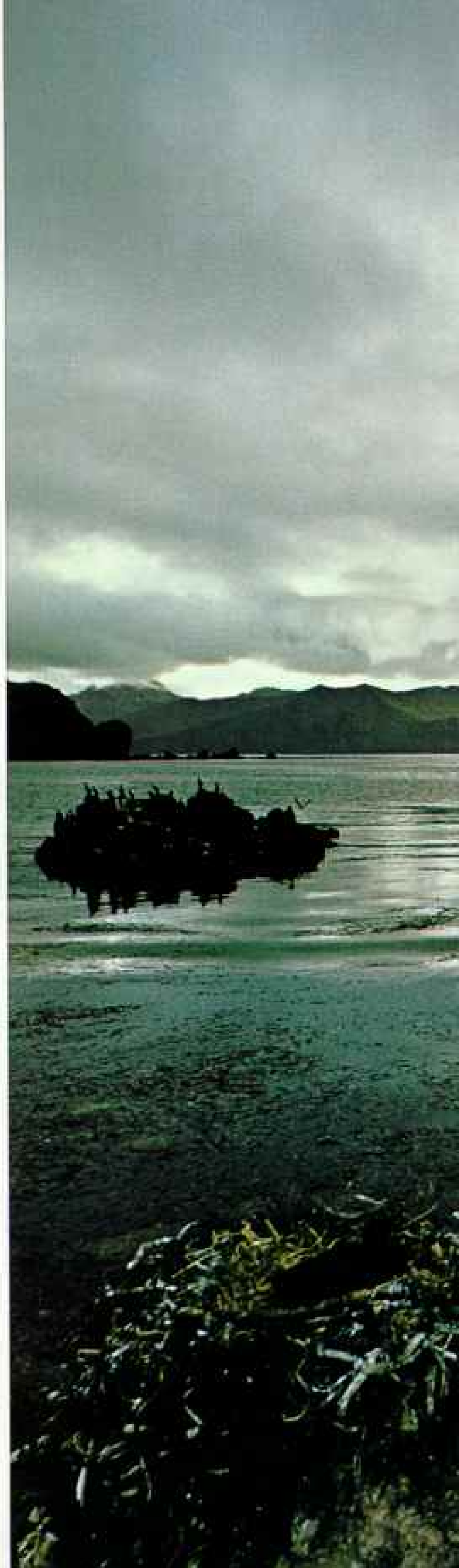
"Isn't it magnificent?" I yelled over the roar of the old Electra prop plane to the Coast Guard novice who had been my seatmate on the six-hour flight from Anchorage.

"The guys tell me this is America's Siberia," he observed dubiously.

Our destination was the 24-man loran station on the westernmost of the Aleutian Islands—the most remote bits of land in the United States, the farthest west extension of the North American Continent and the farthest east, too, because in mid-sweep the archipelago crosses 180° into east longitude (map, pages 340-41).

"It's not the end of the world, but you can see it from here," quipped an old hand across the aisle. "Still, if you like extremes . . . lousy weather, tidal waves, earthquakes. . . ."

I understood these reservations, and yet this graceful island arc, wedged between the fearsome North Pacific and the storm-wracked Bering Sea, is to me the most fascinating place on earth. A stepping-stone chain between continents and the longest network of active volcanoes in North America, the Aleutians are so little



Stirring a tempest *in a lonely outpost, raucous seabirds nest each summer on the kelp-rich shore of Unalga Island in the Aleutian archipelago. A glaucous-wing gull, startled from its nest, overflies a cormorant guarding its young.*

Breeder of storms, *the frigid Bering Sea meets the warmer Kuroshio (Japan Current) in the Aleutian arc, making unpredictable foul weather. Hundred-mile-*

an-hour williwaws blast treeless slopes with horizontal rain and snow. Fog, here rolling over Unalaska, can become so thick that fishermen can't see their boots.

known that whole mountain ranges go unnamed and unexplored. Seabirds—puffins, murres, fulmars, kittiwakes, cormorants, and many other species—mass in these islands by the hundreds of millions. Bald eagles are more common than ravens.

Valuable fur seals and great whales favor island passes on their annual migrations. Perhaps the world's largest concentration of marine mammals is found here: vast colonies of sea lions, seals, and sea otters. Plankton, tiny marine plants and animals that are the basis of the ocean's food chain, thrive in record numbers. More than a million metric tons of pollack, sole, cod, halibut, and salmon are caught in the Bering Sea annually, as well as an enormous tonnage of shellfish.

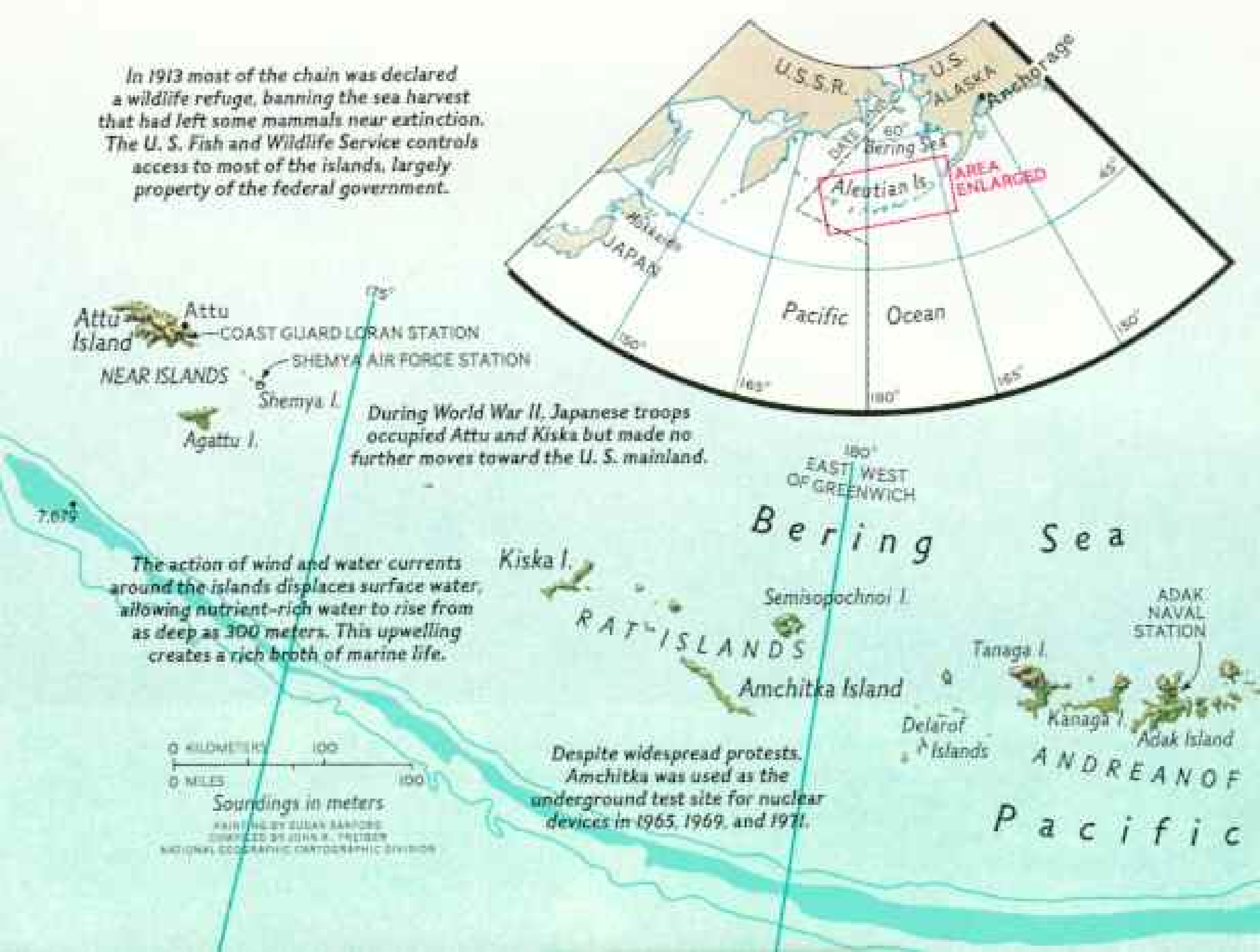
FOR MORE THAN A DECADE I have traveled this area as a journalist in the company of Aleut subsistence hunters, remnants of a people that once lived throughout the archipelago but who now occupy only five of its 124 islands. The amenities of civilization are often hard to come by here, but there is a compensating closeness between families and with nature.

Sailors warn that the Aleutians have the world's worst weather, and most visitors, exiled to remote military outposts, are justified in their tales of bitter hardship.

"These islands are one of the most beautiful spots in the world," said James Bush, a World War II veteran of Attu, where weather caused more casualties than enemy fire. "But you must forgive me if I also see them as death. I think of the young kids, like these running the Coast Guard station today . . . who never got to come home."

American casualties in the 1943 Battle of Attu exceeded 3,500, some 2,100 by exposure. In 1981 the Veterans of Foreign Wars asked that Congress give national recognition to their sacrifices. Still the ground remained unmarked, save for memorials left by families of Japanese who died there. I had asked Jim Bush, who played a major role in that conflict, to return with me to Attu (page 342).

The author draws on long familiarity with the Aleuts for her portraits of the isles and people (March 1973 and October 1974 GEOGRAPHICs). Wildlife and wild places are a specialty of photographer **Steve Wilson** (February 1981).



Although it was spring, the light rain of early morning thickened to snow and began falling sideways, driven by a stiff Aleutian wind. The battlefield, still pockmarked from bombs, mortar fire, and hastily dug entrenchments, was an uphill march.

Bush, 73, lapsed into uncharacteristic silence as he led the way. In his old GI jacket and carrying a battered rucksack, he looked much as he must have under fire on a morning four decades earlier, on May 29, 1943.

After almost three weeks of bitter fighting, the Japanese had been forced to retreat. Jim Bush awakened early to direct road building necessary for the final assault.

Then, in one last desperate attempt to seize U. S. supplies and weapons, a banzai force of about 800 charged Bush's encampment of 600 Americans.

"We engineers hadn't thought that we'd have to fight. They killed about 80 of our people, and they just didn't stop coming. You had to give them credit. They were fanatic but brave.

"The first man I shot, I knew I killed him because I saw the shot dent his coat, and I was elated. But later. . . ."

Later, as a civilian, Bush had returned personal effects to the family of the Japanese officer, and learned that he had been an engineer like himself. Bush was haunted by similarities in their backgrounds.

"Do you know the poet Sir Henry Newbolt?" he asked me.

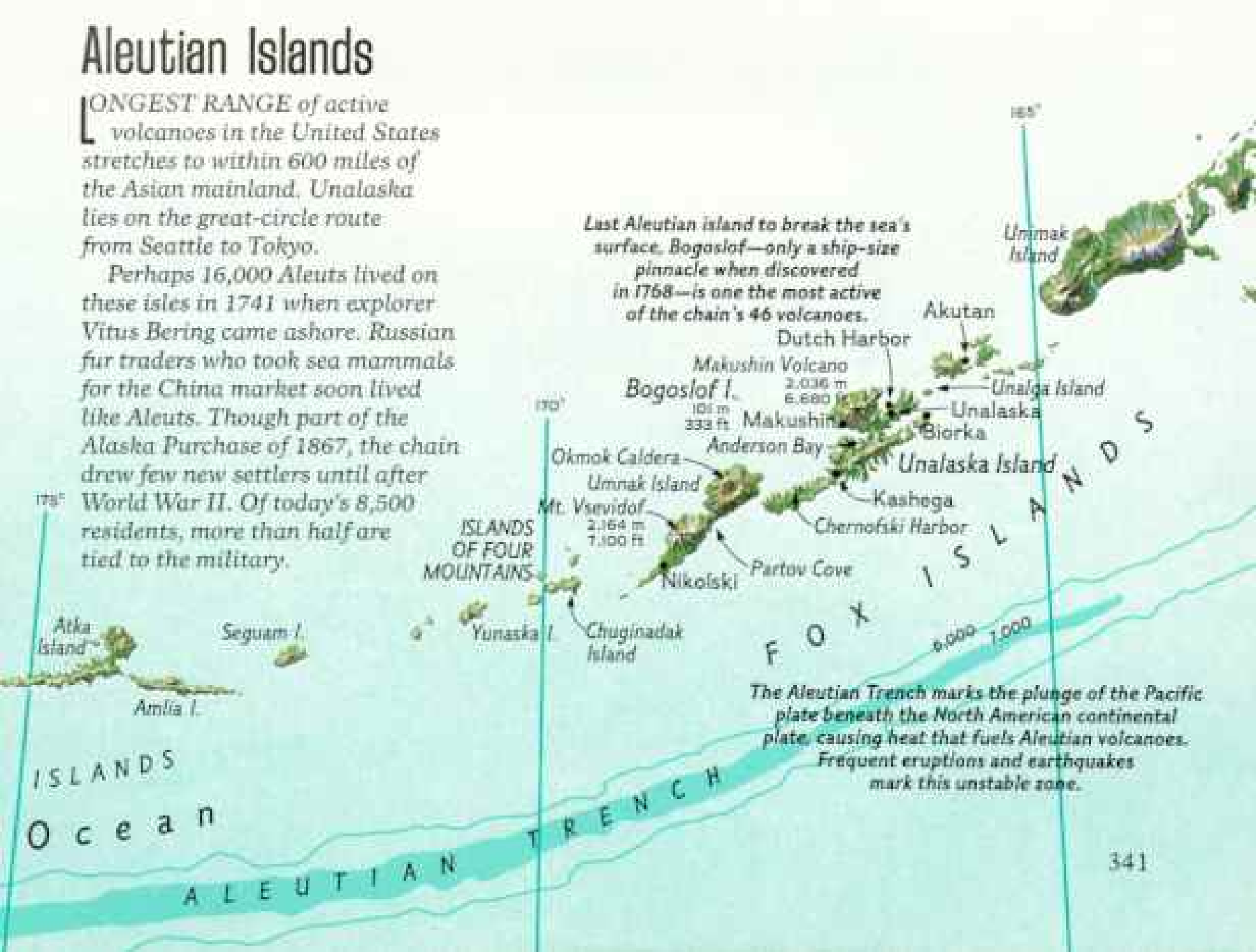
To count the life of battle good
And dear the land that gave you birth,
And dearer yet the brotherhood
That binds the brave of all the earth.

Nor was Bush the only survivor thinking in those terms. A week later on Unalaska, I attended the dedication of a monument to those who had died in the Aleutians campaign. It was a different place from the one I had seen on my first visit in the early 1970s. Then the once proud center of the Aleut nation was struggling to survive. Local industry was virtually nonexistent. Dutch Harbor, the magnificent port that fronts the settlement, stood idle, surrounded by a welter of abandoned military installations, which Aleuts were forbidden to scavenge or clean up because the government had not decided the future of the base.

Aleutian Islands

LONGEST RANGE of active volcanoes in the United States stretches to within 600 miles of the Asian mainland. Unalaska lies on the great-circle route from Seattle to Tokyo.

Perhaps 16,000 Aleuts lived on these isles in 1741 when explorer Vitus Bering came ashore. Russian fur traders who took sea mammals for the China market soon lived like Aleuts. Though part of the Alaska Purchase of 1867, the chain drew few new settlers until after World War II. Of today's 8,500 residents, more than half are tied to the military.



Now waterways teemed with freighters, fishing boats, and oil-exploration vessels. New buildings and docks stood among military ruins. Unalaska village had become a city of 1,300, annexing Dutch Harbor in 1965 to rank among Alaska's fastest growing communities.

The World War II airfield remained in use, and it was here that several hundred turned out in June 1982 to dedicate the simple granite monument to "those who suffered and knew the pain of war." Behind it four flags snapped on angry winds: Alaskan, United States, Canadian, and Japanese.

Two Japanese veterans, Adm. Hiroichi Samejima, who led the first flight of torpedo bombers against Dutch Harbor in 1942, and Zenji Abe, commander of a lethal dive-bomber attack, were accorded a cordial, if restrained, welcome (following page).

Zenji spoke in memory of four of his pilots who died. Samejima expressed hope that our governments would never fight again. An American officer chose to forget an opening remark that "there is no glory in war" and discoursed on it as a character builder.

Only then did Aleut spokesman Agafon Krukoff step forward. "Let us never say war was good for us. It cost us quite dearly. And the question of whether the Aleuts in Japan were treated better than those in the [American] camps is a sad one to be asking."

THE MISTREATMENT of Aleuts in World War II was heartbreaking. Only 21 of 42 captured at Attu survived Japanese imprisonment on Hokkaido. But those who escaped the invaders fared little better at the hands of their countrymen.

Ordered from the chain with only such possessions as they could carry, the refugees—U. S. citizens all—were interned as government wards at abandoned canneries in southeastern Alaska. Conditions varied from camp to camp. In some, few had a chance to work for wages, and government officials responsible for their care showed little concern. The press took scant notice.

Welfare assistance consisted of a diet that was sadly inadequate by any standard, plus cast-off clothing and overcrowded, uninsulated housing without plumbing. In some cases the death rate from illness, malnutrition, and lack of proper medical attention was more than 10 percent—and even higher among the elderly, a blow for those who ultimately returned home to pick up the pieces of their shattered culture.

Nor was there much to return to. Homes, boats, family heirlooms had been vandalized by occupying U. S. troops. Fishing waters were fouled by debris from military transports, herring spawning areas filled in by military builders. While the government cleaned up war ruins and granted economic

*"**I still see kids** bloody, shaking, freezing, and being blown apart," said engineer Col. James Bush (**facing page**), visiting the World War II battlefield of Attu. In May 1943 some 16,000 ill-equipped, desert-trained Americans fought for three weeks to recapture the westernmost Aleutian island from 2,600 Japanese occupiers. After Bush and his road builders stopped a banzai counterattack, the surviving Japanese committed mass suicide. A dump for shell casings (**above**) remains near the Coast Guard loran station.*

COLLECTION OF ERNEST G. LEET (ABOVE AND LEFT)

NATIONAL ARCHIVES

Full-scale armada *of U. S. battleships, cruisers, destroyers, minesweepers, and transports—with an invasion force of 34,000—massed at Adak in August 1943* ***(above)*** *for assault on Japanese-occupied Kiska. Only after landing did Americans learn that the 5,000-man garrison had been evacuated weeks earlier. Soldiers examine a base for midget submarines* ***(lower right)****. Among the personal effects left behind were rolls of exposed film, later developed by the Navy* ***(top right)****.*

The Aleutians campaign was more than a sideshow. Alaska was of great strategic importance, as Gen. Billy Mitchell had warned. When Japan prepared to attack Midway, it opened battle by bombing Dutch Harbor on June 3, 1942, hoping to draw the Pacific Fleet north. After the Midway thrust failed, the Japanese landed on Attu and Kiska to forestall their use against the homeland. The U. S. spent 14 months and hundreds of lives—most lost to weather and disease—in liberating the islands. Amphibious invasions here taught lessons applied later in the war.

Former combatants ***(left)*** *recalled the bloody struggle at a Dutch Harbor ceremony in 1982 honoring all "those who suffered and knew the pain of war." Veterans of the initial air strike, Comdr. Zenji Abe, far left, and Adm. Hiroichi Samejima offer sake and a wreath at the memorial whose words were written by a local schoolgirl.*

aid to those we had defeated, little consideration was accorded the Aleuts.

Before the coming of the white man, the Aleutian chain was one of the most densely populated parts of Alaska, and those who occupied it were among the most advanced of aboriginal settlers. Exploiting the phenomenal richness of their seas, Aleuts enjoyed an unusually high standard of living. They developed art, music, and a knowledge of medicine that included surgery and mummification.

They were, however, no match for well-armed Russian *promyshlenniki*, ruthless fur traders who followed in the wake of Vitus Bering's discovery of this new world in 1741. Aleuts who resisted enslavement were killed, their numbers reduced from perhaps

16,000 to 3,200, and their culture was drastically altered.

The United States, which purchased the Alaska Territory in 1867, licensed outsiders to hunt (to near extinction) the sea otters and fur seals on which Aleuts had long depended for their livelihood; then, in an attempt to repair the damage, declared most of the chain a refuge, withdrawing all but subsistence

Children of two continents, *descendants of Russian-Aleut intermarriages form the remnant Aleut population. In Nikolski, last of 22 native villages on Umnak, Paul Merculief, priest of the Russian Orthodox church, intercedes with officialdom and acts as a father figure to 11-year-old Billy Dushkin, who lost his father to a storm.*

***"When the tide goes out,** the table's set" goes a common expression among Aleuts, who harvest the Bering Sea shore for such delicacies as sea urchins, octopus, clams, mussels, and chitons. Billy Dushkin holds a salmon that he caught. At his family's*

hunting privileges for the native people.

Codfish and herring industries provided an economic base after the turn of the century. Fox farming became lucrative in the 1920s, but after World War II the fur market collapsed, and fox farmers were forced to return to subsistence hunting or travel hundreds of miles to work for wages. Opportunities for private enterprise were slim. Federal agencies claimed 95 percent of the chain as refuge or military sites.

The villages of Biorka, Kashega, Makushin, and Attu became preselected ghost towns. In the face of decreased population resulting from the war, the government decided to force abandonment of these isolated settlements by not reopening their schools and by discontinuing mailboat service. And for the next decade the Atomic Energy Commission used Amchitka Island in the heart of the chain as an underground testing site for nuclear devices 250 times more powerful than the Hiroshima bomb.

REWARD for the Aleuts' forbearance came when they joined other Alaskan natives in a petition to the U. S. Congress, seeking recognition of aboriginal title to territory they had occupied for centuries. In 1971 they were given lands in and around their villages—1.3 million acres—and 38.2 million dollars in cash. The award

summer camp, a traditional dugout for protection from high winds, he chops driftwood for a cooking fire. Most residents of the islands practice subsistence living to some degree since seafood and waterfowl are readily—and enjoyably—available.

was made through village and regional corporations, with recipients serving as management and stockholders. This recognition helped counter the Aleuts' minority status, sparked a resurgence of pride, and gave them a role in the business world.

"I never really thought about being Aleut until I was forced to make a choice about being native [to register] for the claims settlement," recalls Shirley Shaishnikoff Girard.

"I thought about the people I admired most, the ones who impressed me with their way of thinking, like my good father and my grandmother. They were all Aleuts—Russian-Aleuts. That was my way of life."

Aleuts had barely begun to implement the new lands venture when along came another problem in the guise of a bonanza, a record-breaking fishing boom that made the chain one of the hottest economic areas in the nation. In 1975 the Aleutians were not even mentioned on the National Marine Fisheries Services list of top ports. But some 1,000 miles to the east, crab stocks were being depleted around the processing center of Kodiak. As a result, fishermen began exploring resources along the Aleutian chain, and one year later Dutch Harbor replaced Kodiak as the number two port of the nation in the dollar value of seafood landed—$48,000,000 in crabs alone. In 1978 it became the top money-making fishing port in

Safe haven *in the blustery Bering Sea, Dutch Harbor lights up on a clear winter evening. Capital of the Russian fur sealers, stopover for prospectors during gold-rush days, Unalaska thrives now as supply station for transients—fishermen, oil-exploration crews, and scientific research teams. A dozen fish-processing plants, including the U.S.-Japanese UNISEA ship, center, convert to whatever is being caught. The population of about 1,300 swells when hundreds of fish packers come from the lower 48 during the busy season.*

North America. Crab fishing proved so lucrative that many inexperienced crewmen of crab boats found themselves earning $10,000 before lunch.

Yet not many Alaskans profited by the boom. The few Aleuts who owned fishing boats did well, but the bulk of the fleet and its processors were based out of Seattle, and nonresident job seekers flocked to the area.

Suddenly there was no housing and hotel space. Some 200 transient "beach people" squatted in dilapidated Quonsets and barracks hoping to find work. Crime rates

doubled and redoubled. Immigration and labor laws were often ignored. Government regulating agencies were slow to move in. The state of Alaska, charged with enforcing fishing regulations, provided only limited use of an undersized enforcement vessel. There were no local agencies to concern themselves with boating disasters, frequent oil spills, and the dumping of crab waste from dozens of processors.

Worse yet, the locals found themselves overrun politically. Akutan, a village of 70 Aleuts 40 miles northeast of Unalaska, discovered it had no power to tax or control processing boats that housed some 800 migrant workers in its small harbor. Unalaska did have the power to tax, but its government was controlled by the fishing industry, and Aleuts were outnumbered five to one on the city council.

Unalaska residents, estimated at 500 at the beginning of the rush, soon numbered more than 1,000, and the population often swelled to 4,000. Yet, within the mushrooming boomtown, the Aleut community made itself felt. By 1980 Aleut corporations

endowed by the claims settlement controlled most private land on the chain. Despite pressure, natives adopted a conservative land-lease and building program that helped slow the boom. The rush for jobs, housing, and services was still on, though, when I returned in the fall of 1981.

I arrived just before the season started, when the most conspicuous feature of the Unalaska landscape was a ground cover of stored crab pots. At Captains Bay near an abandoned turn-of-the-century gold mine, acres of metal-framed traps were piled 14 deep. "They're the *real* mine," observed my friend Kathy Grimnes, who served as chairman of the Ounalashka Corporation, which leased pot-storage areas.

And it was a growing business. The crab fleet had increased from 130 vessels in 1978 to 236 and operated with such frightening efficiency that some feared it would destroy the resource.

"We have the capacity to set a crab pot [which will hold several hundred crabs] every three minutes, 24 hours a day, until you drop," skipper Mike Palmgren told us.

Competition grew so fierce that the Bering fleet fished in the worst of weather. A dozen or so men were lost each season and many more injured. But the industry was grossing more than a hundred million dollars annually.

Former transients were settling into Unalaska at such a startling rate that the annual city budget rose from $350,000 to $11,000,000.

WANTING TO TOUCH BASE with the past, I flew to Nikolski, on the neighboring island of Umnak, which remained unaffected by fishing bonanzas because it lacked a harbor. With 45 residents, almost all of whom met us as we arrived on the weekly mail plane, Nikolski was the ideal environment for the traditional subsistence way of life.

Dorofey "Rusty" Chercasen, village council president, escorted us to the community center where we were to stay. Villagers had built the hall themselves. "Our new houses will be ready soon too," he reported.

"Did you get to put them where you wanted?" I asked, recalling the meeting a year earlier when a representative of the Aleutian

Best crop of a fickle sea *during 1982 was pollack* ***(above)****. Captain of the Morning Star David Stanchfield spent more than half a million dollars adapting his crab vessel for mid-depth trawls. A single net with 45 tons of fish is usually lifted directly into a mother ship for processing.*

Profits on pollack and cod are low compared to crabs—so plentiful in the late 1970s that scores of Seattle-based vessels came to work the Aleutians. Dutch Harbor became the top money-earning port in the U. S. before the crab population crashed. Hundreds of crab pots are stored in the off season ***(right)*** *at a former military base, now mostly owned by the local Aleut corporation.*


NO TRESPASSING
KEEP OUT

Housing Authority explained that they could not all have preferred locations because part of their village was on a valuable archaeological site that must be protected.

"No, that's a crazy deal," he said.

No one doubted that the site was important. Digs had already established that it had been occupied some 4,000 years. The oldest known settlement of the Aleut world, dating back 8,750 years, had been excavated at Anangula Island, four miles offshore. Caves on the neighboring Islands of Four Mountains had produced a trove of mummies wrapped in furs and meticulously woven grasses. And digs at the Chaluka site in Nikolski village had verified historical accounts of a massacre of Russian fur traders by Aleuts in 1764.

A SHEEP RANCH once provided a fair economic base for the village but had fallen on hard times with a decline in the wool market. The Nikolski village corporation purchased it with money from its land-claims settlement, but the sheep hadn't been sheared in two years because villagers couldn't agree on management strategy. And because of scant employment, most young families had moved away. Nikolski was declining economically and in size.

Still there was good news. When it was discovered that Nikolski people didn't earn

TIM THOMPSON

Largest settlement in the Aleutians, *the naval station at Adak, an antisubmarine patrol base, offers its 4,500 people a modern community with family quarters* ***(left)****. At a Filipino-American festival held each September, youngsters at the base perform traditional dances* ***(above)****. To 100,000 World War II troops the Aleutians were horrendous men-only stations.*

enough money to qualify for badly needed federal low-income housing, Father Paul Merculief, their Russian Orthodox priest, cleverly calculated the dollar value of fish, seals, sea lions, and geese on which they subsisted and reported that as income. Nikolski people conscientiously met the average monthly housing payments of about $110 per household with income from occasional jobs, social security, and welfare.

Despite the new building program, the school was in danger of closing because the number of younger residents had declined and the student body threatened to fall below a viable minimum.

The prospect of no school was good news to Billy Dushkin, who'd been waiting patiently with his dog, Bubbles, to take us to camp. Like any self-respecting Aleut, Billy prefers to be out of doors, and at age 11 he is a thoroughly competent guide.

In light rain we hiked five miles to Sandy Beach, an encampment of *barabaras*—underground sod houses like the ones Aleuts used to build—where Nikolski people preserve their heritage.

"Good to be out of town. I don't ever like to go back," Billy said. "Let's hunt seals."

Later, in the glow of an old kerosene lamp at the Dushkins' snug camp, Billy recounted the wonders of a recent class trip to Seattle . . . of the Tropics Motel with its huge

swimming pool, of the Space Needle. "My mom might take me back there to live for a while so I can go to high school."

Would he return afterward?

"For sure. But I don't know what's going to happen to Nikolski. There's no more young people in the village."

What did he want to be?

"Well, I wouldn't mind being a sheep rancher for a while . . . herding sheep, tying wool . . . like my dad. . . ."

Conversation faltered. Billy's father had disappeared with the Nikolski mail plane and its pilot a few months earlier. But Billy covered his grief, busying himself with being a good guide. His mother had given him permission to use his dad's .22 rifle, and he proudly took the weapon from its storage space in the hunting camp to inspect it.

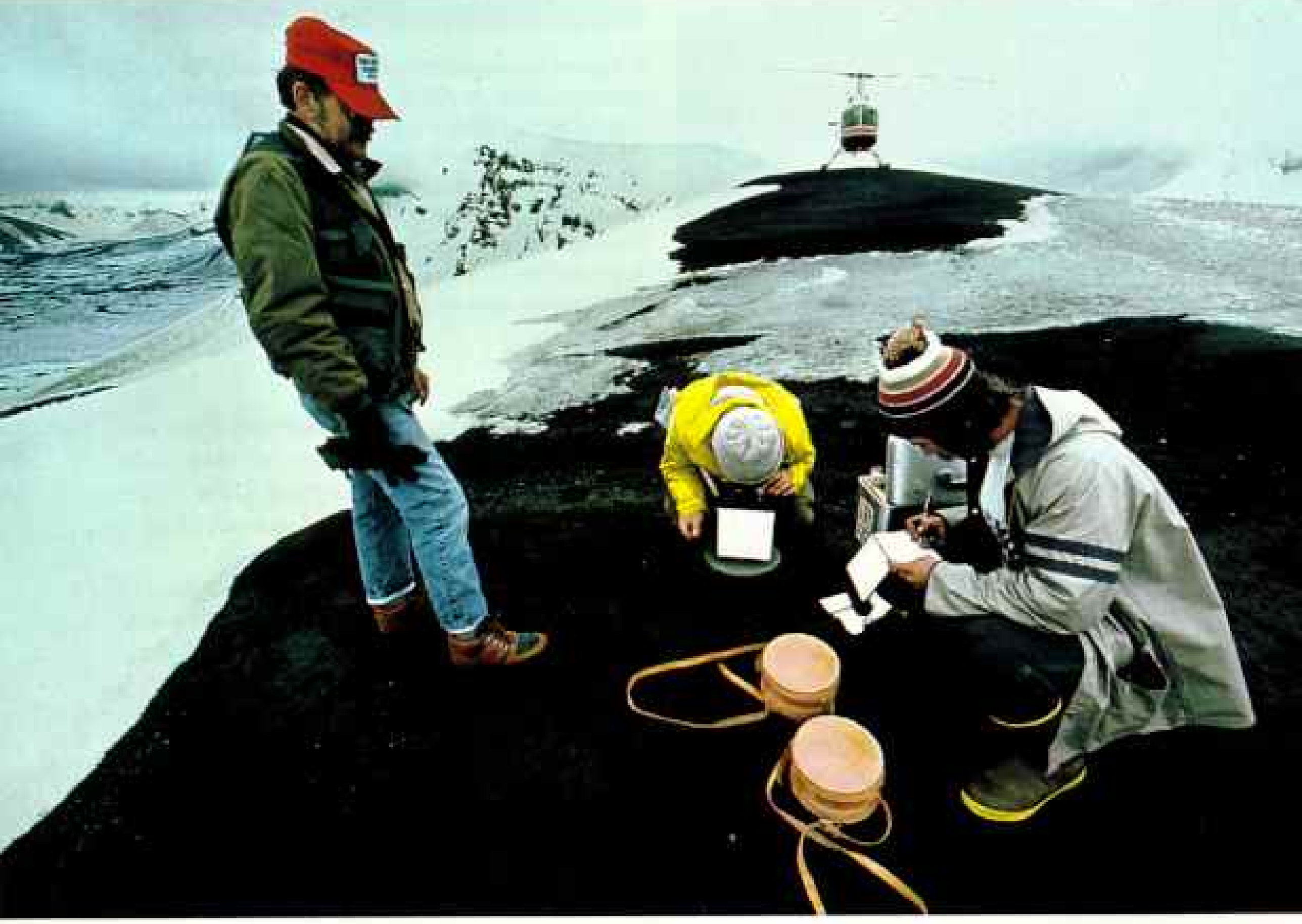
Little Nikolski was not alone in troubled times. Bigger Unalaska was suffering a giant headache. In 1982 I returned there to discover the crab boom was dead. At the start of the season the state Fish and Game Department had predicted a poor harvest.

"The crews of the research vessels were so shocked at what they found they double-checked their survey," recalled biologist Ken Griffin. "But industry refused to believe the results. Fishermen kept insisting the crabs were there."

Actually, it was worse than predicted. Less than a fortieth of the 1980 catch had been taken when the season was closed by emergency order.

The cause of the crash is debated. Some fisheries experts hold that rising temperatures of the Bering Sea hampered breeding; others blame predation by record numbers of cod. Flagrant overfishing because of

Searching for energy, *Dr. John Reeder, center, studies the geothermal potential of Okmok Caldera on Umnak Island. David Edge takes gravity readings, as pilot Mike Arline observes. When Reeder tries to explain his reports in Nikolski, Willie*



ineffective regulation is also mentioned.

"Some are saying, 'I'll wait till the crabs come back.' Well, their grandsons will probably be there when they come back," predicted Clem Tillion, chairman of the North Pacific Fishery Management Council.

The future now lies in bottom fishing for pollack, cod, and related species, Tillion says. This resource, valued at 250 million dollars annually, had gone mainly to foreign fleets until 1976, when the U. S. set a 200-mile limit to exclude outsiders once Americans gear up to replace them. Government agencies now encourage joint ventures by U. S. fishermen and foreign processors.

"HOW DOES the weather look?" I asked John Rosenthal, mate of the *Neahkahnie*, as we set out to fish pollack for a processing Japanese mother ship.

"What's that got to do with it?" he growled. "I tell my crews, you'll make as much as $53 an hour, 24 hours a day. During one five-day period they never got out of their rain gear. Our job is to kill fish. Here they are, and they won't be here next week."

The 109-foot vessel was designed for bottom fishing as well as for crabbing. So owner Frank Bohannon was able to enter this market without the expensive gear conversion needed to adapt most crab boats to trawling.

In 1979, the year *Neahkahnie* was launched, Bohannon landed one of the highest catches of any fisherman in North America. Although he continued to do well, the fact was that while crabs paid two dollars a pound, pollack was currently selling for 5 to 7 cents, if you could get foreign buyers to honor their agreements. Bohannon recently sued a Korean firm for breach of contract.

*Talanoff (**below,** center) questions why they aren't written "so we can understand," while Myron Merculief takes it all in. Reeder believes Unalaska holds the best potential for producing enough geothermal power to end dependence on imported oil.*

"Although this boat has been a joy, it has also been a great disappointment," he confessed when talk got around to the financing of the 2.2-million-dollar *Neahkahnie*. "I had a smaller boat all paid for. Now the economy has changed, and this boat owns me."

David Stanchfield, a top producer in the crab fleet, spent more than half a million dollars to convert his 123-foot *Morning Star* for mid-depth trawling. On an average day he brings in 90 metric tons of fish, but he still needs a 1.5-million-dollar annual gross just to break even.

THE RECENT RUN of boat repossessions and bankruptcies appears to justify the philosophy of those Aleuts who prefer to pursue the traditional subsistence life-style.

"I feel the same about this land as my father did. He wanted it for his children," said an Unalaska Aleut who had turned down an oil firm's sizable offer to build a dock on the waterfront lot that serves as his summer camp. "I think a hundred dollars was more real to my father than $10,000. More money than you need just causes problems."

Unalaska native Benjamin Golodoff told me: "I haven't fished for king crab in five years. A lot of my friends are gone because they took too many chances. It's a tough way of life."

"What would you do if you had a million dollars, Bennie?" I asked.

"I'd build myself a barabara and live in it, pretty much like I do now," he answered, adding with a chuckle, "except maybe I'd have a shag carpet and an air conditioner."

Milt Holmes, who came to work on a ranch at Chernofski Harbor, later bought and successfully expanded the sheep and cattle spread.

"This country . . . you just can't get it out of your blood once you get it in," he says with a smile. "There may not be many beautiful days, but the ones you get make up for the rest."

Guide Scott Kerr's philosophy is similar: "I'd heard from a friend there was absolutely nothing here. I moved to Makushin two and a half years ago just because that was where the boat was going. Built a cabin at Anderson Bay. No roads, no signs, no intense social structure. If I could do anything in the world, it's what I'm doing now. Trapping in the winter, guiding in the summer."

I share Kerr's affinity for remote areas, and Bogoslof, one of the earth's newer landmasses, has long been first on my list. Blasted up from the 1,000-fathom curve of the ocean floor north of Unalaska, this impressive volcano broke the sea's surface in the late 1700s and last erupted in 1931. It is now a wildlife refuge.

I was warned there was no anchorage at Bogoslof except in the calmest weather, but I jumped at the chance to make the trip in a chartered fishing boat. Kathy Grimnes, of the Ounalashka Corporation board, her niece Marcia Shaishnikoff, and Dr. John Reeder, a state geologist, were also aboard.

We managed a surf landing accompanied by a curious entourage of sea lions. The island was an Eden of sea lions—at times 5,000—so unused to man they displayed little fear of us as they lounged on the beaches or taught their young to swim and fish.

Less complacent, with good reason, was a nervous clan of fur seals that had usurped a patch of sea lion territory. The valuable animals have never been known to breed in any Alaskan location except the Pribilofs well to the north,* and I was astonished when I stumbled (quite literally) on two bulls with a harem of three cows and three pups.

Although a scant mile long, Bogoslof offers black beaches bracketed by Castle Rock, a 330-foot crag to the southwest, and a jumbled basaltic dome on the northwest.

"I just can't believe how much the island has eroded since it was surveyed in the 1940s," geologist Reeder marveled as he mapped the volcanic debris, oblivious of the roaring sea mammals around him.

LATER I ACCOMPANIED Reeder on a helicopter survey of Umnak to look at rocks and check out his pet theory that the Aleutians offer some of the best potential for geothermal energy in Alaska. We visited the surrealistic world of Okmok Caldera, the graceful heights of Mount Vsevidof, and a myriad of fumarole fields. Most exciting was an unexpected stay at Partov Cove, a hot-spring site where, long ago, Aleuts had hollowed out a pool for bathing.

*Susan Hackley Johnson saw a better life ahead for Pribilof Islanders in the October 1982 GEOGRAPHIC.

Our party included Tim Perry, expedition cook, helicopter mechanic S. Kerby Reeves, and Jake Chercasen, who as a Nikolski man knew the location well.

"Back in just a minute," promised helicopter pilot Mike Arline, as he dropped us off at Partov Cove and headed out to pick up Reeder and his assistant, David Edge, who were working on the other side of the island. It was only a ten-minute flight.

We finished our baths—muddy but a comfortable 102°F—then followed reindeer down to a starkly beautiful beach, where I found a perfect ivory fishhook eroded from the barrow pit of an old barabara site. "Old-timers hunted geese here in the fall," Jake recalled. "A seasonal camp."

Later we climbed nearby cliffs, looking for our long-overdue helicopter—growing increasingly worried. Nikolski village lay at the other end of the island, a tough three-day walk, Jake said, and we were hesitant to leave without knowing the fate of Reeder's party. If there had been a crash, survivors would try to get back to us for help.

We lacked food, sleeping bags, warm clothing, shelter, and weapons. But we built a sod house and furnished it with dried grass, as had Aleuts of old. Temperatures dropped to freezing, but we survived, and we knew we could continue to do so on Aleut staples we'd noted in the barrow pit—limpets and blue mussels.

Dave Edge, Reeder, and Arline trudged into camp 24 hours later. Their helicopter had made a tail rotor strike on landing, and they'd hiked to us through rugged mountains draped in fog. Amazingly, Reeder guided them with a geologic map and rock hammer, gauging direction by rock samples he found. We were rescued by a helicopter from Unalaska, alerted by 14-year-old Jason Currier, alone at our base in Nikolski, and directed by a Peninsula Airways pilot who spotted the towel we were flying as a distress flag.

THE ISOLATION of our campsite is becoming less and less typical of the Aleutians. The tides of modernity are rushing in. In the summer of 1982, some 30 seismic boats explored for oil in the area.

Some see this potential resource as a threat. A Soviet-American study classes the Bering as among the richest and purest of seas, but warns that because of limited flushing and slow oxidation due to cold, pollutants could cause problems. Alaska is suing the federal government for reassessment of its accelerated offshore leasing schedule.

"The Bering is an enormous aquarium that supports a gorgeous, silent flow of migrations, unique in the world; really an underwater Serengeti," Aleut Corporation president Agafon Krukoff testified at an environmental impact hearing in 1981. "It contains a nutrient broth . . . unrivaled anywhere. It supports the richest fishery in the country. . . . There is an urgency to protect this area that trumps even the immense urgency to find more oil."

FOR ECONOMISTS, bottom fishing may be the islands' most viable prospect. Expansion of this industry, according to one study, could increase population from 8,500 in 1982 to 22,000 in 2000. Other estimates are more conservative.

Geothermal resources may also attract new industry to the chain. Alaska has invested five million dollars in exploratory drilling on Makushin Volcano and has selected other promising sites at Akutan, Atka, and Umnak.

Even without industrial breakthroughs, there is much to be said for the quality of life here of late. An optimism and cohesiveness in the native movement may well surpass economic gains. I noticed it most recently in Akutan. In 1976 it was an isolated village, then suddenly, thanks to the crab boom, it became the seventh largest port in the nation. Residents suffered what sociologists politely refer to as "transitional problems"—sprees of drinking and violence, drug abuse, and general confusion.

Incorporation as a second-class city in 1979 gave the tiny community the power to regulate industry that seemed bent on overrunning it. Inexperienced officials are learning to cope. Village morale is high, though it was dealt a blow last June when fire destroyed the Trident plant, largest land-based fish-processing facility in Alaska.

Similar moves in the direction of self-determination can be seen throughout the Aleut community. In the summer of 1982, Nikolski village finally mustered to shear its

"**This country** . . . *you can't get it out of your blood once you get it in,*" *says Unalaska rancher Milt Holmes. In 1949 the Idaho sheepman answered an ad for a hand at the Chernofski Harbor spread he now owns.*

Son Val, a fisherman in Unalaska, helps with shearing (**above**). *Milt's wife, Cora, bags wool in the kitchen* (**right**), *and her son, Randy Baker* (**far right**), *hauls coal from a pile left by the military in 1945. Randy's schooling is a correspondence course taught by his mother. With no regular plane or ship service, the lonely life bears more resemblance to 19th-century pioneering than to today. But the few fine mornings fit for a cross-island ride* (**upper right**) *make up for the worst of it.*

Resting-places *are rare in the Bering Sea, which supports perhaps the world's largest marine-mammal population, including seals, sea otters, and walruses. As many as 5,000 Steller's sea lions crowd a breeding colony long established on Bogoslof Island* (**above**). *A tufted puffin* (**right**) *burrows its nest in a cliffside colony at Adak. Aleuts recall that their ancestors took sea lion hides for boat coverings and boot soles and used puffin plumes and beaks for ornaments.*

sheep and appears to have negotiated a lease on the ranching operation to help stabilize its economic base. Remote Atka, long without power, grew tired of waiting for government loans and in 1979, using funds from the village corporation, financed, engineered, and built its own system.

Given this new spirit—along with a rich endowment of land and natural resources—the future of the Aleut nation holds promise. Yet its fate may well hinge on the whims of

JOHNNY JOHNSON

war, as it did in 1942. Military and support personnel at Adak, Shemya, and Attu make up 60 percent of the total population of the chain, a clear indication of the strategic importance of the area.

"Adak is at the doorstep of the Soviet Bear, and our job is to meet him as he comes out to forage," said Comdr. James E. Faivre, who is in charge of the patrol squadron detachment at Adak's naval station. His forces conduct antisubmarine missions and last October and again in April participated in the largest naval training exercises in the northern Pacific since World War II. These maneuvers were closely monitored by anxious Russians and caused a shudder of apprehension among those of us who love the wild island preserve.

Yet, if the downfall of the Aleutian chain in World War II came from a complete lack of defenses, perhaps this show of strength will ensure its peaceful future. □

The Living Sands of the NAMIB

By WILLIAM J. HAMILTON III
Photographs by CAROL and DAVID HUGHES

Life seems improbable in the hostile dunes of the Namib Desert. Yet myriad creatures, such as this side-winding adder, use remarkable survival tactics to defy a land of extremes. Stretching 2,100 kilometers (1,300 miles) along Africa's southwest coast, the Namib contains animals that are still being discovered and named.

THREE HOURS before first light I climb in thickening fog through soft sand several hundred meters above the dune base. At the crest of these wind-carved sands, a loose rank of black beetles faces the fog. On this mist, the first in three weeks, these insects' survival depends, for here in Africa's coastal Namib Desert, fog is a critical source of life-giving water.

These glistening insects have emerged from the chill lower slip face, the downwind slope, where they had waited for a fog long in coming. They have staggered, numb with cold, up the steep sands, where they perch near the dune crests to catch the densest, wettest fog. Balanced head downward on their legs, they pirouette to hold their backs to the wet breeze. The blowing fog strikes their backs, water collects and trickles down to their mouths. Thus the head-stander beetles drink and survive (page 368).

Hard to believe? So is the Namib Desert and some of its other strange life forms.

A great sand sea along Africa's South Atlantic coast, the Namib gives South-West Africa its new name, Namibia. It is a region caught in political and social change, as caretaker South Africa eases old controls and tries to reconcile plans for Namibia's autonomy with internal and external factions.*

Coastal fringe of a vast arid land, the Namib stretches 2,100 kilometers (1,300 miles) from the Olifants River in Cape Province, South Africa, northward well into Angola. The seaward part of this little-known territory receives almost no rain and little fog. Eighty kilometers inland, the nourishing mist arrives fewer than 60 days a year. Fog is generated when warm moist air from the open Atlantic blows over the cold Benguela Current that sweeps up from Antarctica, along the west coast of Africa.

In the first half of this century an Austrian entomologist, Charles Koch, collected and described insects from Africa's arid lands. When Dr. Koch reached the Namib, he was amazed to discover a life system different from anything he had ever experienced or read about. He found a cornucopia of indigenous life: beetles of all colors and shapes—black, white, and candy-striped—spiders of the night and spiders of the day. He saw lizards, including strange barking geckos and another that plodded at night on padlike feet across barren sands.

Dr. Koch found among the desert inhabitants evidence of major bodily adjustment to the parched Namib environment. To study this unique ecosystem, he established in 1963 a research station at Gobabeb, the site of an abandoned Hottentot village.

It was this strange Namib world—biologically still little understood—that awaited me when I took up field studies at the Namib Desert Research Station. When Dr. Koch died in 1970, his assistant and my friend Mary Seely became director. Mary and I have collaborated recently in studies of the fog-water adaptations of desert insects. Much of this article's content represents our joint observations.

It was on a morning of dense blowing fog, while Mary and I were watching by flashlight those head-stander beetles mentioned earlier, that another Namib life riddle resolved itself before us.

Button beetles (*Lepidochora*), a species ubiquitous in the dunes, were digging furrows in the sand. Always before, we had thought they were simply having trouble burying themselves against the coming midday heat. But now we comprehended yet another astonishing water-using strategy.

"Look," I said, "the furrows are all parallel to each other and perpendicular to the flow of the fog wind."

"Yes. And the button beetles aren't gathered at the ends of the trails, as they would be if they were simply plowing themselves in," Mary remarked. "They're lined up along the ridges. They must be making fog traps."

*See "Namibia, Nearly a Nation?" by Bryan Hodgson, in the June 1982 NATIONAL GEOGRAPHIC.

The author, a professor in the Division of Environmental Studies at the University of California at Davis, specializes in the complex relationship of oases to deserts. Over a span of 15 years, Dr. Hamilton has made a total of eight trips to the Namib Desert.

And so they were. The tiny raised sand ridges intercepted the billowing mist and soaked up its moisture. In the following weeks we carefully measured the beetle tracks: their orientation to the fog winds (always perpendicular) and their water content (always greater than the surrounding sand—until the beetles crept back along them, sucking up the collected moisture). The beetles, individually marked and put on the scales before and after drinking, showed an immediate gain in weight.

IT IS indeed a strange place, the Namib. Its dunes rise from parallel inter-dune valleys (we call them "streets") to windy crests. In this world of swirling sand live animal species that flourish without ever seeing a living plant. Wind and drifting detritus—plant and animal fragments—activate residents of the dune alps: beetles and spiders, lizards and snakes.

By contrast, on gentle sand slopes at the bases of the dunes and in the intervening streets, rare rainy times produce sudden vegetative growth. As much as 50 millimeters of rain breaks the central desert's dormancy. Deep-buried lily bulbs sprout and flourish. Grasses and other specialized plants turn inter-dune valleys into meadows.

Life absent for a decade now thrives for a few months or even years. Families of turkey-size bustards stride through the valleys, feasting on multitudes of unwary beetles that have known no predators for a dozen generations. Thousands of finches and larks come to harvest grass seeds.

Seeds and stems swirl about the unvegetated dune crests, making possible the Namib's special wonder, the detritus ecosystem. On the loose, high sands, no large predators intrude, and the small animals' reproductive orgy will only dwindle years later, as the last of the seeds and grasses are devoured or buried.

It's been our good fortune that in the past 12 years three good rains have saturated areas near the research station. Apart from nurturing lesser creatures, the relatively moist conditions have helped mammals flourish on the inter-dune flats. Gerbils, Africa's counterparts to America's kangaroo rats, multiply in oasis refuges and spread deep into the desert. Jackals, which hunt them down, breed beneath the scant cover of spiny bunchgrasses. Oryx, large desert antelope that for years have dwindled in numbers, now snort, mate, calve, and wander, foraging on rejuvenated grasses.

We know that in a few years, unless substantial new rain falls, the fruits of these scant waterings will be exhausted. In the very first months of the wet time we watched the annual grasses go to seed, dry, and blow away. The perennials also began to decline, but they stretched their life span by reaching their roots ever deeper.

As the land dries out, oryx begin to quit the dunes, seeking gravel plains where thunderstorms provide temporary grass gardens. There they mix with thousands of mountain zebra. Famished antelope and zebra can consume all the grasses before they are three inches high. In the depths of a drought I have watched oryx fight, in some cases to the death, over a water hole they had dug in a dry riverbed. The desert's unpredictability, for them as for me, is an unending challenge.

An extraordinary perennial plant, *Welwitschia*, is unique to the Namib. Leathery-leaved, octopus-like when mature, it outlives every drought. Scientific accounts of this sprawling, unlikely plant have placed it on the brink of extinction. Not true. In places we found them common, almost weed-like. Ragged and scarce at the edges of their range, welwitschias thrive along the inner fringe of the northern coast, where dry washes meet the dunes. They draw for years on storm water stored in streambed gravel.

During dry periods, welwitschias may wither at the tips of their leaves. Then rains come again, leaves turn from red ocher to green, and growth accelerates. Thin grasses spring up between these desert patriarchs, attracting antelope and zebra. Inevitable drought returns, grasses crumble and blow away, and antelope and zebra trudge off to the horizon, following storm clouds whose thunder promises rain they may not yield. But hardy welwitschias live on, some for a thousand years and more.

Namib life forms, while numerous, are widely scattered, especially during the driest times. To witness desert creatures' full range of behavior, we utilized marvelous little vehicles: three-wheeled motorcycles.

WILLIAM J. HAMILTON III (ABOVE); ROD HORLAND (BELOW)

***Shrouds of fog**—lifeblood of a land where years pass without rain—form when warm Atlantic winds meet the cold coastal current borne from Antarctica. About 60 times a year the nearly ever-present mist offshore of the Great Dune Sea (**right**) thickens and moves inland as fog, the main source of water for many Namib dwellers.*

*One beetle, called a head-stander (**above**), tilts on a dune crest to drink fog droplets trickling down its body. The nocturnal gecko (**below**) may gather precious condensation as it licks and cleans its lidless eyes.*

With their bulging soft tires they can easily surmount the highest dune and take us far across the treeless sands, offering us encounters with the rarest desert life.

ON A NOVEMBER MORNING—springtime in the Southern Hemisphere—I roll out of my sleeping bag after a night alone deep in the dunes. This dawn is without fog; there will be no insects for two hours. I am down to two gallons of water, but this is the last day of my week-long field trip, and I drink my fill from my plastic jug, its water cool for the only time during the day.

Dawn usually breaks silently and windless in the Namib. At first light the night creatures vanish; their telltale tracks trace curious calligraphy on the sands. Barking geckos have ranged in short loops only a meter or two from their burrows. Silverfish, their small prey, may leave no track at all. Marks of other creatures, the dancing white lady spider in particular, show that they move about unafraid.

On gravel flats between the dunes, traces of larger vertebrates, including humans, may linger for years—almost forever. Where oryx cross crumbling schists, they etch tracks several centimeters deep. In one

Food is water *for Namib predators, which gather most of their moisture from the body fluids of their prey.*

*Monstrous jaws enable this four-centimeter-long solifuge (**right**) to attack a locust of equal length. Although this arthropod forages for beetles on the dunes, it generally hunts in the gravel flats between them.*

*With a flick of its sticky tongue, a chameleon (**top left**) snags one of the Namib's many species of beetles. These chameleons live around the vegetation on the borders of the 80- to 160-kilometer-wide desert. Detritus from vegetation blows through the dunes every day and, much like plankton in the sea, provides the basis of the Namib food chain.*

*A female Namib wasp (**left**) hides a dancing white lady spider from competitors after paralyzing it with her sting. Next the wasp crawls a short distance away and digs a nest. Uncovering her victim, she drags it to the nest and buries it again after laying an egg on it. When the wasp larva hatches, the still living spider will be its first meal.*

place, 30-year-old traces of the vehicle of a diamond prospector still show plainly.

Namib dawns are chilly, and most daytime invertebrate life becomes active hours later, when surface sands have warmed. The first creatures astir are the comical little *Aporosaura* lizards that live in the soft dune slip faces. Poking out heads and necks, they first absorb heat from the thin covering of surface sand. After emerging and warming further, they scamper off to inspect one another and to rummage about in the overnight accumulation of detritus for a breakfast of seeds and beetle larvae.

Quickly the day turns warm. Beetles are out in force. Armored with a hard chitinous covering, they show no fear of the lizards. Both lizards and beetles prefer to feed on parts of other creatures, but mostly they have to settle for seeds.

Smaller and more active, the male beetles are more interested in females than in food. To claim exclusive access to their chosen mates, some seize the females and ride them like miniature cowboys, steering their "steeds" to fend off other suitors. One species, while clasping the female with its forelegs, lashes out with its hind legs, springlike, kicking rivals away. The beetles are not mating now, only staking claims. Actual

copulation will take place beneath the sand.

A shiny brown-black scarab is out looking for oryx dung to drag to her spacious underground dwelling, food for her larvae. She positions jelly-bean-size pellets between her hind legs. Sometimes the rearmost pellet rolls—she is partly wheeled along.

In the Namib, as in most deserts, midmorning "warm enough" is quickly followed by "too hot." Lizards, beetles, termites, and spiders are all abroad. Termites race across the sand, gathering pieces of dead grass. Today they will have a scant 20 minutes to work before midday heat forces them to quit until afternoon. Soon all surface dwellers must burrow a few centimeters to inky blackness and a more moderate ambience.

For most Namib life forms, the sand surface and the first half meter down are the limits of existence. But for some, margins of safety and survival are measured in fractions of a body length. Almost all desert insects are flightless; on the surface, their microcosm is one of temperature extremes. At midday, surface sand temperatures can rise to 66°C (150°F), well beyond the tolerance of any small resident.

Now the heat sears: The sand stage is vacant. I find protection under a few yards of nylon stretched from my motorcycle to pegs stuck in the ground. I shove aside sand to find a cooler resting-place for my backside. Now I'll have a few hours to read, daydream, reminisce. . . .

In deadly disguise, *a side-winding adder exposes only its eyes as it waits for prey to approach* ***(above)****. When a lizard nears, the snake strikes, injecting venom, then swallows the lizard whole* ***(left)****. Although only distantly related, the Namib adder and the sidewinder rattlesnake of North American deserts have many traits in common.*

BY THREE, I'm bored and set out prematurely to continue my patrol. The sands have begun to cool but are still too hot for bare feet. First out are some beetles that, like me, have emerged too soon. They can't return through the hot sand without being cooked. To stay cool and alive, they rise on spindly legs, stilt-like, reaching to cooler air a body length away.

I come upon a favorite of mine—little *Cardiosis*, a yellow-and-black afternoon beetle that climbs to the top of the dunes to catch freshets of wind. Volkswagen-shaped, no larger than a pepper seed, it races across wind-lashed slip faces, chasing scuds of detritus in the alpine crests of its sandy world.

Soon an indescribable vitality pervades the sands. As the heat moderates, I trudge along, alert for tracks and movement. A sand-colored solifuge, or sun spider, whisks by, tracking back and forth, hunting. Actually an eight-legged arthropod, but not a true spider, it curls its abdomen straight up into the air, perhaps to avoid having its insides fried. It comes upon a *Cardiosis*,

shallowly buried. Suddenly the sun spider has the beetle on its back and at once begins to suck its body juices.

In the mellow afternoon, beetles and other insects appear everywhere, racing across the dunes' slip faces, inspecting fragments of breeze-stirred debris. As sands cool, I take off my shoes and shirt.

I continue my walk and nearly stub my toe on an unaccustomed object—a burnished, roughly oval russet stone. It's a prehistoric axhead, left by Stone Age hunters who ranged across this desert. Throughout the now unpeopled Namib, scores of multicolored stone axes strew the gravel flats and lie buried beneath the dunes.

Mary Seely once took me to a secret place 50 kilometers southwest of the research station, where stone hand axes lie scattered on the flat streets between towering dunes.

"How could people have existed here?" I asked. "I couldn't walk this far, much less stalk an antelope, and get back to water. There'd be no point in carrying hand axes when I had to haul in all the water I could manage in ostrich-egg shells."

Dancing to beat the heat, *the lizard* Aporosaura *lifts its legs (**top**), then dives beneath the sand before midday surface temperatures climb as high as 66°C (150°F). Ironically, in the early morning it must warm up on its belly (**above**).*

*Following its nose, the blind and nocturnal golden mole (**left**) tunnels just below the surface for prey.*

"You're right," Mary agreed. "Under present conditions, living here would have been impossible. But see—we're at the end of an ancient river that flowed into the dunes here. Trees must once have flourished in the stream's outflow, where an early people lived. The axes are their only trace; they left no other clues. The river has long since disappeared. Their bones are a part of the Namib dust."

Dusk descends on my walk. The first night creatures are emerging. Saucer-shaped button beetles are circling about. On our approach they squeak an alarm, then dive into the soft high dunes. Soon other actors appear on this red Mars-scape. Moonlight, reflecting from the sand, turns furry dancing white lady spiders an eerie dull red as they prance on tiptoe for reasons we are only beginning to understand. Geckos walk on their paddle-like feet, foraging for insects. Voracious golden moles glide under the sand. But I must soon slip into my sleeping bag.

About 3 a.m. I am awakened by sand blowing in my face. I am up with a start. The dampness exaggerates the chill, and I pull on long johns and zip my parka tight. Back at the station Mary will be out in the dunes too, hunting for marked beetles carefully weighed the previous evening.

By four the fog is swirling all around; visibility is nil. My flashlight reveals a veil of tiny droplets slanting by. By six the button beetles have dug their moisture-catching furrows, drunk their fill, and are back below the dune surface.

By nine the fog has lifted. It breaks up into puffs of cloud painted pink by light reflected from the red sands. Now the sun thrusts warmth to the dunes again. In another hour lizards will poke out heads. A daily cycle passes, another begins.

Nocturnal traffic patterns *of zigzagging beetles and a bounding gerbil* (**facing page**) *linger at dawn before the Namib's winds clear the slate. A corn cricket* (**above**), *uncommon in the heart of the dunes, briefly leaves its own distinctive signature on this desert realm, only recently marked by the footprints of modern man.*

ITS UNIQUE CREATURES and their strange ways should make the Namib a mecca for biologists. But the region is politically troubled. Today it takes a light step in southern Africa to stay in grace.

And now the Namib is under pressure from mining interests. Uranium lies beneath its sands. Mines for copper and diamonds are developing, and technicians and workers are assembling from all over the world. Vehicle wheels scar desert surfaces, their tracks to last for centuries.

In the sandy heart of the desert, far beyond the last human trace, problems seem remote. Deep in the great dunes, I have never seen another person who did not go there with me. Only satellites, relentlessly tracking black night skies, intrude into this solemn hiatus to remind me of my own humanity, and that against human onslaughts not even the Namib's empty horizons will remain inviolate. □

High-Flying Tulsa

By ROBERT PAUL JORDAN Photographs by ANNIE GRIFFITHS
SENIOR ASSISTANT EDITOR

At the controls of city hall as well as his 1942 Stearman PT-17, Mayor James M. Inhofe defines Tulsa's spirit as "young, vibrant, aggressive." In Oklahoma's Green Country the sky's the limit for ambition—tethered only by down-to-earth religious convictions.

TULSA. Strange and graceful name. In 1836 a band of Creeks, the Lochapokas, uprooted with other southeastern tribes and force-marched by federal soldiers, ended a cruel journey over the Trail of Tears to Indian Territory. The Lochapokas carried with them a bag of ashes from the sacred fire at their *tulsey*—old town—in Alabama. On a rise above a sand-logged river, beneath an oak's boughs, they started a new council fire. From ashes, a new life.

For a moment it was good. Think of it! Less than a century ago three sovereign nations shared borders here: Creek, Osage, Cherokee. Their sovereignty vanished when Oklahoma became a state in 1907. The oak tree survives, neatly fenced, dominated by a circular apartment house of towering inelegance, hemmed in by the white man's civilization. In these surroundings it weighs on me to stand beside that great tree, for I became a member of the Creek tribe by adoption many years ago.

Not so the old white man with me, born when Tulsa was Indian Territory. He looks out glumly on the Arkansas River. "When I was growing up," he says, "we couldn't drink its water. Thick with mud. Polluted with natural salts. It's still not fit to drink. Some things don't change. Hotter than hellfire here in summer, with long dry spells. Downpours. Tornadoes."

He turns to me, suddenly pleased. "But this is the place to be. One boom after another. Something's always been happening in Tulsa."

Just so, and by design. Tulsans are opportunists, quick to move with the times. From turn-of-the-century oil strikes they plunged into the worldwide energy play. From strut-wing aviation they ascended to aerospace. Now Tulsa is a center of the information age—data processing and telecommunications. The city handles an avalanche of credit-card slips. Call Avis's 800 number for a rental car, and you go into a Tulsa computer bank. American Airlines electronically manages you here.

Tulsey Town began erupting not long after the 1900s came on. Bonanza! Black gold gushed nearby. Tulsa handled the financing and logistics. Local historians trace the city's character to the kind of people who flocked to this raw frontier town to get rich. Some were rascals and hustlers. All disliked bosses. They were tough, aggressive, individualistic, and optimistic—people in the oil business need to be supreme optimists.

A number struck it big. Their names live on; Tulsa and Oklahoma know them, and so does the world, oil being international. Phillips, Skelly, Getty, Warren, Gilcrease, LaFortune, others. Men of courage and determination, and when the time came, men of philanthropy.

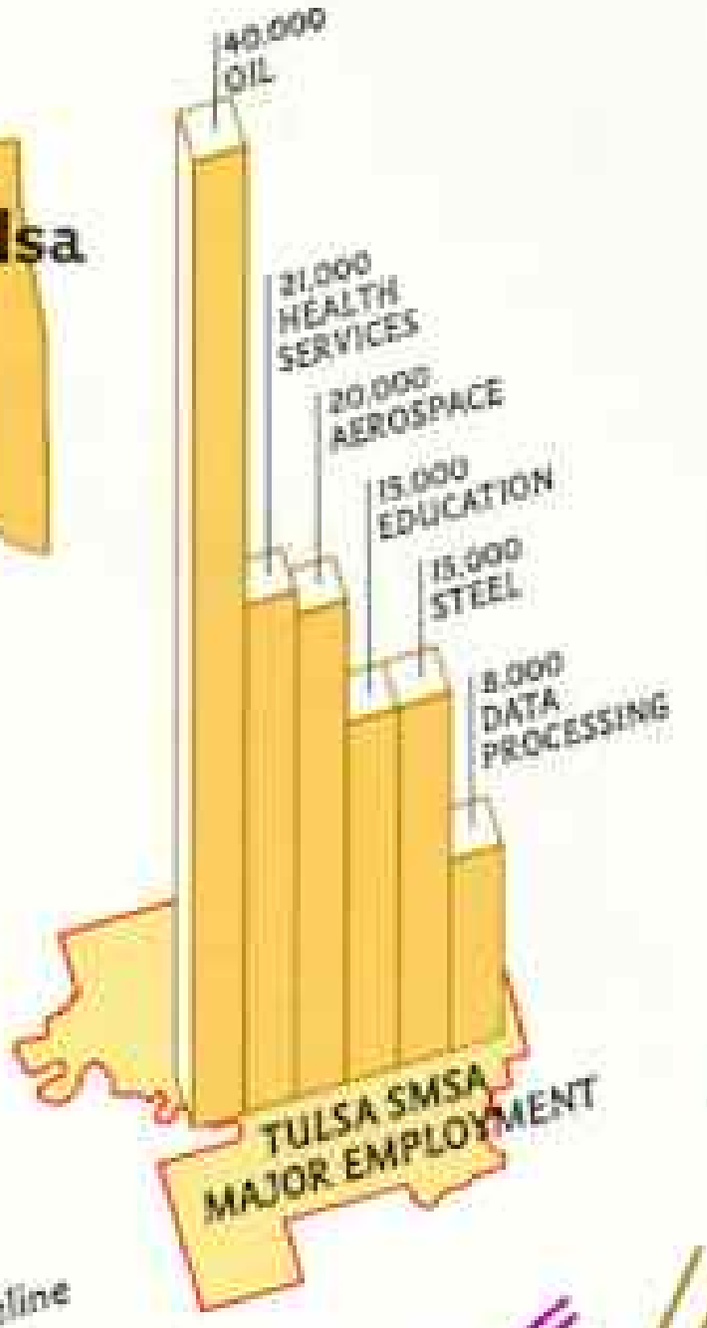
Tulsa's motto (it has none) might well be "Go for it!" The city is a shrine to the American dream, to personal independence, hard work, home and family, pride of place, and the hope of heaven. All this comes wrapped in a complacent phrase, "Tulsa Spirit."

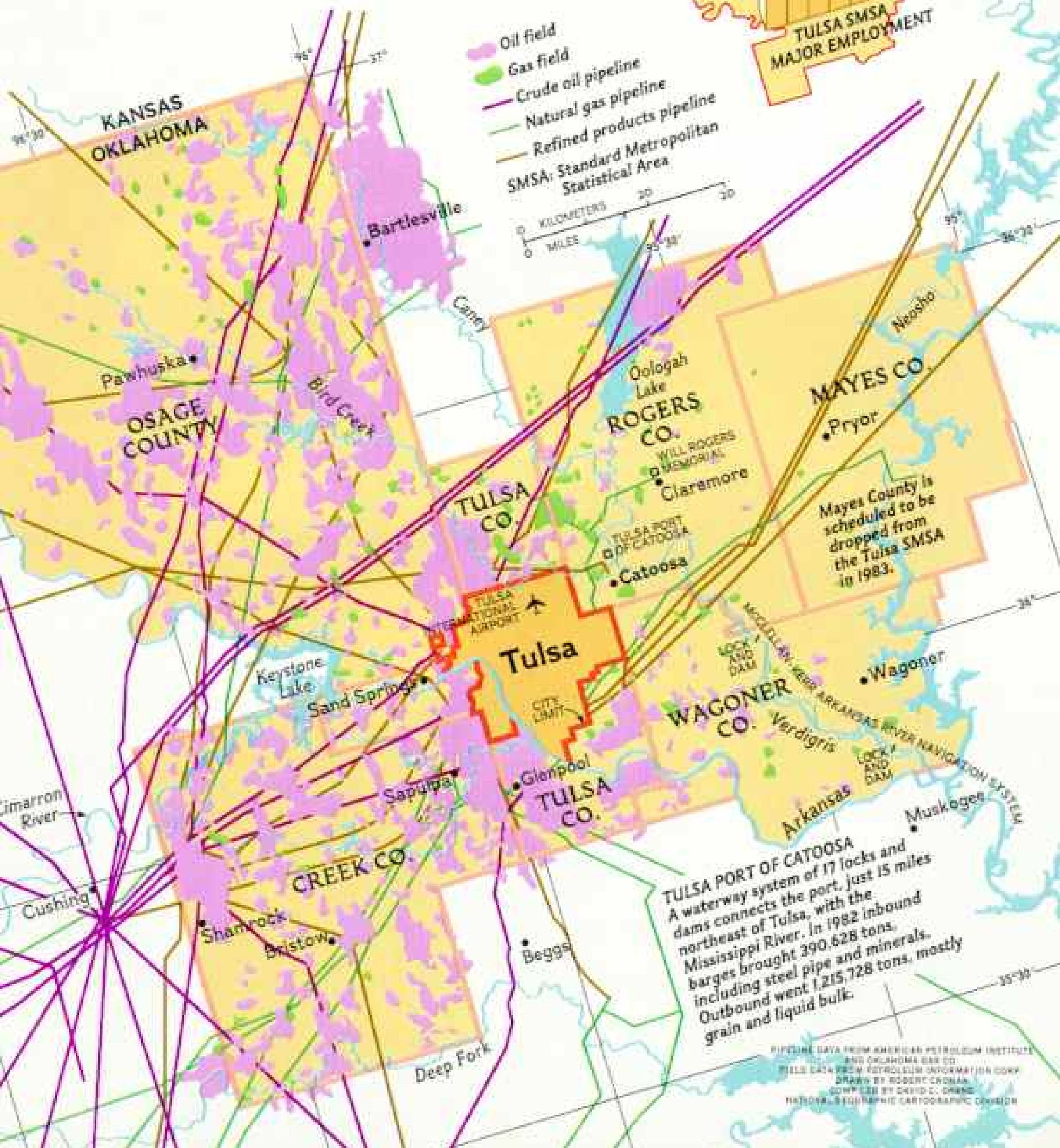
As in other middle American cities the spirit recedes homeward at 5 p.m., and night falls on an empty downtown. Lunchtime is best for a conversation with the business district. I like to begin at Nelson's Buffeteria, an old-timey hole-in-the-wall establishment where a long line is shuffling toward the entrance. Nelson's is esteemed for chicken-fried steak, the Nellie Burger, Super Donut, and Jewel's scrumptious pies.

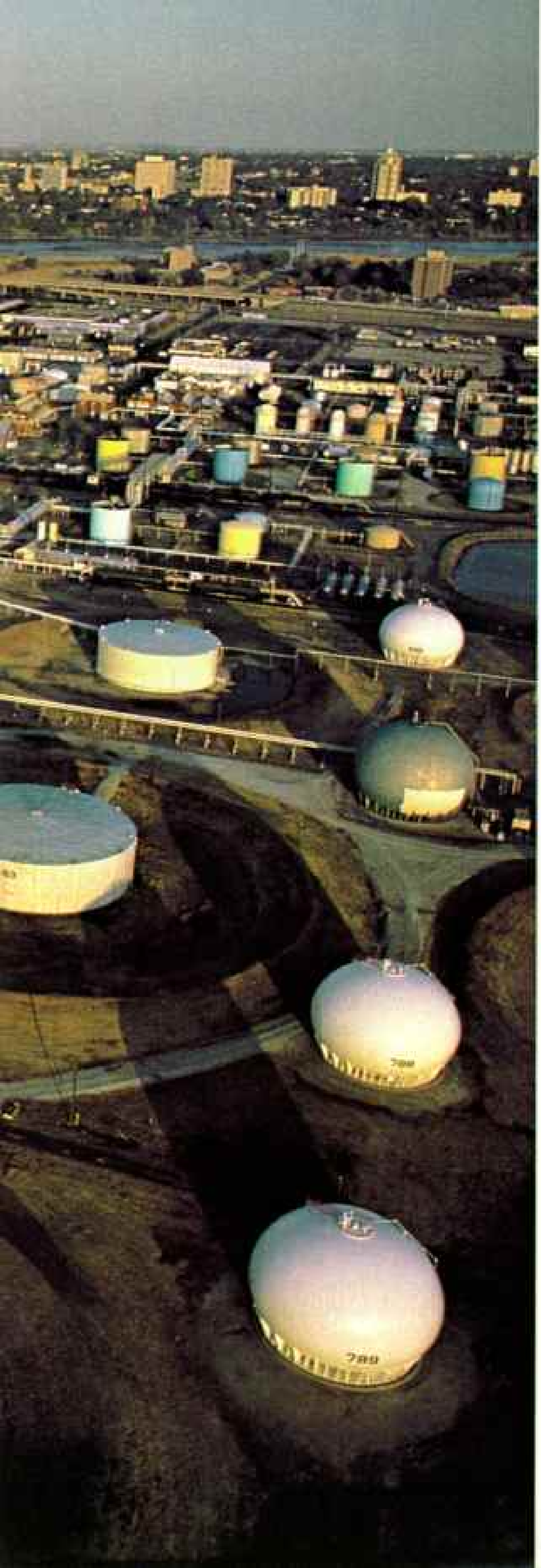
Jewel Fisher is at her art in a small kitchen space, plump arms flying, when I introduce myself. A cheery black lady, she talks as she stirs. "I've made 60,000 pies, I guess. I start at six in the morning, and make 50. Takes about four and a half hours. I learned pie dough from mother and taught myself the fillings. Apple. Cherry. Peach. Chocolate. Vanilla. Lemon meringue. Banana. Coconut cream. All by hand. I get about one proposal of marriage a week."

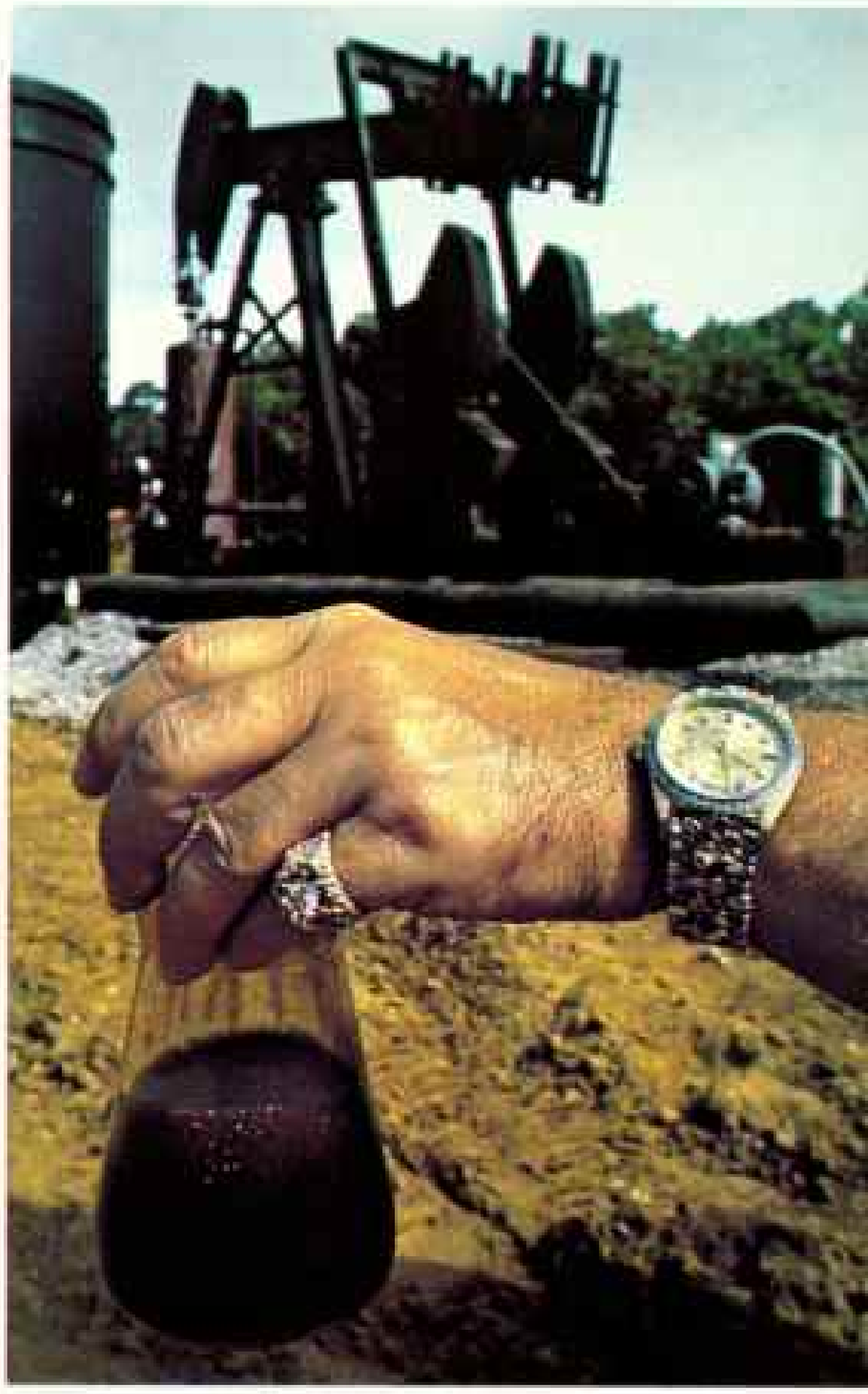
Stroll around the corner. At Bartlett Square on Main Mall a western swing band is playing "Milk Cow Blues." Tulsa is a great country-western town. Modish secretaries perch beside the fountain, swapping gossip. Young businessmen in cowboy boots and three-piece suits survey them endlessly. The sun sets alabaster skyscrapers agleam and blesses a street preacher as he exhorts

A COUNCIL FIRE lit above the Arkansas River by a band of Creek Indians exiled from Alabama began Tulsey, as they called their town, in 1836. By 1882 red man and white shipped cattle via Tulsa's first railroad. Then in the early 1900s oil strikes nearby touched off a mighty boom. More than 1,200 oil and oil-related companies still have offices in and around Tulsa, though today they account for only 11 percent of a work force now diversified in health care, aerospace, and data processing. The city's population of about 370,000 is nearly doubled by its six-county metropolitan area.









*"**Oil! Oil!** My God, Bob, we got an oil well." Thus Frank Chesley awakened his partner, Robert Galbreath, at their rig about 15 miles south of town on November 22, 1905. Their gusher discovered the Glenn Pool field that made Tulsa the Oil Capital of the World. In West Tulsa a refinery (**left**) that dates from 1913 is today operated by the Sun Refining and Marketing Company.*

*Beyond the suburbs, the smell of oil still entices speculators like Jim Holman, holding a beaker of crude (**above**) from his No. 3 Barb—a well named for his wife. Holman, whose jewelry reflects a fortune made largely in real estate, came to Tulsa 17 years ago because "I got tired of driving a truck."*

From milkman to millionaire, *Roger Hardesty travels in a Rolls-Royce Silver Spur and a Boeing 727—and drives both, having had his pilot's license since age 16. He calls Tulsa "a city that's willing to give somebody a chance." After moving here in 1958, he leaped into the construction business with a determination that built the Hardesty Company and 12,000 multifamily units in 16 states. Worth about 150 million dollars, he has developed a passion for Alaska, where he bagged a brown bear, walrus, Dall sheep, and musk-ox* (**right**). *But, says he, "I still enjoy the simple things in life," such as playing Pac-Man with grandson Paul.*

sinners—"Now is the time to repent." He takes up his post every day.

Few pay heed. Not the broken men chained to alcohol who panhandle on the mall. Tulsa's affluence long has been a magnet for them. Recently, unemployed people from throughout the country made their way to the city as the nation's economy worsened. Two years ago the city's unemployment rate was among the country's lowest. Today few jobs are available. The longtime boom has slowed, and some projects have been dropped or are on hold.

In the seventies 600 million dollars was spent on construction and renovation in Tulsa's central core. Work in progress will cost hundreds of millions more. The centerpiece of this revitalization is Williams Center, a 200-million-dollar private development. It occupies about a third of

downtown, spreading over nine square blocks that once contained skid row. Three more blocks are being added.

A VISIONARY named John H. Williams brought all this about, beginning back in the mid-sixties when he took the gamble of his life. Tall and quiet-spoken, he told me about it as we looked out on Williams Center from high in the 52-story Bank of Oklahoma Tower, the state's tallest office building (following page). It's also home of the behemoth organization he created.

"I grew up in the pipeline construction business. It was a family company and very successful—assets of about 50 million dollars. But I didn't want us to be just ditchdiggers. So I mortgaged the whole company and borrowed more."

He borrowed a lot more, enough to buy an established and vast pipeline network. Great Lakes Pipe Line Company cost 290 million dollars. The deal dazzled Wall Street —the largest cash-for-assets purchase in American corporate history up to that time.

He continued diversifying, assembling a string of enterprises: fertilizer, energy, metals, real estate. The 50-million-dollar ditchdigger has burgeoned into the Williams Companies, with 1982 assets of a whopping 2.4 billion dollars.

John's cousin Joseph H. Williams is his successor as chairman and chief executive officer. Just turned 50, Joe Williams has been instrumental in the firm's growth and Tulsa's. "We had a unique opportunity," he told me, "to meld our very substantial business need with our desire to do something for the community. We chose to stay in Tulsa

MARTIN ROGERS

Main Street is for people *where a pedestrian mall of fountains, shops, and sculptures counters downtown's onetime deterioration. Beyond rises the Bank of Oklahoma Tower, the state's tallest building and part of the 200-million-dollar Williams Center.*

and downtown. We're pretty proud of Williams Center."

Downtown ends at the tracks, and freights still rumble through (though nary a passenger train rolls in all Oklahoma). Bridges carry you into North Tulsa, where most blacks live. Blacks make up around 12 percent of the city's people. Beneath the bridges, homeless job seekers and winos pass the long nights. For the most part, North Tulsa is a residential district of small homes and quiet streets.

Near the tracks, at First and Main, Tulsey Town once resounded, a shoot-'em-up cow town and outlaw roost. Not far away, cattlemen, primarily Indians, ran herds as large as 15,000 head, shipping cattle by train to eastern markets. The rails reached Tulsey Town in 1882.

I went around to police headquarters one day, signed a liability release form, and cruised about North Tulsa with police officer Gerald W. Atchley. A slim, friendly man of 30, he wears on his blouse a small cross; on the dashboard he keeps a Bible. "The Lord told me to be a policeman," he said. "And I have come to realize that a policeman has a ministry, which is to minister justice tempered with mercy. You can't be an effective policeman until you become a Christian. When I go into a broken home—family fights—I try to bind that marriage back together, and what you have in the end is a stronger union. The usual police practice, in order to bring quiet, is to say, 'One of you is going to have to leave.'"

He glanced at a house we were passing. "Mainly it's burglary around here. Last week I caught four burglars, and yesterday I chased three out of a house. They took off across the tracks and disappeared. Kids. Truancy is superbad. A while back there was this guy driving around and dropping them off. They'd hit a house, and he'd come back and pick them up. He'd give each of them ten dollars. Then he'd sell the stuff and make a bunch of money."

Officer Atchley pulled the cruiser over in a dilapidated area, parked, rolled down a window. "This is the *real* poor section," he said. "Prostitution. Drugs. Crazies." He stared at a woman who had flagged down a man in a passing car. "She's hustling up business. Now over *there*"—he brightened

and pointed to a renovated church that stood out, a beacon, among its ramshackle neighbors—"is Mother Tucker's House of Prayer. We've made the whole upstairs into a dormitory that sleeps 80 men. It's a community project. All the months we were working on it, Mother Tucker never turned anyone away. They slept on pews. We've even got two or three large rooms for families."

As I got out of the patrol car, I asked Gerald Atchley if he always had the Bible with him, the one on the dashboard. "Yes," he replied. "This cover is all leather, stitching and everything, hand-tooled. The guy making these is doing life for murder. He turned to God as he came through our jail."

TULSA: cosmopolis on the sandy Arkansas. Seaport (yes, seaport), immensely wealthy industrial-business headquarters, richly endowed cultural hub. The performing arts are big time. Productions of Tulsa Opera and the American Theatre Company appear in the Performing Arts Center, a splendid building with several theaters that seat 3,300. The Ballet Theatre and Philharmonic also play here to large followings.

About 370,000 souls reside here, making Tulsa the 38th city by population in the U. S. Another 365,000 live in the six-county metropolitan area. For many, only one thing keeps the city from being absolutely up-to-date: The state law against selling liquor by the drink. Some restaurants simply ignore the law, others offer free "private club" memberships. This is referred to, a Tulsan told me soberly, as "liquor by the wink."

What's so great about Tulsa? Drumbeaters enjoy the question. Room to grow, they inform you. High quality of life, measured against other cities by education, environment, housing, government, income, health care, recreation. Churches overflow on Sunday, weekday activities are well attended. Tulsa is a citadel of the Bible belt, as prayerful a community as you are likely to find.

"A lot of people," Steve Crane, a young photographer, said to me, "believe that God has chosen Tulsa to be a city of refuge when Judgment Day comes. The Bible speaks of cities of refuge. We are living, I believe, in end times."

Well, God-fearing Tulsa is also the buckle on the tornado belt. I remember an Easter when the Reverend Bill McClellan and his small flock thought the end had come while they were at worship. Tornadoes struck suddenly like a wrathful Jehovah, making evensong hideous. On Tulsa's south, the Liberty Heights Freewill Baptist Church collapsed during a Communion and foot-washing service. Thirty worshipers, four of them children, were pinned beneath the fallen roof and walls. Though serious injuries resulted, no one, miraculously, was killed. It took nearly an hour to free everyone.

A day or two later I walked with Bill McClellan through the ruins. He sat on a salvaged pew. "Some of my people thought it was the devil's work. No. The Lord was testing us, testing our faith. This was only a building. *We* are the church. And through our prayers He brought us out of it. He saved us to go and win souls for Him. Now we must rebuild."

I called Pastor McClellan again last Easter. "A fine day of preachin' and singin'," he told me. All was well with his people and their new building.

Sometimes in deep night I pondered Tulsa's sturdy underpinnings, waking to a church bell attesting time's round. Presently a mournful whistle would lull me to sleep—another freight clattering through. I did not look forward to morning light, when a fearful clamor would erupt overhead. My hotel, the new Williams Plaza, already was adding floors, growing with Tulsa.

That work now has been completed, and two resplendent black office towers have sprung up next door. Other spires for banks and corporate empires are rising. New hotels have opened. One, the swank Excelsior, makes its Rolls-Royce available to guests. Cultural delights await. To the opera? Theater? Ballet? Ball game? The Tulsa Drillers, a farm team of the Texas Rangers, strive in a fancy new ball park with aluminum grandstands and artificial turf.

Beyond downtown, out the thoroughfares, more construction. Woodland Hills Mall adds 160 stores, making it the largest shopping center for a hundred miles around. The first phase of Warren Place, a 450-million-dollar office park development, goes up. Evangelist Oral Roberts' dream,

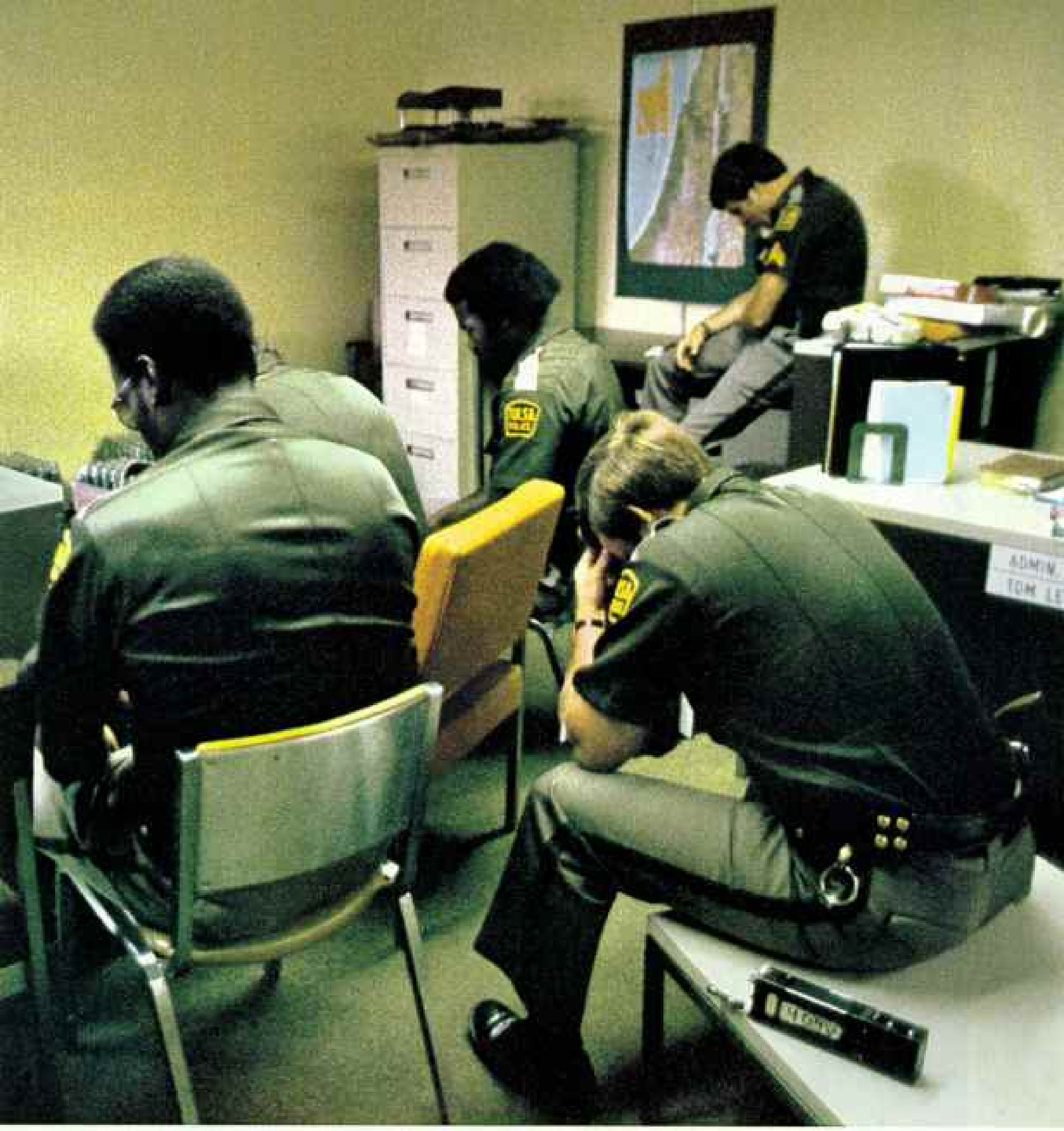
Blessed are the peacemakers *of Uniform District West, who start the day with Bible study* ***(right)****; posters came from one officer's Holy Land pilgrimage. To help the force cope with a series of tragic and scandalous incidents that began with a policeman's suicide in*

1981, the Reverend Danny Lynchard's Peace Officers Prayer Partner Program finds community volunteers to pray daily for individual officers.

Officer Gerald W. Atchley ***(above)*** *believes that "the only way to rehabilitate a criminal is to get his soul saved." He ministers to Larry Loggins, recovering from a gunshot wound received when he allegedly threatened with a shotgun a policeman who was attempting to serve him with a warrant.*

the 150-million-dollar high-rise City of Faith Medical and Research Center, receives its first patients (pages 394-5). The first section of a planned 1,000-room hotel opens nearby to serve families of patients. With so many new projects looming in outlying neighborhoods, I sometimes thought I was watching a city fragment itself.

Still, change is the rule here. Tulsa has a habit of building on its beginnings. Area corporations bet vast sums on the natural-resources game; more than 1,200 companies



and 36,000 people are involved one way or another in the energy industry.

Tulsans pop up around the world. About 450 corporate aircraft were flying out of Tulsa during one of my visits. Largest were Boeing 727s owned by Parker Drilling, the giant onshore operator, and Hardesty, a huge construction company. Reading & Bates—offshore contract drilling, oil and gas exploration, pipeline building, coal mining—was keeping five planes and a dozen pilots busy.

American Airlines is the city's largest employer, with a work force of 5,600 at its sprawling Maintenance and Engineering Center. Neighboring McDonnell Douglas and Rockwell International, with other companies here, pioneered technology for the Apollo moon flights. Rockwell's Tulsa Facility is handcrafting the 60-foot-long gull-wing doors for the space shuttles.

I drove out to Rockwell one morning and watched men and women painstakingly building one of the doors. "It's made of

Queens for a day dress up the neighborhood. Laura Beckert, far right, and

MARTIN ROGERS

her sister Stacie watch Andrea Stewart promenade down the Beckerts' steps.

graphite," said Dick Tyndall, the supervisor. "We save about 900 pounds by using graphite epoxy instead of aluminum. What we keep in mind all the time—*all the time*—is that the doors must not fail. The shuttle gets up there and the doors don't open, that scrubs the mission. And if they open but don't close out there in space, the crew can't bring the shuttle home through the atmosphere because there's no way to keep it from burning up. In our plant here they tell us over the loudspeaker how each mission is going, and when the shuttle has landed. Now that's a fine feeling."

A port in Oklahoma? *Linked to the Mississippi, a 445-mile navigation system delivers pipe from Austria and carries away glass destined for Italy. The port, a foreign trade zone, attracts business by limiting customs formalities.*

MARTIN ROGERS

BACK IN 1971, to shrill cries of "boondoggle," this landlocked metropolis acquired a different and improbable form of transportation. I attended the birth of Tulsa Port of Catoosa, sailing in on the first tow to dock with commercial cargo. We pushed a lone barge loaded with newsprint. Modestly did Tulsa tie itself by a 1.2-billion-dollar waterway to the Great Lakes, Gulf of Mexico, and the world.

I returned recently and found that despite dismal predictions the port was paying off. Outbound shipments—oil, coal, fertilizer, grain—had set new tonnage records year after year, until the economic slowdown. Incoming cargoes, however, were considerably short of expectations.

Near the tiny community of Catoosa, a haven for outlaws called Rascal Flat in Indian Territory days, I toured a growing 2,000-acre industrial complex. Then I boarded the towboat *Tommy Sayre*, and away we glided on a cloudless day, throbbing twin diesels propelling eight barges filled with Kansas wheat.

In the wheelhouse Capt. Ronnie Price, in his early 30s an easygoing veteran of the rivers, flicked steering levers and reached for coffee on a hot plate beside him. This river, the slender Verdigris, had been dredged and shaped by the U. S. Army Corps of Engineers. A 48-mile-long waterway, it flows into the Arkansas, which leads to the Mississippi. At New Orleans, a thousand miles southeast, the wheat would begin a journey to a foreign land. Our cargo could have been auto glass for Italy, petroleum meters for Mexico, soybeans for Africa.

"It's an easier job than any I've had on the bank," drawled Captain Price. "But it does get monotonous. Six-hour shifts around the clock. Twenty days on the water, ten off. You been out here a few days, you sure like to see people."

See people? Out here in nowheresville?

"Sure. Fishermen. Families picnicking on the bank. They wave. You see lovers sometimes. They don't take much interest in us. Oh, there are things. Lots of mink on the bank, small herds of deer, raccoon. Their eyes glitter like diamonds when you catch 'em in the spotlight on a dark night. One day, it was real hot, I saw a brown bear run down into the water. He just sat there in it, up to his neck."

Encapsulated in that comfortable cage of a wheelhouse, I felt uncommon peace. A distance to the northwest the tawny Osage Hills rolled away. The Ozarks began their

low rise behind us, heading for Missouri. Green Country, people call this part of Oklahoma. For many outsiders the image of dust-bowl days lingers. Okies pounding west in jalopies with mattresses strapped on top. Forget it. Boats are what you see on the roads of a summer weekend. Half a dozen large man-made lakes lie within an hour's drive of Tulsa. In the manufacture of fishing tackle Tulsa is supreme.

The skipper poured more coffee. "The only drawback is not being home. I miss my little daughter. She's six." His voice softened. He looked from the river to me. "Can you put my daughter's name in your story?"

Glad to. Hi, Heather. Your daddy misses you a lot.

I CALLED UP Mayor James M. Inhofe not long after that, and he promptly offered me another broad view of Tulsa. An avid private pilot with an instructor's rating, he flies at every opportunity. "We'll go up first thing tomorrow," he said, and came by to collect me before dawn.

In eerie first light we coursed above the braided Arkansas River, its thin streams so many jagged streaks of silver. Jim Inhofe slid open the canopy, full of elation. "Isn't that beautiful!"

Long ago, he said, Tulsa had turned its back on the shallow river, dumping trash and garbage on its banks. Now people had pitched in to create a handsome linear park. It stretched for miles along both sides—I made out early-bird joggers moving along the winding paths. Soon a low-water dam would be completed, impounding a large recreational lake. On the empty west bank, new homes and stores would be built.

"The river was a natural barrier," the mayor went on. "It made West Tulsa a stepchild. We're overcoming that. Downtown, the railroad tracks are still a barrier. We're planning redevelopment on the north side."

He pointed the plane west. "People don't think of Tulsa as sailboat country"—the ship nosed down—"but take a look." On Keystone Lake, short miles from the city, danced a flotilla of gaudy sails. Above the lake on tree-covered hills I glimpsed expensive homes, served by a private airstrip. We buzzed it.

"Sunrise over the Tulsa mountains," said my ebullient host, turning back to base. "It's a beautiful town."

Seen this way, who would not agree? And who would not be astonished at a new vision I drank in as we settled to earth? From the valley of the Arkansas rose three otherworldly towers, an ethereal bastion radiant in gold and white. Here was the lofty City of Faith Medical and Research Center, still incomplete but beginning service.

It had long been the subject of stormy controversy—did Tulsa *need* such a facility? City of Faith officials maintained that a majority of patients would come from elsewhere in the U. S. and Canada. The battle ended when the Oklahoma Supreme Court unanimously voted to approve the hospital for 294 beds (more than 100 are now occupied).

I made my way there and wandered about. Rising 60 stories, the highest tower houses the clinic and diagnostic center. On one side of it is a 20-story clinical research center to be concerned with cancer, heart disease, problems of aging, and the crippling nerve, muscle, and joint diseases. When the City of Faith is fully operational in mid-1988, the clinic should be able to tend 4,000 patients a day. The third tower, 30 stories high, is the hospital; each patient has a doctor, nurse, and, optionally, a "prayer partner."

The hospital is designed for 777 beds. The address of Oral Roberts University, across the street, is 7777 South Lewis Avenue. Several years ago, in the early fund-raising stages of the City of Faith, evangelist Roberts asked donors to contribute in amounts of $7, $77, $777, or $7,777.

Intrigued, I asked Dr. Carl H. Hamilton, provost and executive vice president of the university, to explain. "We don't place emphasis on numerology," he said. "But in the Bible, seven is a number that is used to express perfection, completion, infinity, wholeness."

Standing before the central spire, I contemplated sculptured bronze prayer hands 60 feet high, a formidable symbol of the union of medicine and prayer. There I met and talked with Oral Roberts. The famed evangelist is 65, tall, well proportioned, warm of welcome. God's self-proclaimed agent. He has long had his instructions.

"The whole panorama was spread before

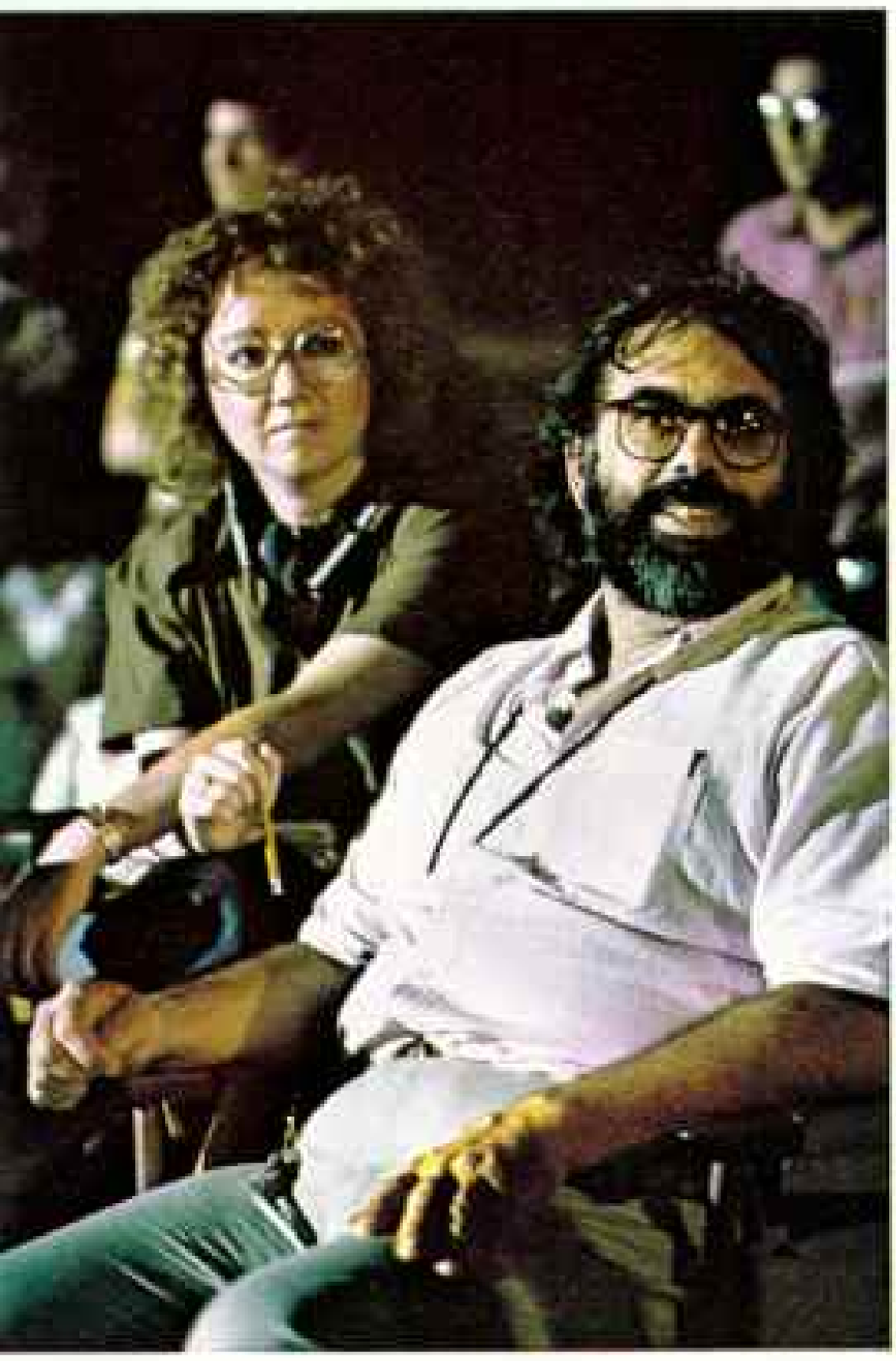
MARTIN ROGERS

***Golf's a religion** to many Tulsans, but not to evangelist Oral Roberts, an eight-handicapper playing the famed Southern Hills course with his son and likely successor, Richard (**above**). Monuments to the power of Roberts' word—heard in Tulsa since 1947—the City of Faith Medical and Research Center rises behind the Oral Roberts University campus (**right**). Between parabolic Howard Auditorium and the multiarched Learning Resources Center at left, the spired Prayer Tower provides 24-hour telephone "prayer partners" who handle some 1,900 calls a day. Some 4,000 students must obey a strict moral code and watch their weight with mandatory fitness classes.*

The medical complex, marked by 60-foot-high bronze Healing Hands, includes a hospital built for 777 beds, currently certified for 294. Even before construction began, Tulsa hospital authorities protested that the city had a bed surplus. Though daily occupancy has averaged about 100, the evangelist says legions of his believers will fill the hospital. The Lord, he avows, prescribed a contribution of $240 this year from each follower—part of a fund-raising effort that since 1977 has exceeded 150 million dollars.

me at 17 or 18," he began. "I was to get into the healing ministry. I was told that someday I was going to build a university and"—he gestured at the bronze hands—"merge medicine and prayer. When I am spoken to by the Lord, I have no advance notice. So a few years ago I felt this tingle going through me, and I knew He was dealing with me. I grabbed a pad—I always carry a yellow legal pad—and began to write. And for one hour this vision that you see here came as clear as your face. And I wrote it, every word, and I never changed a word, and I laid out plans for the hospital. It took 60 minutes, but there was a lifetime of preparation.

"I'm told there are 30 million Americans who will not take medicine or go to the hospital until it is virtually too late. Then they have guilt feelings. They think their faith has failed. If the doctors and the hospitals could have gotten to them earlier. . . . But they trusted me. And the more I was hit by



*"**Ballet Alfresco**": The Tulsa Ballet Theatre's season opens with a free performance at the Philbrook Art Center (**right**). In 1938 oilman Waite Phillips gave the people of Tulsa his Italian Renaissance villa as a museum—then threw in a downtown building to finance it.*

*Growing up in Tulsa inspired author S. E. Hinton, on a Tulsa set with Francis Ford Coppola (**above**) as he films* Rumble Fish, *based on her novel. Of the city's well-supported cultural riches she says, "I think there are better places for some of that money. Like playgrounds."*

the media, and doctors not understanding me, the more those people trusted me. Their response was like lightning. When you come here, your doctor is a praying man. Your guilt is half gone. The nurse is a praying person as well. All right. More of your guilt is gone. Now the prayer partner comes in and says, 'Let's pray together.' And then the doctor comes, and you're ready: 'Okay, doctor, whatever you have, I'm ready.'"

Oral Roberts paused. "Do you see now," he asked me, "how the Lord can give hope to 30 million people in America that nobody could handle?"

The City of Faith rests on an 80-acre site adjoining another futuristic panoply, the 500-acre campus of Oral Roberts University. Here 4,000 students live and take classes in eight accredited schools, including medicine, dentistry, and law. They observe strict codes of conduct and dress; no drinking, no smoking. Participation in a physical-fitness

program and twice-weekly attendance at chapel are mandatory. In talking with students, going to chapel with them, I found their pride in O.R.U. boundless.

Donations from Oral Roberts' followers in the United States and around the world have built the spectacular complex on Tulsa's south side. Unsurprisingly, it is the state's leading tourist attraction. It is debt free and always needful of contributions. What does it cost to operate? Around four million dollars a month for the university, which requires a 40 percent subsidy, and some 2.5 million dollars a month for the City of Faith.

A HANDFUL of miles north, but a world apart, you come to the University of Tulsa. Here the spectacular is absent. Old buildings and new blend comfortably on a spreading greensward; students dress as they please, and some wear long hair.

Like the city, the university is the product of changing times. It began as a school for Indian girls in the town of Muskogee and was moved to Tulsa in 1907 when citizens demanded a university. Today its 129.6-million-dollar endowment and trust fund places it among the nation's 25 most highly endowed private universities. Oil countries send their brightest students to Tulsa U.'s famed petroleum engineering school; energy companies recruit lawyers trained in energy law policy.

Oil made Tulsa. (Some add that air conditioning made Tulsa livable.) Oil Capital of the World, exulted boosters in black gold's heyday. By law, no wells can be drilled in the city proper. But the countryside is never far, and soon you pass ever nodding steel mule heads; watching them pump away, with oil around $30 a barrel, you may be forgiven a twinge of envy. You also see them occasionally probing in wells that were plugged 50 or more years ago when a barrel of oil was worth only 25 cents.

Back in the hills marvelous ghosts lurk, forlorn and crumbling wooden derricks, rusted hulks of machinery. My favorite derelict of boom times is the shade of Shamrock town, where the firehouse bell still hangs over the entrance; the rest of the building has disappeared, along with the old town. Oil from Shamrock and such fields helped win World War I.

I headed down the "beeline" highway from Tulsa one day with Jim Holman and his wife, Barbara. In undulating, wooded pastureland near the community of Beggs, the Holmans and their partners have drilled a number of wells. They are working an old field; around 1918 more than a hundred wells were producing here, some yielding 1,200 to 1,500 barrels a day.

"Well, I guess I'm prejudiced," Jim told me as we walked about. He is a large, outspoken, congenial man of 50, a real estate and oil investor in the freewheeling tradition. "I love Tulsa—you can do anything you've got the guts to do. Go get it! The greater the risk, the greater the reward. I went to high school two years and then

joined the Marine Corps at 16. Came out of the Korean War a sergeant. Then I drove a truck in Kansas City and got started in real estate. I came to Tulsa in 1966." He gave me a broad smile. "These wells are all producers. Named the first four after Barbara. No. 3 Barb was the biggest—121 barrels a day—until Eagle No. 2 came in at 145. We've just finished drilling Hoss No. 1. I think it's going to be our best yet!"

A FEW MILES AWAY lies Glenpool, a sleepy collection of modest dwellings, a bedroom for Tulsa. Three-quarters of a century ago it was an incredible place: a forest of derricks, a commotion beyond imagination. With 500 wells, this was perhaps the richest small pool in the world.

It happened that the land was part of the Creek Nation. The government had allotted parcels to Creeks, one of whom was a boy named Thomas Gilcrease. His mother was one-quarter Creek, his father French-Scotch-Irish. Young Gilcrease became a millionaire with the discovery of the fabulous Glenn Pool and then a multimillionaire. He set out to realize a dream, a museum devoted to the American Indian.

Now the Thomas Gilcrease Institute of American History and Art belongs to Tulsa and everybody. Featured in its vast collection, 90 percent of which cannot be displayed for lack of space, is the finest single assemblage of works by Frederic Remington and Charles Russell.

I am myself moved by Brummett Echohawk's poignant painting "Trail of Tears." It is done in tempera in black and white, the

Here's mud in your eye *and a number of other places, plastered during a gooey raceway contest called mud-boggin'. Flat out on an all-terrain vehicle, Herman Gillum* ***(left)*** *explains: "They dig a trench about 500 feet long and four feet deep and then water it about 48 hours. I mean, it's gumbo." From other heats, a pickup displays its battle splatter, as a footrace winner does to Charyl Warren* ***(right)****.*

In sports Tulsans generate only lukewarm support for their Roughnecks of soccer, Drillers of AA baseball, and Oilers of hockey. Their burning loyalty is to the alien town of Norman, site of the University of Oklahoma Sooners' gridiron. Says Bill Connors, sports editor of the Tulsa World, *"It's a riot trying to drive to Norman on a fall Saturday morning."*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Coins
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MARTIN ROGERS

*"**He knew the horse,**" self-composed epitaph of Frederic Remington, is powerfully apparent in "The Buffalo Horse" (**above,** at right) and "Comin' Thro' The Rye," at left, among 23 of his bronzes in the Thomas Gilcrease Institute of American History and Art. Other works by such masters as Charles Russell, George Catlin, Thomas Moran, and more than 120,000 rare documents, books, and Indian artifacts contribute to one of the nation's finest collections of Americana. Like many Tulsa legacies, it was begotten by oil. As a boy, Gilcrease received a 160-acre allotment of Indian Territory because his mother was one-quarter Creek—and lo, it proved to be sitting atop the rich Glenn Pool.*

*In 1935 a musical phenomenon that came to be called western swing found a home at 423 North Main Street. An old photograph of Bob Wills (**facing page**) honors the fiddle player and his Texas Playboys, who made an institution of Cain's. Also billed as Tulsa's Timeless Honky-Tonk, Cain's began as a dance academy of Madison W. "Daddy" Cain. Playing for dances there and broadcasting on KVOO radio (owned by oilman W. G. Skelly), the Playboys enjoyed their best years in Tulsa, blending folk music, blues, New Orleans jazz, big-band swing, and a special dance beat—the Wills' rhythm—into hits like "Take Me Back to Tulsa" and "San Antonio Rose." Bob died in 1975, but brother Johnnie Lee (**above left**) and his band still play for special engagements. He remembers close dancing at Cain's, "when you knew who your partner was when you got through."*

stark evocation of a dispossessed people's anguish. "I want a feeling of depression to hit everyone who sees it," the artist said. "I am proud of my heritage. In my painting I try to capture things that are meaningful."

A pureblood Pawnee, Brummett and his wife, Mary, live in a small brick bungalow not far from the Gilcrease Institute. Every morning he raises a large American flag. He speaks in detail of his World War II service, during which he was wounded. Classical music plays in his studio as he paints, using an arrow shaft to steady his hand.

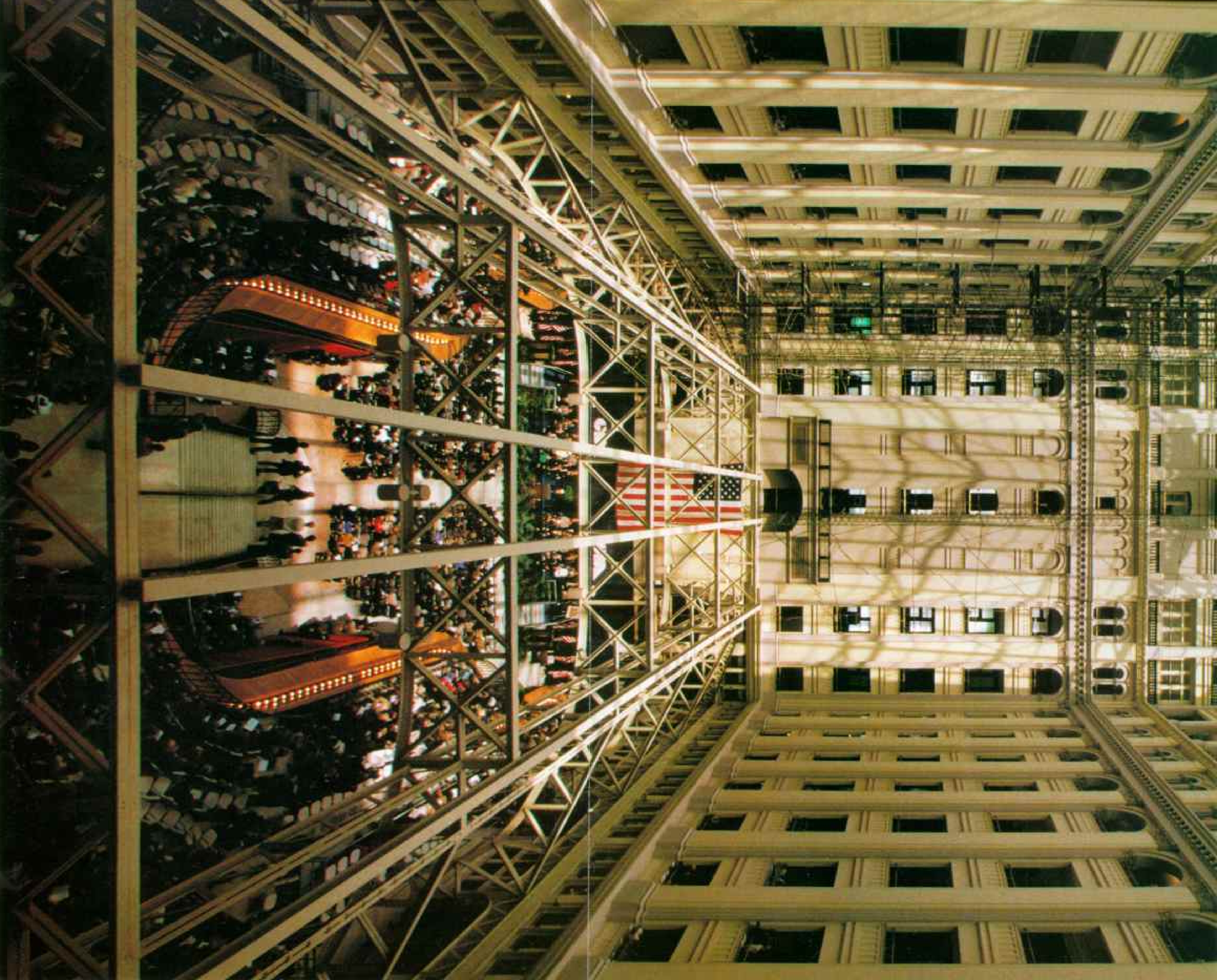
"I paint all day long," he said. "I've been doing it all my life. I'm doing my first love.

"Where is the Indian today? Society asks, 'How come the Indian isn't in the mainstream?' All we want to do is to be ourselves. That's all anyone wants. We pursue our lives like anyone else."

I shook hands with Brummett Echohawk and turned my car northeast. In half an hour I came to Claremore, where a great memorial building salutes an Oklahoman revered the world over. Will Rogers grew up near Claremore. His father, Clem, was one of those Indian cattlemen who a century ago shipped beef from Indian Territory to eastern markets.

Will Rogers had a wondrous way with words. "Live your life," he once said, "so that whenever you lose you are ahead." He knew about the Trail of Tears, and he knew about Tulsa. "A real town," Will Rogers wrote. "For it is founded on the spirit of its people." □

Honored head dancer *at a Seminole powwow near Seminole, Oklahoma, Wade Weller (**above,** at left) dresses with his brother Weston. Standout athletes at Cascia Hall Preparatory School in Tulsa, they keep close ties with their Caddo tribe, originally from Louisiana. Delegates from many of the state's 65 tribes—whites are welcome too—swell Tulsa's summer powwow with a harmony mirrored by father and daughter (**right**).*



A Preservation Victory Saves Washington's

OLD POST OFFICE

By WOLF VON ECKARDT Photographs by VOLKMAR WENTZEL NATIONAL GEOGRAPHIC PHOTOGRAPHER

THE OLD POST OFFICE building in Washington, D. C., ten floors of gray Maine granite topped by a 315-foot clock tower, looked, one critic said, like "a cross between a cathedral and a cotton mill."

It seemed to have been built under an unlucky star. In 1899, not long after the building was occupied, former Washington Postmaster James P. Willett plunged down an elevator shaft and departed this life. It became the "old" Post Office after just 15 years, replaced by a more efficient edifice. To citizens gazing up at its tower, the tallest structure in the capital save for the Washington Monument, the building was that "Old Tooth."

While accumulating grime beside Pennsylvania Avenue, the Old Tooth housed the nation's postmasters general until 1934, then the overspill of sundry federal agencies, including the Federal Bureau of Investigation. As

Eyewitness to history, *the bulky fortress completed in 1899 to house the federal postal department has viewed Pennsylvania Avenue parades from inaugural to astronaut, suffragette to war vet. Flags draped its gray granite in June 1923* ***(left)*** *for a national Shriners convention. Its clock tower looms behind President Woodrow Wilson* ***(below,*** *right of center), leading World War I soldiers on February 27, 1919, in a welcome home that included biplanes and a blimp.*

Outmoded and targeted for destruction in 1934, the Old Post Office miraculously survived and was recently renovated. Its best surprise is a soaring atrium ***(overleaf)****, here seen during rededication on April 19, 1983. Trusses, bottom, once held an interior skylight. Architects cut into the basement to create this multilevel space.*

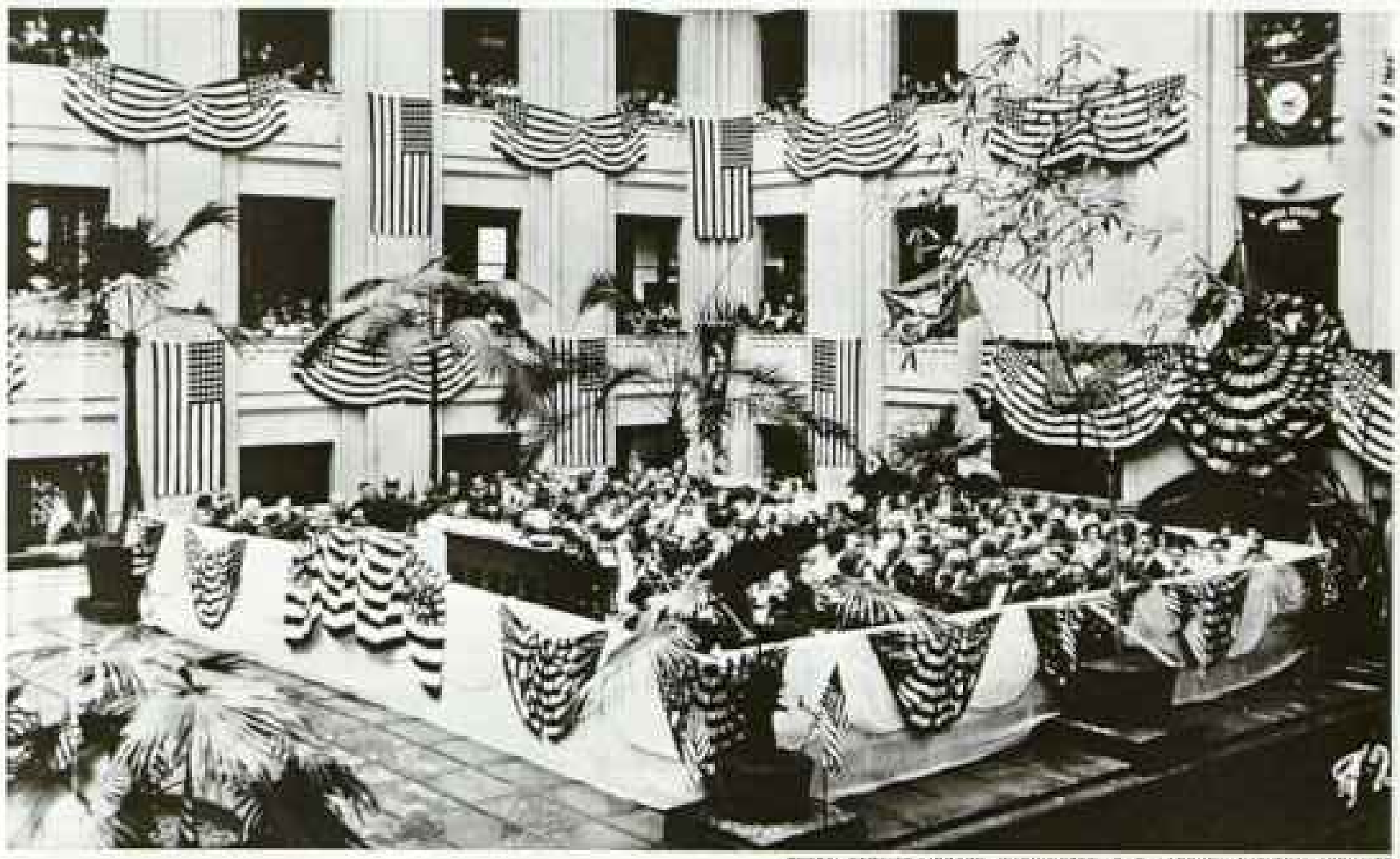
WASHINGTONIANA DIVISION, D. C. PUBLIC LIBRARY

other architectural fashions bloomed along the "Avenue of the Presidents" (***above***), the Romanesque revival style of the Old Tooth drew contempt; for decades the building lay under the threat of demolition.

But Americans have been rediscovering their cities in recent years, and the Old Post Office bids to become a tower in the movement. Reprieved and renovated, upgraded from grimy derelict to community asset, the pioneering project will combine government quarters with shops, restaurants, entertainment, and just plain fun. Its salvation was due to a mannerly public revolt, decisively abetted by the late Nancy Hanks, chairman of the National Endowment for the Arts under Presidents Nixon and Ford, and to 30 million dollars in federal funds.

Seven floors of pleasant offices already house federal agencies devoted to the arts and humanities. The arched galleries of these upper floors look down on a magnificent cortile, or inner court, 99 feet wide and 184 feet long. The first-floor area, where mail was once sorted, now boasts restaurants that overlook a stage. Roundabout on three levels, 60,000 square feet of space has been leased for specialty food shops and boutiques that will cater to both office workers and capital visitors.

That is not all. In the tower, dramatically visible through the cortile's glass canopy, ten great bells will peal from time to time, providing, their donors hope, that occasional "blinding flash of inspiration which helps drive *(Continued on page 414)*



POSTAL SERVICE LIBRARY, WASHINGTON, D. C. (ABOVE); NATIONAL ARCHIVES

Promoting Flag Day, *postal workers celebrate in the Wilson era by attending a concert, played from a stage atop the interior skylight. In 1949 Congress recognized growing observances of the June 14 salute by voting it national status.*

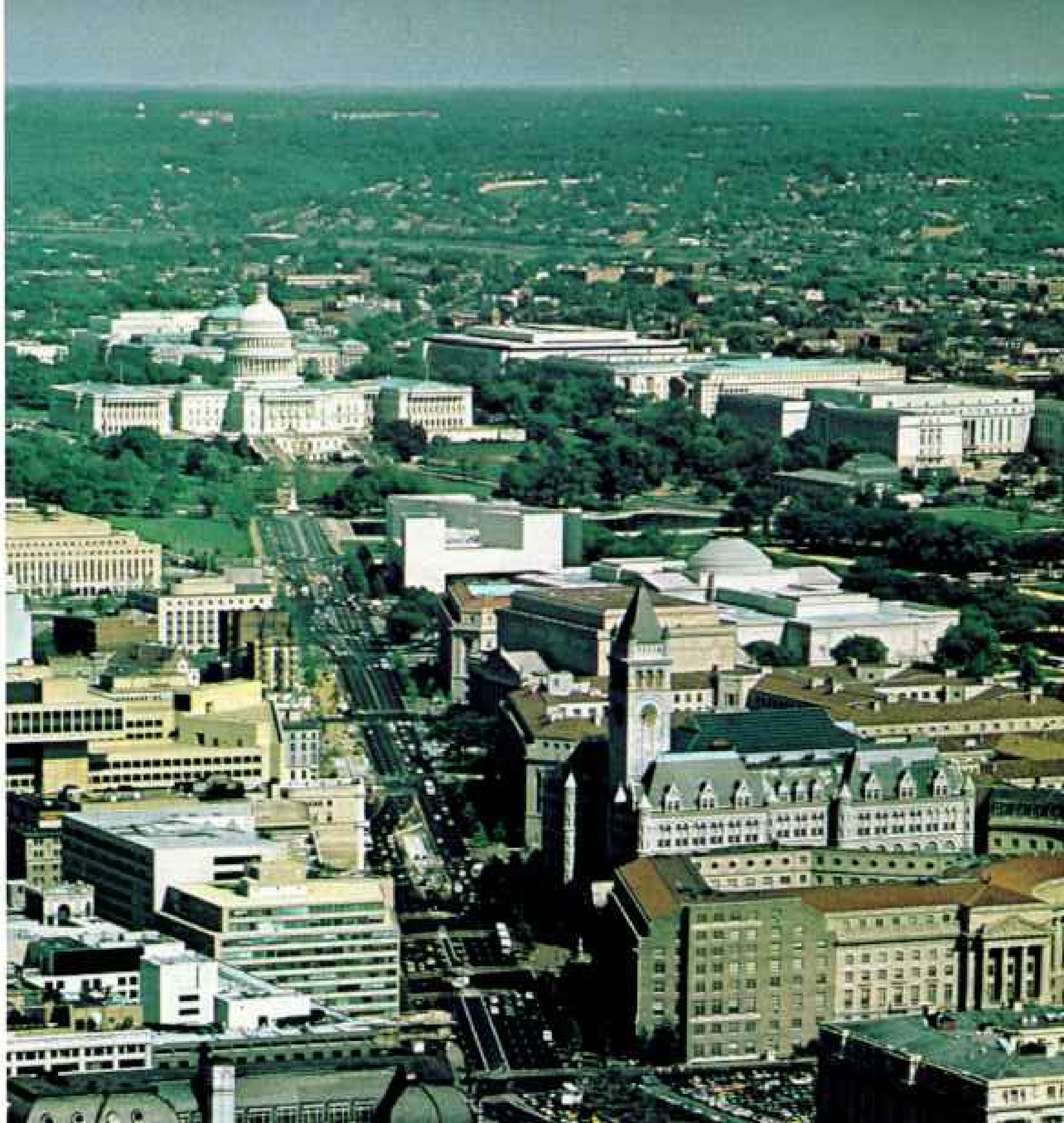
In a dim corridor federal clerks ***(left)*** *use wax to seal official envelopes. The building also served as city post office until 1914.*

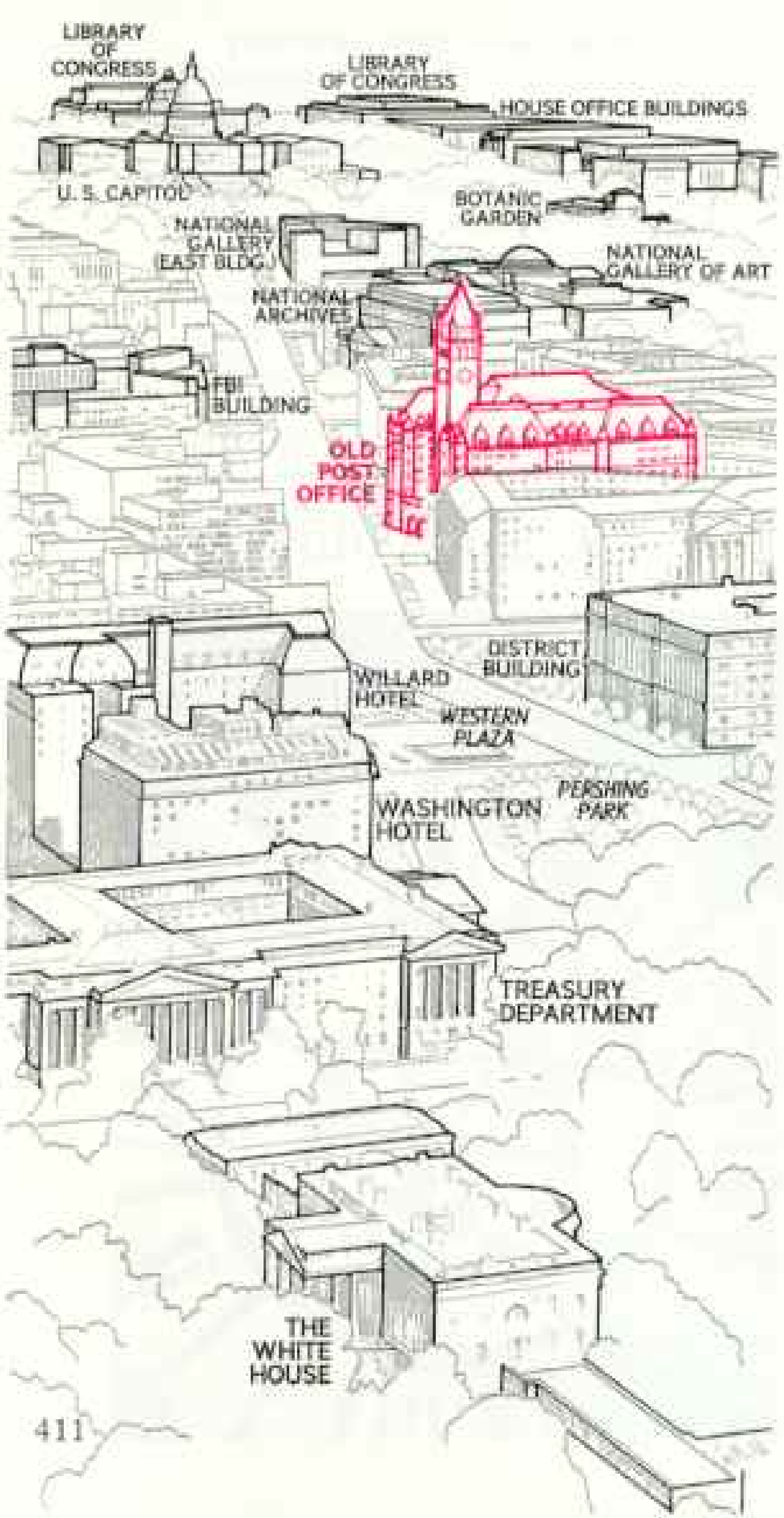
Diversity marks the nation's Main Street

*PENNSYLVANIA Avenue—showcase of changing architectural fashion—harks back to noble beginnings. City planner Pierre Charles L'Enfant envisioned a broad avenue—at the time a swampy morass—to connect the Capitol on Jenkins Hill and the President's House on a ridge 1½ miles west (**right,** lower). After the Treasury burned, its replacement in 1836, approved by President Andrew Jackson, followed the idea of placing executive departments around the President's home. The Treasury was not extended until after Jackson left office, contradicting a legend that he deliberately built it to block his view of the Congress he detested.*

From the start the thoroughfare was vibrant with vendors, a central market, gambling halls, theaters, newspaper offices, taverns, and hotels.

As soon as the Post Office opened, its style—Richardsonian Romanesque—was in disrepute. By 1926 executive departments were being urged to build in the Federal Triangle in neoclassic style. In 1964 Pennsylvania Avenue planners intended to raze the Old Post Office, except for its freestanding tower. Also targeted was the Willard Hotel, to make way for a huge plaza. But by 1980 other planners were building Pershing Park—a terraced pool garden—and Western Plaza, which maps L'Enfant's design in stone while intruding on his avenue.




LIBRARY OF CONGRESS
LIBRARY OF CONGRESS
HOUSE OFFICE BUILDINGS
U. S. CAPITOL
BOTANIC GARDEN
NATIONAL GALLERY (EAST BLDG.)
NATIONAL GALLERY OF ART
NATIONAL ARCHIVES
FBI BUILDING
OLD POST OFFICE
DISTRICT BUILDING
WILLARD HOTEL
WESTERN PLAZA
PERSHING PARK
WASHINGTON HOTEL
TREASURY DEPARTMENT
THE WHITE HOUSE

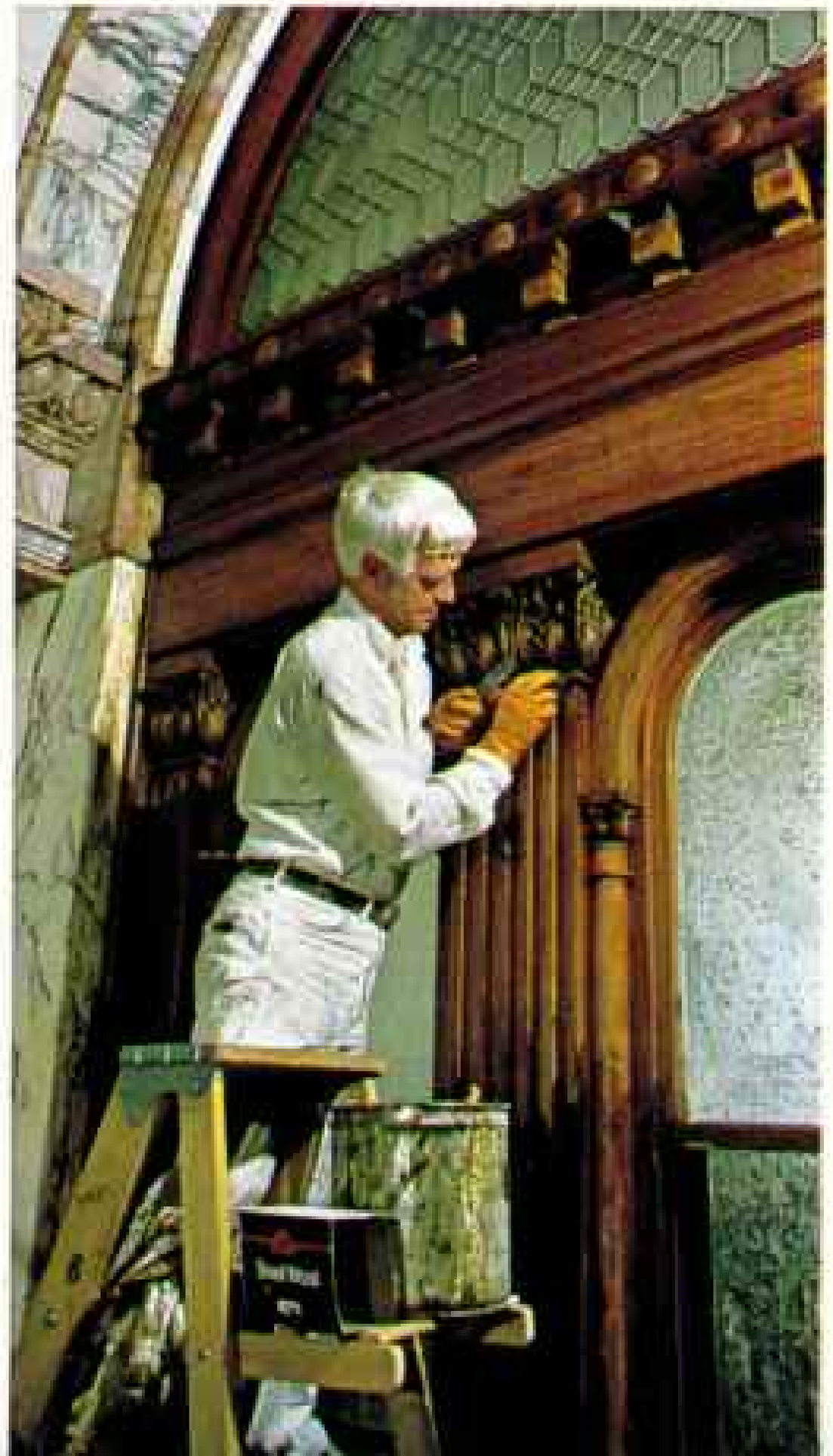
Bringing light to a stunning courtyard

*AFTER RENOVATION began in 1978, the old metal roof came off and a glass skylight was reinstalled. The glorious atrium lined with balconied corridors, reminiscent of an Italian palazzo, came back into view (**right**). After 1934, when the postal department moved out, assorted government offices had been housed here.*

High in the clock tower, the painted

*glass (**top**) of each of four dials, 15 feet in diameter, was replaced by a fiberglass screen with painted numerals to permit the sound of newly installed bells to ring across Washington. Boxed in glass, the refurbished clock mechanism can be viewed by visitors who ascend to the top of the 315-foot tower for a sweeping view of Washington.*

*Ornate brass letter box (**above**) in the 12th Street lobby recalls the building's original function. An area of the Pennsylvania Avenue foyer will become a philatelic shop. There Albert Penn (**below**) strips off multilayered paint to reveal the glow of mahogany; woodwork, most of it red oak, has been revarnished. The 175 skilled craftsmen assembled for the renovation included marble polishers, finish carpenters, and ornamental plasterers like Norval Sipes (**below right**), who cast this plaster-and-jute replacement for a damaged capital. The celery-like tendrils of another capital (**bottom**) needed no repair. Matching the original colors, painters cloaked the interior in pearl gray and creamy yellow. The eclectic ornaments and colors reflect the again-appreciated exuberance of the late Victorian age.*



GENERAL SERVICES ADMINISTRATION (ABOVE)

(Continued from page 409) civilisation on its way." A bicentennial gift to Congress from the Ditchley Foundation of Great Britain, the bells duplicate those of Westminster Abbey. In fact, they were made in the same foundry, Whitechapel, that cast bells for the abbey four centuries ago (and later cast the Liberty Bell). For a closer look, or for a panoramic view of Washington, visitors will ascend to the tower entrance in a glass-walled elevator.

The recycled building will provide a "multisensory experience" and host a "festival market," according to Charles C. G. Evans, Jr., of the Evans Development Company of Baltimore, in charge of the commercial areas. Evans is planning morning-to-evening cultural programs in the cortile, with musicians, jugglers, dancers, and puppeteers. "We are treating the city to a nonstop party," declared architect Benjamin Thompson, who designed the food and shopping areas, as well as markets in three other cities, Boston's Faneuil Hall, Baltimore's Harborplace, and New York City's South Street Seaport, all testifying to the new vitality of the American city.

LIKE MOST federal buildings of its day, the Old Post Office was designed in the Treasury Department by the office of its supervising architect, Willoughby J. Edbrooke. The design was inspired by the Allegheny County Courthouse in Pittsburgh, one of the most renowned buildings to emanate from the drawing board of Henry Hobson Richardson. In the 1870s and into the

PAINTING BY NATIONAL GEOGRAPHIC ARTIST WILLIAM H. BOND

New life, new sounds for downtown Washington

*OPENING this fall, a complex called the Pavilion promises cafés, boutiques, and a stage; upstairs offices house agencies connected with the arts. Appropriately the building and adjoining plazas compose the Nancy Hanks Center, honoring the late leader of the preservation drive. Visitors will ride the bubble elevator to the tower entrance, just below ten great bells, the only replicas ever cast of those in London's Westminster Abbey. Here Princess Alexandra and her husband, Angus Ogilvy (**below, center**), guests at the April dedication, inspect the peal, a bicentennial gift of Britain's Ditchley Foundation.*

1880s, Richardson utilized the rough stonework, massive arches, and turrets inspired by 12th-century Romanesque architecture of southern France. Edbrooke also applied the style to federal buildings in St. Paul, Milwaukee, and Omaha.

Architectural tastes change, however, especially in Washington, where officials periodically attempt to bring grandeur to streets and structures. In the great triangle of Pennsylvania and Constitution Avenues and 15th Street, the Old Post Office had been the single federal edifice. A drive for classic order and more office space, headed by Secretary of the Treasury Andrew W. Mellon, resulted in an enclave of new buildings—the Federal Triangle—in the years after World War I.

The Old Tooth was to be extracted. Only the Depression, foreshortening the Mellon plan, saved it. But time was taking a toll. Its deterioration was dramatized in 1956 when a 1,200-pound clock weight crashed through two floors.

Other buildings along Pennsylvania Avenue also needed attention. Labor Secretary Arthur J. Goldberg reported to President John F. Kennedy in 1961 that the avenue's north side was "a blighted area that is unsightly by day and empty by night." Thus was born another commission charged with replanning the avenue. Its proposals dealt in modern superblocks. Dissenting architecture would be replaced with updated versions of the Federal Triangle buildings constructed in the late 1920s and 1930s. Only the Old Post Office's tower would be allowed to remain—standing in naked solitude.

Public anger began to rise. "The Old Post Office was there first!" I protested in my "Cityscape" column in the *Washington Post* in 1970. Not many years previously, the idea of preserving an obsolete building without historic significance had seemed vaguely un-American. But now civic activists were beginning to argue that the urban environment had valuable cultural attributes and, like wilderness, needed protection from destruction and pollution.

AN EARLY pioneer in the Save-the-Old-Post-Office drive was Alison Owings, then 26, a television producer: "Every time I returned to Washington from a trip, I found another piece of the city gone. I thought of the skill and caring and effort that craftsmen applied to laying a course of brick or carving woodwork. I got mad at the arrogance of bulldozing this devotion."

On April 19, 1971, she rallied two dozen protesters in front of the doomed Old Tooth. Their slogan, Don't Tear It Down, became the name of their organization. Officials were to hear that name many times, for the group attacked the Pennsylvania Avenue plan before zoning and planning agencies, the City Council, and congressional committees.

They hoped, as did I, not merely to salvage an old pile of granite but to adapt it to another use. The ground floor, we suggested, could be "Washington's Ghirardelli." Recently

completed, San Francisco's Ghirardelli Square had rekindled urban bustle around an old chocolate factory.

The new mood began to catch on; officials who had espoused the radical rebuilding of Pennsylvania Avenue began to back away. Still, the government's landlord, the General Services Administration (GSA), adamantly clutched the death warrant. GSA is, after all, in the business of providing efficient quarters for bureaucrats; it reckoned that an extension of the nearby Internal Revenue Service building would provide twice as much office space as remodeling the Old Tooth.

ENTER NANCY HANKS, a crafty politician and a girlishly unaffected, warmhearted woman. "She cared deeply—she cared about little things," said Bill N. Lacy, who introduced her to the Old Post Office when he was director of architecture and environmental arts for the National Endowment for the Arts.

The place was a mess. The ground floor was carved up by partitions. Eighty years of grime had accumulated on the glass over the mail-sorting room. The skylight eight floors above that glass had been covered with metal sheathing. All the same, Miss Hanks was enamored.

"Nancy used all her charm, cunning, and power of persuasion to save the building," Mr. Lacy said. "I remember that our staff would meet with the GSA staff and get nowhere. Then Nancy arranged a breakfast meeting with Arthur Sampson, the GSA administrator. She took him a single red rose."

Miss Hanks talked to congressmen. She ordered a feasibility study, hoping to show that the building could be remodeled cost-effectively. She had no authority to commission that study. So she went back to Mr. Sampson—with another rose, no doubt. He agreed that GSA would cosponsor it.

"Old buildings are like friends," Miss Hanks told a Senate subcommittee. They reassure people in times of change. The National Endowment, she hoped, would "encourage people to dream about their cities—to think before they build, to consider the alternatives before they tear down." No building, she thought, could give greater visibility to the Endowment's goals than the Old Post Office.

She hoped it could be used for both government offices and public enjoyment. But commercial activities were prohibited in federal buildings by law. Her office drafted the Public Buildings Cooperative Use Act, which, passed by Congress in 1976, made it possible to bring into this and other federal buildings the throb of the marketplace and the vitality of the stage. In memory of Miss Hanks, who died last January, Congress named the Old Post Office and its plazas the Nancy Hanks Center.

Washington architect Arthur Cotton Moore had long been active in the fight to save the building. A renovation design competition was won by a joint venture of McGaughy, Marshall, & McMillan, Arthur Cotton Moore Associates, Associated Space Design, Inc., and Stewart Daniel Hoban Associates. Together they created the award-winning multitiered cortile area. When they replaced the metal roof with glass, they uncovered and enhanced what in my mind is one of the most cheerful interior spaces in all architecture.

The cortile area, named the Pavilion, was leased for 55 years to the Evans Company, which is investing nine million dollars of its own to create shops and other spaces. "It's a wonderful opportunity for both parties," Charles Evans said. "The taxpayer gets not only rent but also a share of the income from the commercial services. In other words, we shall be making money for the government."

But the greatest attraction is the setting, "the restored old building's beauty and magnificence," as Mr. Evans describes it. "No suburban shopping center can beat that."

The hum of the place is certain to attract Washingtonians as well as tourists from the great monuments on the Mall, just a short walk away. After office hours tourists have too few places to rest their feet in downtown Washington; when the workers go home, Pennsylvania Avenue still turns into a veritable necropolis.

Lighting up after dark, the Nancy Hanks Center will surely spark further activity. With the restoration of other buildings, Pennsylvania Avenue could again become a people magnet and the lively, cosmopolitan Main Street of the nation. □

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Photographed by Francois Gohier. *Pampas Deer: Genus: Ozotoceros Species: bezoarticus Adult size: Stands 69cm at the shoulder Adult weight: Approximately 45.4kg Habitat: The pampas of Argentina and grasslands of Uruguay, Paraguay, Bolivia and Brazil Surviving number: A few hundred in Uruguay, less than 100 in Argentina, unknown in Brazil, Paraguay and Bolivia*

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

The pampas deer was once one of the most common animals on the Argentine pampas and elsewhere in South America. It ranged large tracts of land in herds of hundreds of thousands. Today, because of excessive hunting in the past and continued loss of habitat, this gentle herbivore numbers no more than a few hundred.

The pampas deer 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.

The main threat to the pampas deer today is the loss of habitat. As a research tool, photography can assist in finding the means of helping the pampas deer withstand and survive in its changed and reduced range.

In addition, photography can make a dramatic point of the plight of the pampas deer and other endangered species. It can show people the natural grace and elegance of this animal and help solicit their understanding of the urgency to save such a work of creation.

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

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The
is not in the

THE PLACE.

Even the casual visitor, totally ignorant of yacht racing, will realise that, for Newport, Rhode Island, this is a very special summer.

The town is jammed. The harbour packed. Hotels and restaurants all full.

Once again, Newport is in the grip of America's Cup fever.

From May until September, 12-metre yachts and crews from all over the world have been striving to eliminate their fellow challengers, for the honour of attempting to wrest the Cup itself from the defending American boat and so put an end to the longest sporting winning streak in history.

THE RACE.

To be aboard an America's Cup 12-metre is an unforgettable experience. The silence is quite uncanny. After two years together the reactions of the crew are instantaneous and automatic…speech has become virtually superfluous. Waves do not crash over the bow, nor is there any discernible motion. The boat is held rock steady by its huge lead keel. The sails are smooth and taut; as perfectly fitted as a drumskin.

word "failure" America's Cup vocabulary.

In the cockpit the on-board computer constantly monitors wind speed, wind direction and hull speed.

This boat is designed not to do battle with the ocean, but to pass through the water with the absolute minimum of disturbance. But when things go wrong on a modern 12-metre they do so with terrifying suddenness.

A mast snaps; a line parts; a sail bursts with the sound of a cannon shot. But every crewman knows that returning the boat to top efficiency is paramount. This constant quest for speed puts both men and equipment under relentless strain. As the culmination of years of practice, training and research approaches, many of the original crew members will have been replaced. And equally, millions of dollars-worth of equipment—on occasions even the boat itself—will have been found wanting and ruthlessly discarded.

THE TIMING.

Yet, as Official Timekeepers of the event, the dependability and durability of the Rolex watch has gone unquestioned for over 20 years by challenger and defender alike.

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And for the men competing in the America's Cup, the word "failure" is not in their vocabulary.

Nor is it in ours.

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X-700

Members Forum

BROOKLYN

Your feature (May 1983) was bountiful in areas of community pride, cultural and racial diversity, and hope for that community and our nation as well. No longer will the prevailing image of Brooklyn be of violence, prejudice, and depression. I would love to fly there and embrace a city of positive growth, a beacon to us all from coast to coast.

Marc Steffler
Fallbrook, California

My bride and I recently returned to Brooklyn to be remarried 35 years later by the same priest, and in the same church. Our next priorities were to gorge on Nathan's hot dogs, then enjoy a ride across the Brooklyn Bridge. A person will never know how much of life he has missed if he hasn't lived at least two years in Brooklyn.

Patrick M. Royce
Newport Beach, California

Where else can you find a pizza, bagels and lox, a French croissant, a piece of Swedish pastry, a Chinese egg roll, and a delicious Russian knish—and never leave your own neighborhood?

Julia R. Talbot
Delta, Utah

At a dinner marking the end of my training as a resident at Kings County Hospital, I said: "I have grown rather fond of Brooklyn. I got my first car in Brooklyn; my first car was wrecked in Brooklyn. My two children were born in Brooklyn; they don't know it yet, but I will tell them as soon as they are old enough to take it."

The years have not changed my fondness for Brooklyn. I have told my children; they are fine.

Jose C. Pangan, Jr., M.D.
Ware, Massachusetts

Several years ago I left Brooklyn to complete my education and see something of our country. When I decided to come home, friends from coast to coast wanted to know why, if I left in the first place, was I returning. You answered the question perfectly. Thank you.

William Castoro
Brooklyn, New York

BROOKLYN BRIDGE

I only wish that my great-great-uncle, Charles Carlton Overton, could have shared my delight in your splendid history of the Brooklyn Bridge (May 1983). "Uncle Carlie" considered it "his" bridge, since he was among the first to cross it on its inauguration day, May 24, 1883.

Martha M. Robinson
Amherst, Massachusetts

In the fine article on the Brooklyn Bridge you mentioned that the suspension cables formed a "lazy catenary curve." It's been many years since I failed to finish at Rutgers, but I seem to remember that a catenary is the curve formed when a cord or cable is suspended freely between two points, loaded with its own weight alone. When the weight of the bridge roadway is added, the catenary becomes distorted.

David P. Samson, Jr.
Port Tobacco, Maryland

The bridge cables hung as catenaries only until the suspenders and road deck were added; then they followed approximate parabolic curves.

Reading the articles on the bridge and Brooklyn brought back memories of my youth. I can remember telling an Army buddy during World War II, when he kidded me about being from Brooklyn: "If not for the Brooklyn Bridge, the rest of the United States would float away."

Sheldon King
Hyde Park, New York

MARY ROSE

In "The Search for *Mary Rose*" (May 1983) I detect an old wives' tale in a caption that describes English archers as being "deadly accurate within 300 yards." Consider the evidence.

The National Archery Association held its 50th annual tournament in 1930 at a time when matched arrows were available and the yew bow was in its heyday. Part of the competition called for deliberate shooting of 144 arrows at a four-foot target 100 yards distant. The champion missed it 42 times. A long-range barrage by 16th-century English bowmen was devastating, but hits were more by chance than by accuracy.

Harris A. Palmer
Platteville, Wisconsin

Robin Hood aside, we're inclined to agree.

In writing of the English longbowmen, you mention "drawing" their bows. Actually, a major reason for the superiority of the English longbowmen was that they did not draw their bows, they "bent" them. In drawing the bow, the right hand and arm are used to pull back the arrow and bowstring. In bending a bow, the arrow and bowstring are held steady in the firing position, and the archer bends the bow by leaning into it with his left arm and upper body. Bending a bow, utilizing the strength of the entire upper body rather than one arm, enabled English longbowmen to use bows with greater tension and gave them the endurance to use them longer.

John G. Hemry, Lt. USN
Alexandria, Virginia

The English technique involved flexing both arms and was called "shooting inside the bow."

Page 654 refers to an "antiboarding net of woven rope." The net was a splinter net, suspended by halyards, ridgeropes, and jackstays several feet above the heads of personnel standing on the weather deck or gangways. The purpose of a splinter net was to catch rigging, sails, broken spars, and so on falling from aloft and injuring or obstructing men on deck.

In contrast to the horizontal splinter netting was the boarding netting. This could be extended vertically upward from the tops of the bulwarks or deck edge.

I do agree that a splinter net would trap personnel on the weather deck of the sinking vessel.

Clyde M. Leavitt
Ocean Springs, Mississippi

TASMANIA

Congratulations to Carolyn Bennett Patterson, not only for a vivid account of Tasmania's wild river country (May 1983), but for her opening paragraph use of the now old-fashioned word "sculpturing" rather than that modern abomination "sculpting."

V. T. Bone
Ashland, Virginia

The point is not made that in this huge area of wilderness the portion to be affected by the new dam is minuscule. Conservationists seem to forget two very important points—the necessity to conserve water in a country such as Australia, which is plagued by droughts, and to conserve our beautiful, clean, fresh air and not pollute it with the burning of fossil fuels such as coal.

Diana Ward
Lindisfarne, Tasmania

As an Australian living in Canada, I see a parallel between the saving of the Franklin wilderness and the fight to save Canadian waterways from acid rain. In both cases, beautiful and valuable national heritages are being destroyed—gradually but inexorably, by those in power.

Howard Clark
Bracebridge, Ontario

JERUSALEM

"This Year in Jerusalem" (April 1983) should be translated into many languages and distributed all over. It could also serve as an impartial guide for those politicians responsible for dealing with Middle Eastern affairs. Your regular readers have learned more facts about this city and its inhabitants than ever published before.

Johannes Vennix
Oisterwijk, Netherlands

On finishing your superb article on Jerusalem in one breath, I was left with an iota of disappointment. You had left out the name of your agnostic friend, a man worthy of his name in a world surrounding him with men of blind faith.

Zacky Zakariya
Paris, France

WORLD OF TRASH

In "The Fascinating World of Trash" (April 1983) you accurately depict the uninspiring history of large-scale automated resource-recovery plants. The current sad state of resource recovery is the direct result of unwillingness to properly invest in research prior to launching a new technology. At Duke University we are quite actively trying to further research in resource recovery; we have had very encouraging results to date. Large-scale automated resource recovery is definitely feasible; we feel we understand much of what remains to be done. With realistic funding levels for research, many of our cities could seriously consider getting "gold from refuse."

Richard Ian Stessel
Durham, North Carolina

The 400 million tons of municipal, agricultural, and forestry wastes that we throw away each year are an incredible waste of our limited resources. The potential energy savings in recycling municipal trash and converting it to energy adds up to 10 percent of our energy needs. Even worse, landfills are dangerous to our health. Nationwide in 1980, about 75 percent of our landfills were out of compliance with prohibitions against groundwater contamination, open burning, disease prevention, odors, or surface-water pollution. We need to get moving on recycling, composting, and waste-to-energy systems.

Terry A. Trumbull, Chairman
California Waste Management Board
Sacramento, California

Letters should be addressed to ***Members Forum****, National Geographic Magazine, Box 37448, Washington, D. C. 20013, and should include sender's address and telephone number. Not all letters can be used. Those that are will often be edited and excerpted.*

Members Forum

On Assignment

CHERYL ROSS

VOLKMAR WENTZEL

IN THE DEPTHS of the Depression a dreamy adventure-seeking teenager set out hitchhiking from Binghamton, New York, bent on a goodwill mission to South America. By the time ***Volkmar Kurt Wentzel*** reached Washington, D. C., reality set in. He was broke. But with a working knowledge of cameras and darkrooms, he found jobs, eventually at the National Geographic photo laboratory.

On foggy nights Kurt prowled the city with his camera, finding that the monuments shone "as with an inner glow." His portfolio, including this scene of the Capitol and the Old Post Office tower, then planned for demolition, was published in the April 1940 NATIONAL GEOGRAPHIC. It marked the first of scores of world-ranging assignments, as the camera became "my passport to a fascinating life."

Before the jet and jeep made the world readily accessible, Kurt traveled by freighter to India and outfitted an army-surplus ambulance for a two-year photo survey of the subcontinent. To reach Ladakh, he traveled on foot and by pony. His color images were among the first of little-known western Nepal, Tibetan monastery libraries, cave temples at Ajanta and Ellora. His photos of Mount Everest helped Sir Edmund Hillary plan his climb.

Kurt covered prewar Sweden, postwar Berlin, lands girdling the Atlantic. His lens gave readers last glimpses of Portugal's overseas empire and fast-changing African kingdoms.

Recently, like a circle closing, Kurt was home in his beloved Washington, recording the renovation of a favorite landmark, the Old Post Office (***above left***). For the article, he teamed with respected architecture critic ***Wolf Von Eckardt,*** formerly with the *Washington Post,* now with *Time*.

Concerned with historical preservation, Wentzel has spearheaded the Society's efforts to preserve its extensive library of Autochrome glass plates and other early color photographs made in the first decades of this century.

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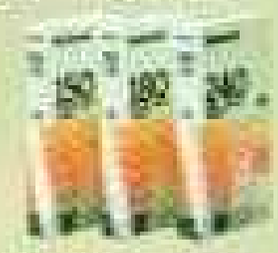

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