

SPECIAL RECORDING: "SOUNDS OF THE SPACE AGE" (page 750)

VOL. 136, NO. 6

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NATIONAL GEOGRAPHIC

FIRST EXPLORERS ON THE MOON

THE INCREDIBLE
STORY OF APOLLO 11
IN FIVE PARTS 735

YANKEE SAILS TURKEY'S
HISTORY-HAUNTED COAST 798
IRVING AND ELECITA JOHNSON
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INSIDE A HORNBILL'S
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OF THE AGE OF FAITH 857
KENNETH McLEISH
DEAN CONGER

*"...in peace for
all mankind"*

December 1969

NATIONAL GEOGRAPHIC

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*"... in peace for
all mankind"*

FIRST EXPLORERS ON THE MOON



NEIL A. ARMSTRONG (LEFT) AND EDWIN E. ALDRIN, JR., RAISE THE AMERICAN FLAG ON THE SEA OF TRANQUILITY, JULY 20, 1969. AN AUTOMATIC SEQUENCE CAMERA MADE THE PHOTOGRAPH.

THE INCREDIBLE STORY OF APOLLO 11

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



EXTRACHROMES BY NEIL A. ARMSTRONG, NASA

FOOTPRINT ON THE VIRGIN MOON marks fulfillment of an age-old dream, which was made a national objective by President John F. Kennedy on May 25, 1961. The United States, he said, "should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth." Neil Armstrong and Edwin Aldrin set foot on the moon's firm, granular surface 5 months and 11 days before the end of the 1960's.

AT DAWN OF A TWO-WEEK LUNAR DAY, Edwin Aldrin strides across a small crater near one of Eagle's foil-wrapped landing probes. Visor reflects his long black shadow, the solar wind collector, the Stars and Stripes planted by the moonwalkers, the white figure of Armstrong (who took this picture), and the buglike lunar module. A few hours earlier the two men had flashed the words that thrilled a waiting world: "Tranquillity Base here. The Eagle has landed." While Armstrong and Aldrin explore the surface, Michael Collins keeps lonely vigil in Columbia, Apollo 11's command module orbiting the moon.





I: Man Walks on Another World

Historic words and photographs by NEIL A. ARMSTRONG, EDWIN E. ALDRIN, JR.,

THE TALK was weighted with cryptic exchanges of scientific data, but still it rang with the stupendous drama of the greatest achievement in the history of exploration. For these were the voices of Apollo 11—voices carrying over nearly a quarter of a million miles to tell of man's first steps on the moon. The world listened as Neil Armstrong, Edwin (Buzz) Aldrin, and Michael Collins spoke to each other and to CapCom, the capsule communicator in Houston. And as Eagle (the lunar module) separated from Columbia (the command module) and touched down in the dust of that desolate, windless world on July 20, at 4:17 and 43 seconds p.m. (EDT)—102 hours, 45 minutes, and 43 seconds after launch—this in part is what was said:

ARMSTRONG: Houston, Tranquillity Base here. The Eagle has landed.

CAPCOM (Astronaut Charles M. Duke): Roger, Tranquillity, we copy you on the ground. You got a bunch of guys about to turn blue. We're breathing again. Thanks a lot.

COLLINS (in Columbia): Fantastic!

ARMSTRONG: Houston, that may have seemed like a very long final phase. The auto-targeting was taking us right into a...

crater, with a large number of big boulders and rocks... and it required... flying manually over the rock field to find a reasonably good area.

CAPCOM: Roger, we copy. It was beautiful from here, Tranquillity. Over.

ALDRIN: We'll get to the details of what's around here, but it looks like a collection of just about every variety of shape—angularity, granularity, about every variety of rock... The colors—well... There doesn't appear to be too much of a general color at all; however, it looks as though some of the rocks and boulders [are] going to have some interesting colors to them. Over.

CAPCOM: Rog, Tranquillity. Be advised there are lots of smiling faces in this room and all over the world. Over.

ARMSTRONG: There are two of them up here.

COLLINS: And don't forget one in the command module... And thanks for putting me on relay, Houston. I was missing all the action.

CAPCOM: Rog, Columbia... Say something. They ought to be able to hear you...

COLLINS: Roger, Tranquillity Base, it sure sounded great from up here. You guys did a fantastic job.

ARMSTRONG: Thank you. Just keep that orbiting base ready for us up there now.

CAPCOM: Tranquillity Base... Houston. All your consumables are solid [normal consumptions of fuel and oxygen]. You're looking good in every respect... Everything is copacetic. Over.

ARMSTRONG: You might be interested to know that I don't think we notice any difficulty at all in adapting to 1/6 g; at least, immediately natural to move in this environment.

CAPCOM: Roger, Tranquillity. We copy. Over.

ARMSTRONG: [Outside the] window is a relatively level plain cratered with a fairly



PICTURE TRANSMITTED BY TV CAMERA MOUNTED ON LUNAR MODULE, SASA

"Live from the moon." That message flashed across TV screens the world over when Armstrong's ghostly figure appeared, groping with a heavy-booted foot from the last rung of the ladder. He stepped to the lunar module's footpad and then to the surface of the moon as an estimated one fourth of earth's people shared history in the making via TV and radio from 240,000 miles away.

and MICHAEL COLLINS

large number of craters of the five- to fifty-foot variety and some ridges, small, twenty, thirty feet high, I would guess, and literally thousands of little one- and two-foot craters around the area. We see some angular blocks out several hundred feet in front of us that are probably two feet in size and have angular edges. There is a hill in view, just . . . ahead of us, difficult to estimate but might be a half a mile or a mile.

COLLINS: Sounds like it looks a lot better now than it did yesterday at that very low sun angle. It looked rough as a cob then.

ALDRIN: . . . I'd like to take this opportunity to ask every person listening in, whoever and wherever they may be, to pause for a moment and contemplate the events of the past few hours, and to give thanks in his or her own way. Over.

The astronauts begin preparations to leave the LM, first having made a detailed check of their craft to make sure all is in order for eventual lift-off. Armstrong will be the first out, about 6½ hours after the landing.

ARMSTRONG: The hatch is coming open.

ALDRIN: Neil, you're lined up nicely. Toward me a little bit. O.K., down.

ARMSTRONG: How am I doing?

ALDRIN: You're doing fine.

ARMSTRONG: O.K., Houston, I'm on the porch.

CAPCOM (now Astronaut Bruce McCandless):

Man, we're getting a picture on the TV.

ALDRIN: Oh, you got a good picture, huh?

CAPCOM: There's a great deal of contrast in it, and currently it's upside down on our monitor, but we can make out a fair amount of detail. . . . O.K., Neil, we can see you coming down the ladder now.

ARMSTRONG: I'm at the foot of the ladder. The LM [lunar module] footpads are only depressed in the surface about one or two inches, although the surface appears to be very, very fine grained, as you get close to it. It's almost like a powder. Now and then it's very fine. I'm going to step off the LM now. That's one small step for a man, one giant leap for mankind.

The television camera on the LM records Armstrong's first movements through the moon's dark shadows and blinding sunlight.

ARMSTRONG: The surface is fine and powdery. I can—I can pick it up loosely with



EXTRACAMERA BY NEIL A. ARMSTRONG, NASA

An eager Aldrin joins Armstrong on the moon 19 minutes later. On his back rides a portable life-support system with oxygen for breathing, water for cooling, an electric-power supply, and radio equipment.

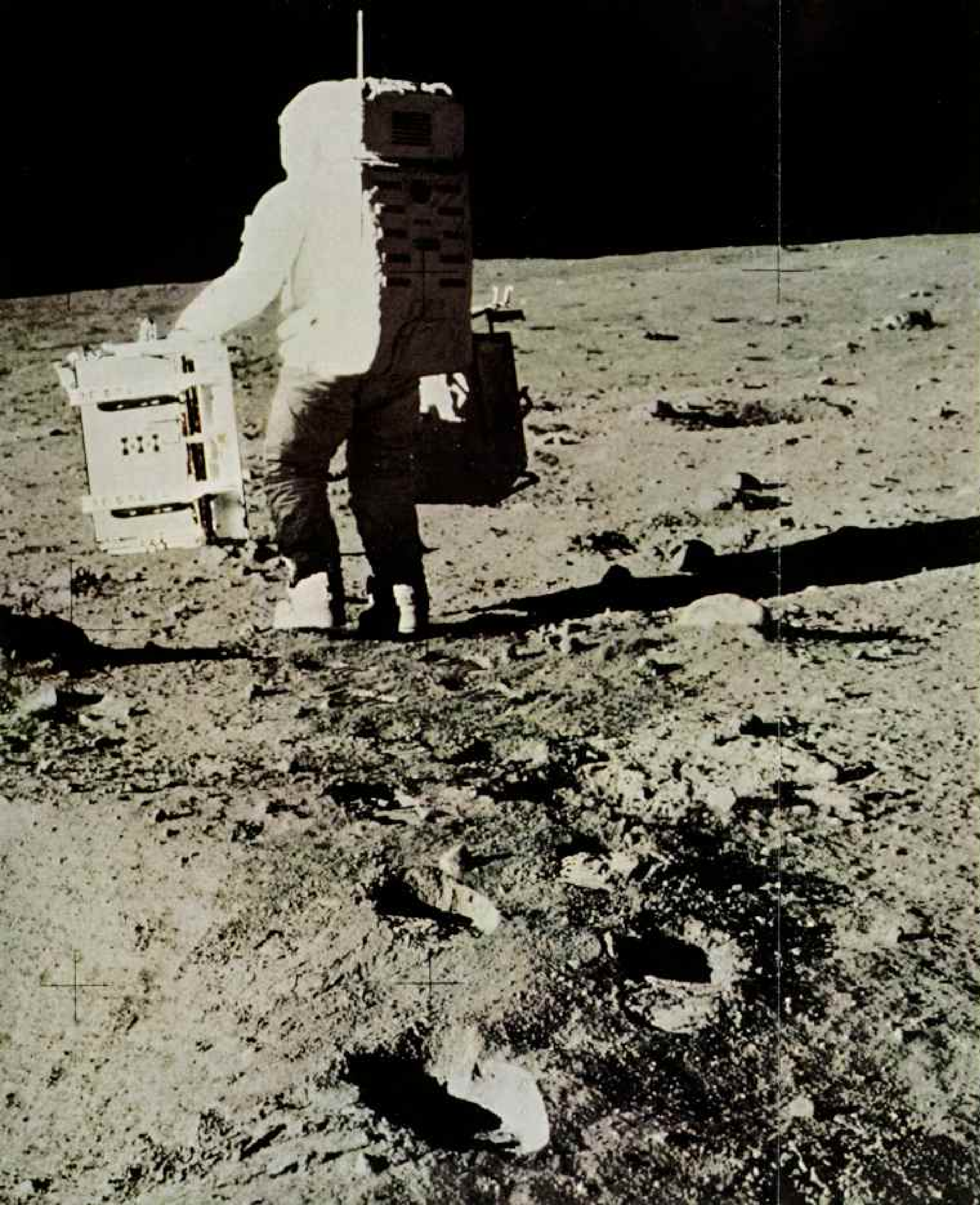
my toe. It does adhere in fine layers like powdered charcoal to the sole and sides of my boots. I only go in a small fraction of an inch, maybe an eighth of an inch, but I can see the footprints of my boots and the treads in the fine sandy particles.

CAPCOM: Neil, this is Houston. We're copying.

ARMSTRONG: There seems to be no difficulty in moving around. As we suspected, it's even

(Continued on page 746)

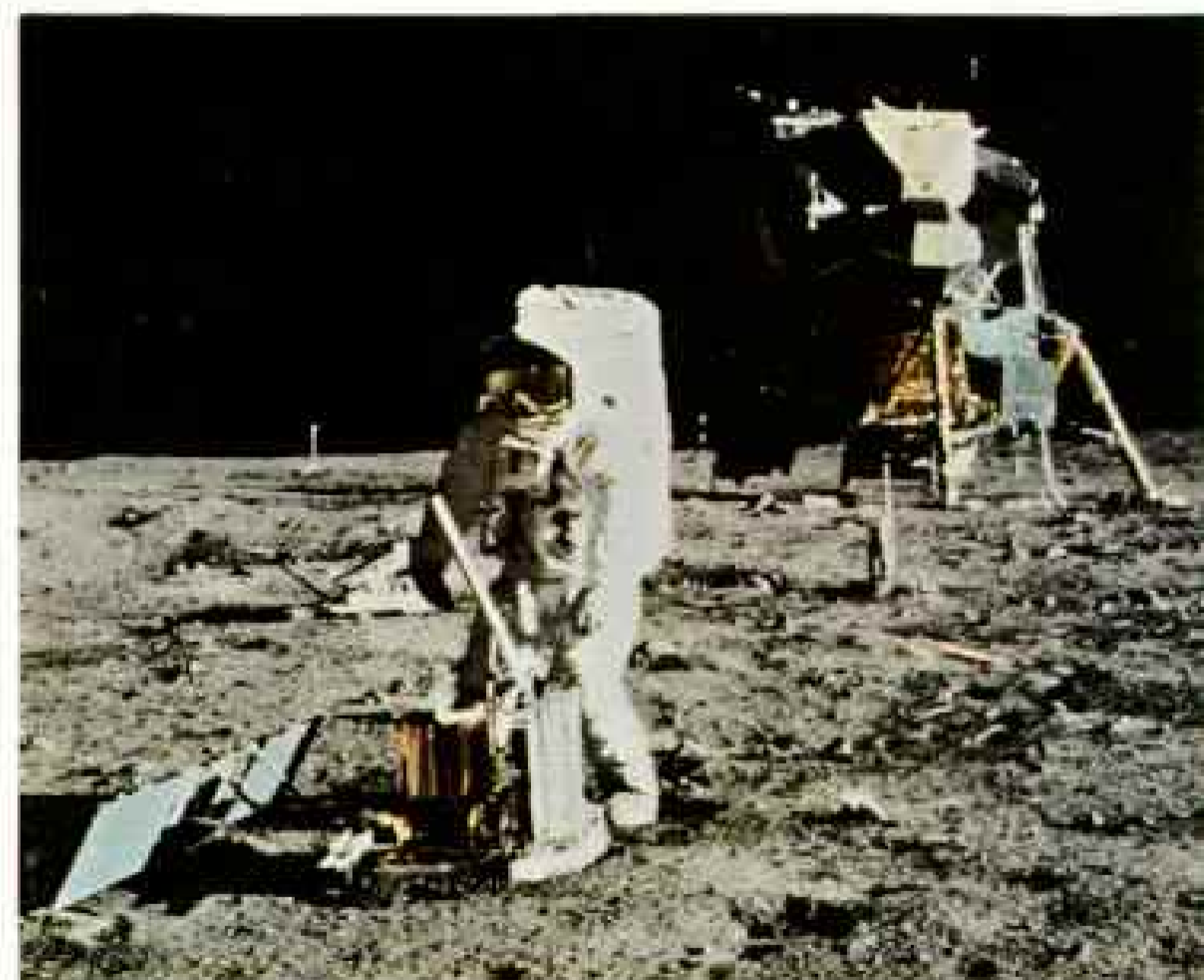




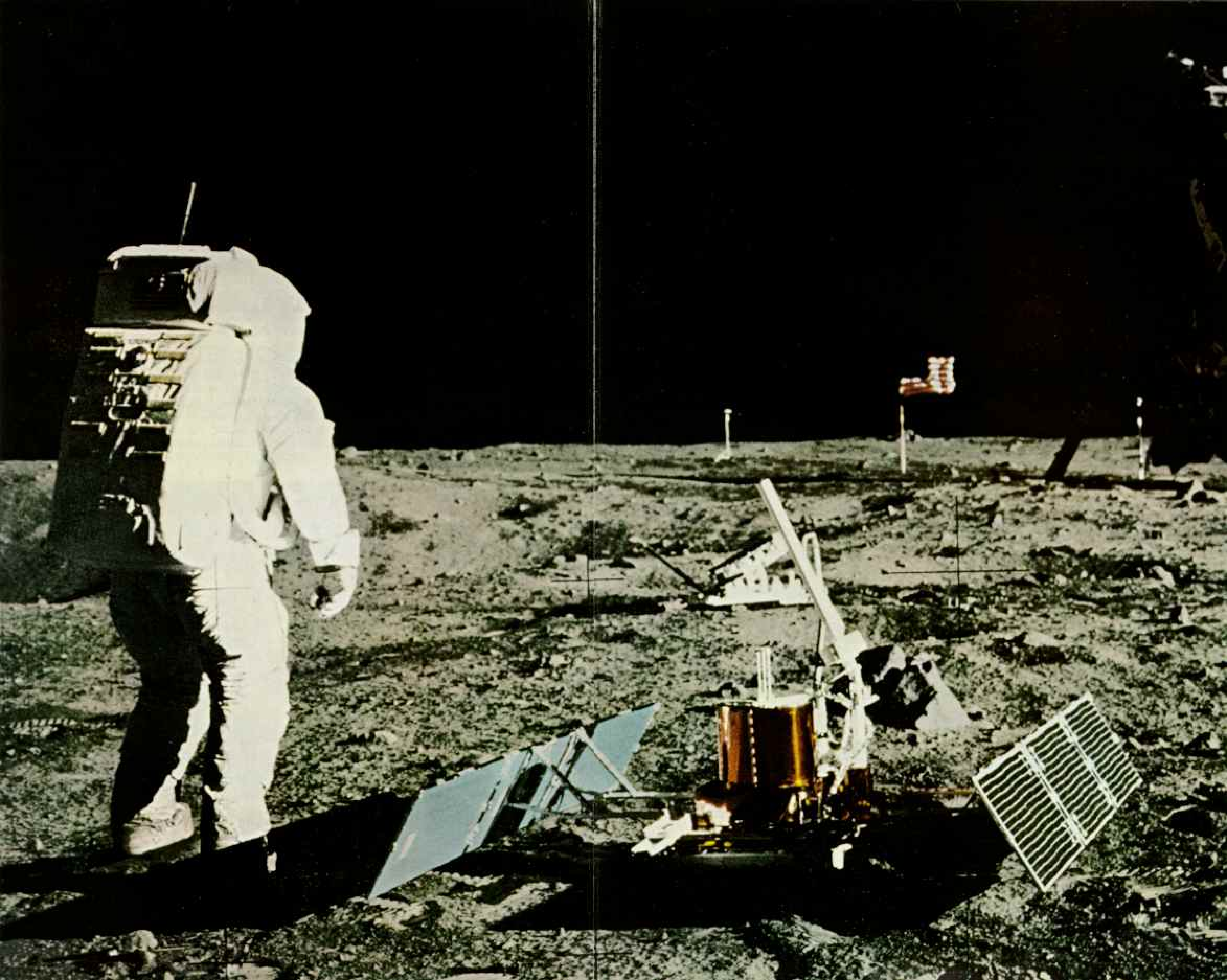
EXTRACHROMES (INCLUDING FOLLOWING PAGES) BY NEIL A. ARMSTRONG, NASA

Spaceman at work for science, Aldrin (left) makes three- to four-inch-deep tracks as he bypasses a crater. He carries a laser reflector (right hand) and a seismic unit to record lunar tremors. Aldrin's weight, including backpack, space suit, and apparatus, would total more than 500 pounds on earth, but the weak lunar gravity reduces it to less than 100, and the astronaut literally bounces as he walks. Some 60 feet from the spacecraft, he sets up the seismic unit (above and below).

Eagle's crinkled-foil insulation creates a fiery glow. Yellow object on the ground is part of the plastic laser-reflector cover.



Ready to check the pulse of the moon (following pages), the seismic unit—four seismometers in one—is powered by solar panels and has nuclear heaters to help it withstand frigid lunar nights. Aldrin returns to *Eagle* after setting up the instrument, which is so sensitive it can detect pea-size meteorites hitting the moon half a mile away. Laser reflector, behind the seismic unit, bounces narrow light beams back to earth so physicists can measure earth-moon distances precisely.







PHOTOGRAPH BY EDWIN E. ALDRIN, JR., NASA

Back inside *Eagle* after his two hours and twenty minutes outside the spacecraft, moon explorer Armstrong wears a grin as he talks into a microphone to Houston. Safely aboard are the prized samples of soil and rock.

perhaps easier than the simulations at 1/6 g that we performed . . . on the ground. It's actually no trouble to walk around.

The descent engine did not leave a crater of any size. . . . We're essentially on a very level place here. I can see some evidence of rays emanating from the descent engine, but very insignificant amount. O.K., Buzz, we're ready to bring down the camera.

ALDRIN: I'm all ready.

ARMSTRONG: O.K., it's quite dark here in the shadow and a little hard for me to see that I have good footing. I'll work my way over into the sunlight here without looking directly into the sun.

ALDRIN: O.K., going to get the contingency sample now, Neil?

ARMSTRONG: This is very interesting. It's a very soft surface, but here and there where I plug with the contingency sample collector, I run into a very hard surface, but it appears to be very cohesive material of the same sort. I'll try to get a rock in here. Here's a couple.

ALDRIN: That looks beautiful from here, Neil.

ARMSTRONG: It has a stark beauty all its own. It's like much of the high desert of the United States. It's different, but it's very pretty out here.

ALDRIN: Are you ready for me to come out?

ARMSTRONG: All set, O.K., you saw what difficulties I was having. I'll try to watch your PLSS [portable life-support system] from underneath here.

ALDRIN: Now I want to back up and partially close the hatch. Making sure not to lock it.

ARMSTRONG: A particularly good thought.

ALDRIN: That's our home for the next couple of hours and we want to take good care of it. . . . That's a very simple matter to hop down from one step to the next.

ARMSTRONG: There you go.

ALDRIN: Beautiful view.

ARMSTRONG: Isn't that something? Magnificent sight out here. . . . Isn't it fun?

ALDRIN: . . . The rocks are rather slippery. . . .

Have to be careful that you are leaning in the direction you want to go. . . . You have to cross your foot over to stay underneath where your center of mass is. And, Neil, didn't I say we might see some purple rocks?

ARMSTRONG: Find a purple rock?

ALDRIN: Yep. Very small, sparkly. . . .

ARMSTRONG: For those who haven't read the plaque, we'll read the plaque that's on the front landing gear of this LM. First there's two hemispheres, one showing each of the two hemispheres of earth. Underneath it says, "HERE MEN FROM THE PLANET EARTH FIRST SET FOOT UPON THE MOON JULY 1969, A.D. WE CAME IN PEACE FOR ALL MANKIND." It has the crew members' signatures and the signature of the President of the United States.

COLLINS (in *Columbia*): . . . This is history.

CAPCOM: Roger. . . . I believe they are setting up the flag now.

COLLINS: Great.

CAPCOM: I guess you're about the only person around that doesn't have TV coverage.

COLLINS: That's right. That's all right. I don't mind a bit. How is the quality of the TV?

CAPCOM: Oh, it's beautiful, Mike. Really is.

COLLINS: Oh, gee, that's great. Is the lighting halfway decent?

CAPCOM: Yes, indeed. They've got the flag up now and you can see the Stars and Stripes on the lunar surface.

COLLINS: Beautiful. Just beautiful.

ALDRIN: You do have to be rather careful to keep track of where your center of mass is. Sometimes it takes about two or three paces to make sure that you've got your

feet underneath you. . . .

CAPCOM: Neil and Buzz, the President of the United States is in his office now and would like to say a few words to you. Over.

ARMSTRONG: That would be an honor.

CAPCOM: Go ahead, Mr. President.

PRESIDENT NIXON: Hello, Neil and Buzz, I am talking to you by telephone from the Oval Room at the White House. And this certainly has to be the most historic telephone call ever made from the White House.

I just can't tell you how proud we all are of what you have done. For every American, this has to be the proudest day of our lives, and for people all over the world I am sure they, too, join with Americans in recognizing what an immense feat this is.

Because of what you have done, the heavens have become part of man's world. And as you talk to us from the Sea of Tranquility, it inspires us to redouble our efforts to bring peace and tranquillity to earth.

For one priceless moment in the whole history of man, all the people on this earth are truly one. One in their pride in what you have done. And one in our prayers, that you will return safely to earth.

ARMSTRONG: Thank you, Mr. President. It's a great honor and privilege for us to be here representing not only the United States, but men of peace of all nations. And with interest and a curiosity and a vision for the future. It's an honor for us to be able to participate here today.

ALDRIN: How's the bulk sample coming, Neil?

ARMSTRONG: Bulk sample is . . . sealed.

ALDRIN: Houston. The passive seismometer has been deployed manually.

ARMSTRONG: These boulders look like basalt and they have probably 2 percent white minerals in them. . . .

Armstrong has been on the surface of the moon nearly two hours now. The astronauts have devoted most of their time to setting up scientific instruments and taking samples of moon material. Houston advises them that they have about ten minutes left before beginning preparations to re-enter the LM.

ALDRIN (collecting a core sample): I hope you're watching how hard I have to hit this into the ground to the tune of about five inches. . . . It almost looks wet.

CAPCOM: Buzz, this is Houston. It's about time for you to start your EVA [extravehicular activity] close-out activities.

ARMSTRONG: . . . I'm picking up several pieces of really vesicular rock out here now.

CAPCOM: Roger, Neil and Buzz. Let's press



To peace and fallen comrades: *Eagle's* crew left on the moon a shoulder patch of the Apollo 1 mission, to honor Astronauts Gus Grissom, Edward White, and Roger Chaffee, who died in a launch simulation fire, and medals (not photographed) commemorating two Soviet cosmonauts—Yuri Gagarin and Vladimir Komarov—who lost their lives in their nation's space effort. With these mementos lie a gold olive branch symbolizing peace and a silicon disk (not shown) about the size of a half dollar, etched microscopically with good-will messages from leaders of 73 countries. Marking the historic spot stands *Eagle's* abandoned landing stage, bearing the plaque (upper) signed by the astronauts and President Nixon.

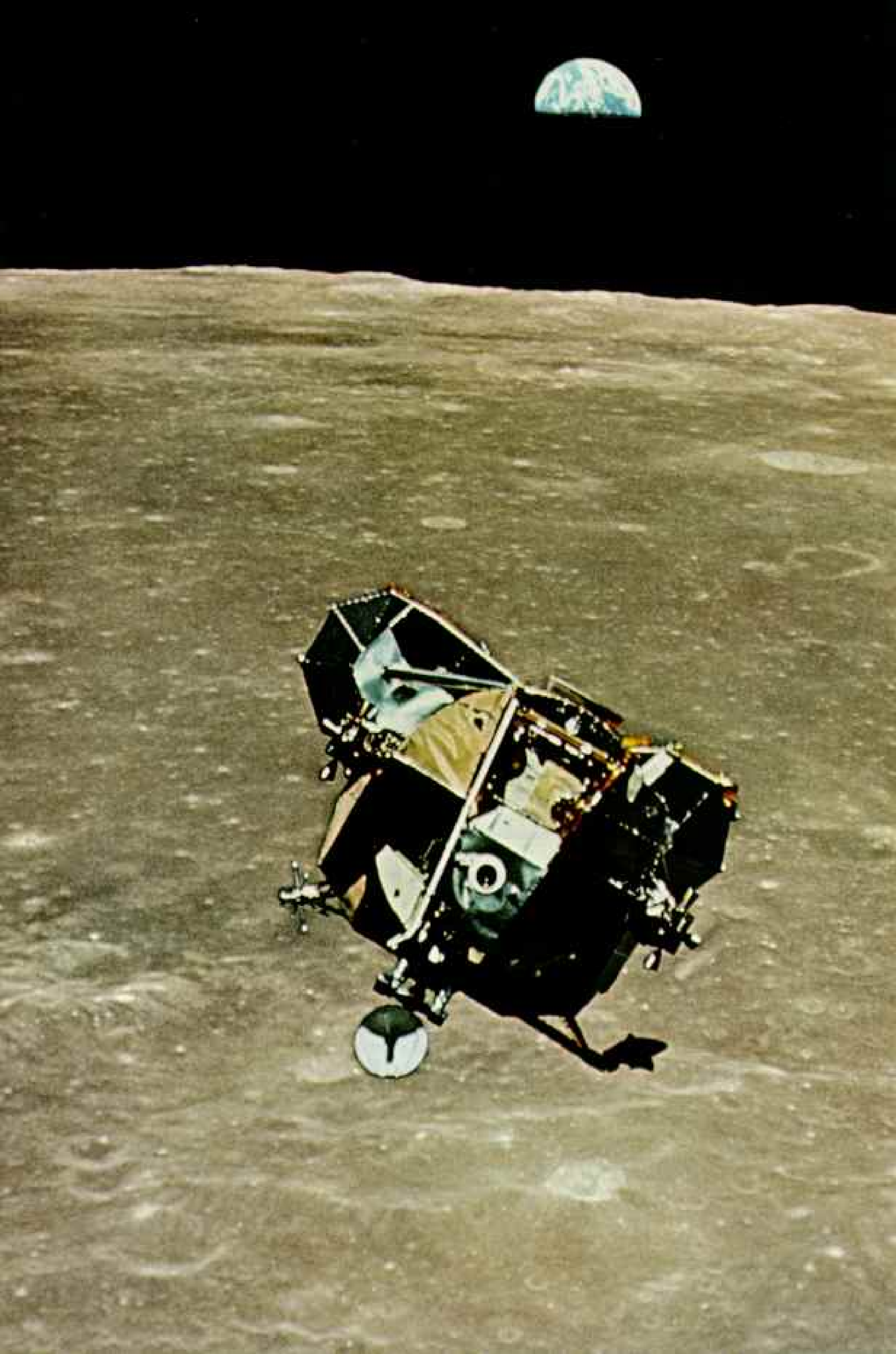
on. . . We're running a little low on time.
ALDRIN: . . . I'll head on up the ladder. . . .

Adios, amigos.
Just as he was the first to step onto the moon, Neil Armstrong is the last to step off. After loading about fifty pounds of rocks and soil in the LM by means of a rope-and-pulley hoist, he climbs up the ladder. Aldrin guides him through the hatch.

ALDRIN: . . . Now start arching your back.
That's good. Plenty of room.

ARMSTRONG: Thank you. I'm bumping now?

ALDRIN: Now you're clear. You're rubbing up against me a little bit. . . . Now move your



Riding to rendezvous with a half earth in sight, Armstrong and Aldrin guide *Eagle* to its docking with *Columbia*. "Absolutely beautiful," said Collins. The eastern rim of the moon lies 70 miles below.

EXCERPTS BY MICHAEL COLLINS, NASA

foot and I'll get the hatch. . . . The hatch is closed and latched.

CAPCOM: . . . The crew of Tranquillity Base is back inside their base. . . everything went beautifully.

COLLINS: Hallelujah!

ARMSTRONG: Houston, Tranquillity Base. Repress [repressurization] complete.

CAPCOM: Roger, Tranquillity. We observed your equipment jettison on TV, and the passive seismic experiment reported shocks when each PLSS hit the surface. Over.

ARMSTRONG: You can't get away with anything any more, can you?

CAPCOM: . . . We would like to say from all of us down here in Houston and really from all of us in all the countries and in the entire world, we think that you have done a magnificent job up there today. Over.

ALDRIN: Thank you very much. It has been a long day.

CAPCOM: Yes, indeed. Get some rest there. . . .

ALDRIN: Houston, Tranquillity. Have you had enough TV for today?

CAPCOM: Tranquillity, this is Houston. Yes, indeed; a mighty fine presentation.

ALDRIN: O.K., signing off. See you tomorrow.

It is nearly 12 hours since Eagle's landing when the television camera on the moon stops transmitting. Armstrong and Aldrin rest before the critical lift-off. If the engine fails to ignite, there will be no return to earth for the two astronauts. Houston announces that ignition is two minutes away. And then:

ALDRIN: . . . That was beautiful. Twenty-six, 36 feet per second up. . . very smooth. . . very quiet ride. There's that one crater down there.

CAPCOM (now Astronaut Ronald Evans): *Eagle*, Houston. One minute and you're looking good.

ALDRIN: . . . 150 up. Beautiful.

CAPCOM: . . . You are go. . . everything is looking good.

ARMSTRONG: I'm going right down U. S. 1.

What remains now is Eagle's docking with Columbia, the 60-hour ride back to earth, and the searing re-entry. The spacecraft come together, only to be gripped in a moment of unexpected motion.

COLLINS: That was a funny one. . . did it appear. . . that you were jerking around quite a bit during the retract cycle?

ARMSTRONG: Yeah. It seemed to happen at the time I put the plus X [upward] thrust to it. . . .

COLLINS: Yeah, I was sure busy there for a couple of seconds.

CAPCOM: . . . You're looking great. It's been a mighty fine day.

COLLINS: Boy, you're not kidding. * * *

II: Sounds of the Space Age

A record narrated by Astronaut FRANK BORMAN

THEY WERE EERIE, those first electronic beeps. Later came the voices, exultant in the thrill of discovery. Each sound leaping the chasm of space bore to a rapt world the drama of man's venture into the airless

Pressed on vinyl flexible enough to be bound into the magazine, yet durable enough for excellent sound reproduction, this record—issued in an edition of 6½ million copies—stands as another milestone in NATIONAL GEOGRAPHIC

recordings from all possible sources: NASA, the United States Air Force—even Radio Moscow, which provided the voice of Yuri Gagarin, first man in space (page 751).

From this 12-year wealth of auditory history of space exploration, Joseph Judge, of the Society's Senior Editorial Staff, and Jon H. Larimore, staff audiovisual engineer, distilled 10 minutes and 51 seconds of playing time.

As America's first orbital flight begins, you will hear a controller's prayerful benediction: "May God speed John Glenn." You will hear Ed White's ecstatic voice as he walks in space—and returns with laughing reluctance.

You will hear Neil Armstrong's historic words as he sets foot on the moon: "That's one small step for a man, one giant leap for mankind."

To ensure a record of the highest quality (electronic filtering has improved the clarity of many of the voices), your Society recorded the complete Apollo 11 space-ground communications, piped by two phone lines from NASA's Goddard Space Flight Center. At Society headquarters, diesel generators, a safeguard against power failures, drove the recorders.

The Apollo 11 tapes, on 95 10-inch reels, now form a part of your Society's growing audiovisual library—a part that is literally out of this world.

HOW TO REMOVE THE RECORD

Hold magazine with left hand and grasp vinyl sheet in upper right-hand corner with right thumb and forefinger; pull vinyl to separate from top staple. In the same way, free record from bottom staple. Pull away excess plastic at perforations to make record square. On automatic phonographs use "Manual" setting. If record slips or makes a rumbling sound, tape it to another record.



PHOTOGRAPH BY HENRY HEER BILLS FOR NASA

"Gee, you look great!" exclaimed President Nixon, greeting the returned crew of Apollo 11 in the mobile quarantine facility on board the carrier U.S.S. *Hornet*. Accompanied by Astronaut Frank Borman, the President speaks with Armstrong, left, Collins, and Aldrin.

void beyond his home planet.

That drama—culminating in the first landing on the moon—comes vividly alive in the special recording, "Sounds of the Space Age, From Sputnik to Lunar Landing," presented to the National Geographic Society's worldwide membership with this issue. Its narrator: Col. Frank Borman, firm friend and eight-year member of the Society, whose voice was heard by millions last December when he and his companions in Apollo 8 became the first men to orbit the moon.

history. This is the second time the Society's magazine has marked an era with distribution of a record. Our first, in the August 1965 issue, brought to members the voice and funeral of the Allies' great World War II leader, Sir Winston Churchill.

For the "Sounds of Space," your Society brought together



LUIS DRESDEN, ILLUSTRATOR

First in space, Russia's Yuri Gagarin orbited earth April 12, 1961.

Milestones on the way to the moon

SOON AFTER the landing on the moon last July the National Geographic Society received a letter from a member-family in Dallas, Texas. "I could not help but marvel," wrote Bruce Topletz, a sophomore at Rice University, "that, as man jubilantly descended on the lunar surface, the March 1964 issue containing an article by Dr. Hugh L.



EXTRACTED BY JEAN CONGER FOR NASA LINDSEY AND JAMES E. WELBY, NASA

American space pioneer Alan B. Shepard, Jr., receives NASA's Distinguished Service Medal from President John F. Kennedy after a suborbital flight May 5, 1961. Other Mercury astronauts grin approval.



Tethered to Gemini 4, Maj. Edward H. White II walks in space.

Dryden, 'Footprints on the Moon,' predicted to the last detail, in writing and excellent drawings, a landing achieved five years later."

In that memorable article Dr. Dryden—NASA's Deputy Administrator and top scientist—made the unqualified prediction that "there will be footprints in the lunar dust." Dr. Dryden served your Society as a Trustee from 1951 until his death in 1965.

Members may find it helpful to have the following list of NATIONAL GEOGRAPHIC articles on the space program and space-related subjects:

- "Aviation Medicine on the Threshold of Space," by Allan C. Fisher, Jr., August 1955.
 - "New Light on the Changing Face of Mars," by E. C. Sipher, September 1955.
 - "Space Satellites, Tools of Earth Research," by Heinz Haber, April 1956.
 - "To 76,000 Feet by Stratos-Lab Balloon," by Lt. Comdr. Malcolm D. Ross, USNR, and M. Lee Lewis, USN, February 1957.
 - "Rockets Explore the Air Above Us," by Newman Bumstead, April 1957.*
 - "Reaching for the Moon," by Allan C. Fisher, Jr., February 1959.
 - "Cape Canaveral's 6,000-mile Shooting Gallery," by Allan C. Fisher, Jr., October 1959.
 - "Exploring Tomorrow With the Space Agency," by Allan C. Fisher, Jr., July 1960.
 - "Our Earth as a Satellite Sees It," by W. G. Stroud, August 1960.
 - "The Long, Lonely Leap," by Capt. Joseph W. Kittinger, Jr., USAF, December 1960.
 - "Countdown For Space," by Kenneth F. Weaver, May 1961.
 - "The Flight of Freedom 7," by Curmault B. Jackson, Jr., M.D., and "The Pilot's Story," by Alan B. Shepard, Jr., September 1961.
 - "We Saw the World From the Edge of Space," by Comdr. Malcolm D. Ross, USNR, November 1961.*
 - "Tracking America's Man in Orbit," by Kenneth F. Weaver, February 1962.
 - "Telephone a Star," by Rowe Findley, May 1962.
 - "John Glenn's Three Orbits in Friendship 7," by Robert H. Voas, June 1962.
 - "I Fly the X-15," by Joseph A. Walker, September 1962.*
 - "Robots to the Moon," by Frank Sirtwell, October 1962.
 - "Mariner Scans a Lifeless Venus," by Frank Sirtwell, May 1963.
 - "Footprints on the Moon," by Hugh L. Dryden, March 1964.*
 - "The Moon Close Up," by Eugene M. Shoemaker, November 1964.*
 - "The Making of an Astronaut," by Robert R. Gilroth, January 1965.
 - "America's 6,000-Mile Walk in Space," September 1965.
 - "Space Rendezvous, Milestone on the Way to the Moon," by Kenneth F. Weaver, April 1966.
 - "Surveyor: Candid Camera on the Moon," by Homer E. Newell, October 1966.*
 - "The Earth From Orbit," by Paul D. Lowman, Jr., November 1966.
 - "Historic Color Portrait of Earth From Space," by Kenneth F. Weaver, November 1967.
 - "Mars: A New World to Explore," by Carl Sagan, December 1967.*
 - "That Orbited Maiden... the Moon," by Kenneth F. Weaver, "Awesome Views of the Forbidding Mooncape," and "How We Mapped the Moon," by David W. Cook, February 1969.
 - "A Most Fantastic Voyage," by Lt. Gen. Sam C. Phillips, USAF, and "And Now to Touch the Moon's Forbidding Face," by Kenneth F. Weaver, May 1969.
- Man's Conquest of Space*, a book by William R. Shelton, chronicles man's yearning to reach the stars, 200 pages, 231 illustrations, \$4.25 plus postage and handling; ask for later billing if desired.
- *Indicates out of print but available in most public libraries. Issues after 1965: \$1; 1966-64: \$1.50; prior to 1956: \$2. Order from the National Geographic Society, Dept. 60, Washington, D. C. 20036.

III: The Flight of Apollo 11:

By KENNETH F. WEAVER, Assistant Editor

TWO THOUSAND FEET above the Sea of Tranquillity, the little silver, black, and gold space bug named *Eagle* braked itself with a tail of flame as it plunged toward the face of the moon. The two men inside—standing like the motorman in a 19th-century trolley car—strained to see their goal. Guided by numbers from their computer, they sighted through a grid on one triangular window.

Suddenly they spotted the onrushing target. What they saw set the adrenalin pumping and the blood racing. Instead of the level, obstacle-free plain called for in the Apollo 11 flight plan, they were aimed for a sharply etched crater, 600 feet across and surrounded by heavy boulders.

For Astronaut Neil Armstrong, at the controls of the frail, spidery craft, a crisis in flight was nothing new. In 1966 he had subdued the wildly gyrating Gemini 8 when one of its thrusters stuck. More recently, he had ejected safely from the "flying bedstead," a jet-powered lunar-landing training vehicle,

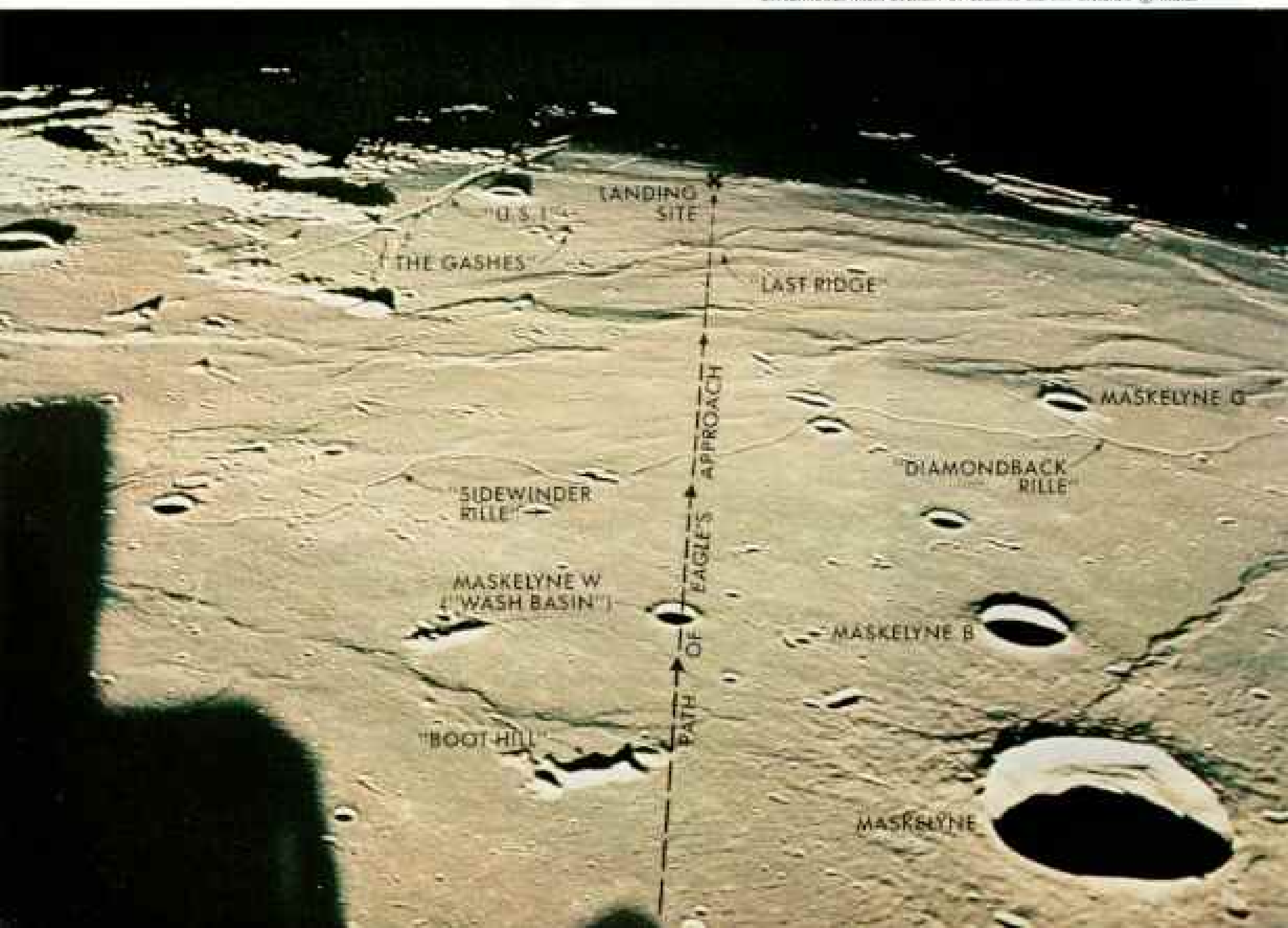
just before it crashed. Now he would need all the coolness and skill acquired during 500 earthbound hours in simulators and during years test-flying the X-15 and other experimental aircraft for the National Aeronautics and Space Administration.

The problem was not completely unexpected. Shortly after Armstrong and his companion, Edwin (Buzz) Aldrin, had begun their powered dive for the lunar surface ten minutes earlier, they had checked against landmarks such as crater Maskelyne (below) and discovered that they were going to land some distance beyond their intended target.

And there were other complications. Communications with earth had been blacking out at intervals. These failures had heightened an already palpable tension in the control room in Houston. This unprecedented landing was the trickiest, most dangerous part of the flight. Without information and help from the ground, *Eagle* might have to abandon its attempt.

752

EXTRACHROME, NASA; OVERLAY BY GEOGRAPHIC ART DIVISION © N.A.S.A.



“One giant leap for mankind”

Moreover, the spacecraft's all-important computer had repeatedly flashed the danger signals “1201” and “1202,” warning of an overload. If continued, it would interfere with the computer's job of calculating altitude and speed, and neither autopilot nor astronaut could guide *Eagle* to a safe landing.

Eagle's Descent Fuel Runs Low

Armstrong revealed nothing to the ground controllers about the crater ahead. Indeed, he said nothing at all; he was much too busy. The men back on earth, a quarter of a million miles away, heard only the clipped, deadpan voice of Aldrin, reading off the instruments.

“Hang tight; we're go. 2,000 feet.”

Telemetry on the ground showed the altitude dropping . . . 1,600 feet . . . 1,400 . . . 1,000. The beleaguered computer flashed another warning. The two men far away said nothing.

Not till *Eagle* reached 750 feet did Aldrin speak again. And now it was a terse litany: “750 [altitude], coming down at 23 [feet per second, or about 16 miles an hour] . . . 600 feet, down at 19 . . . 540 feet, down at 15 . . . 400 feet, down at 9 . . . 8 [feet per second] forward . . . 330, 3½ down.” *Eagle* was braking its fall, as it should, and nosing slowly forward.

But now the men in the control room in Houston realized that something was wrong. *Eagle* had almost stopped dropping, but suddenly—between 300 and 200 feet altitude—its forward speed shot up to 80 feet a second—about 55 miles an hour! This was strictly not according to plan.

Orbiting 70 miles above the moon, *Eagle's* astronauts spy out their shadowy landing site. The site near the dawn line was chosen so that the men, in landing, would have the sun behind them and low enough to show surface features in sharp relief. The astronauts had nicknames—here quoted—for many lunar landmarks. One of *Eagle's* thrusters creates the silhouette at left.

“They made it!” The jubilant cry rings out in Houston's Mission Control when a display panel (right) flashes a likeness of *Eagle* touching down at Landing Site 2. Place names in capitals are Anglicized versions of Latin-named *maria*, or “seas.” Craters Ptolemaeus, Theophilus, and Langrenus honor early astronomers.

At last forward speed slackened again and downward velocity picked up slightly.

“Down at 2½ [feet per second], 19 forward . . . 3½ down, 220 feet [altitude] . . . 11 forward, coming down nicely, 200 feet, 4½ down . . . 160, 6½ down . . . 9 forward . . . 100 feet.”

And then, abruptly, a red light flashed on *Eagle's* instrument panel, and a warning came on in Mission Control. To the worried flight controllers the meaning was clear. Only 5 percent of *Eagle's* descent fuel remained. By mission rules, *Eagle* must be on the surface within 94 seconds or the crew must abort—give up the attempt to land on the moon. They would have to fire the descent engine full throttle and then ignite the ascent engine to get back into lunar orbit for a rendezvous with *Columbia*, the mother ship.

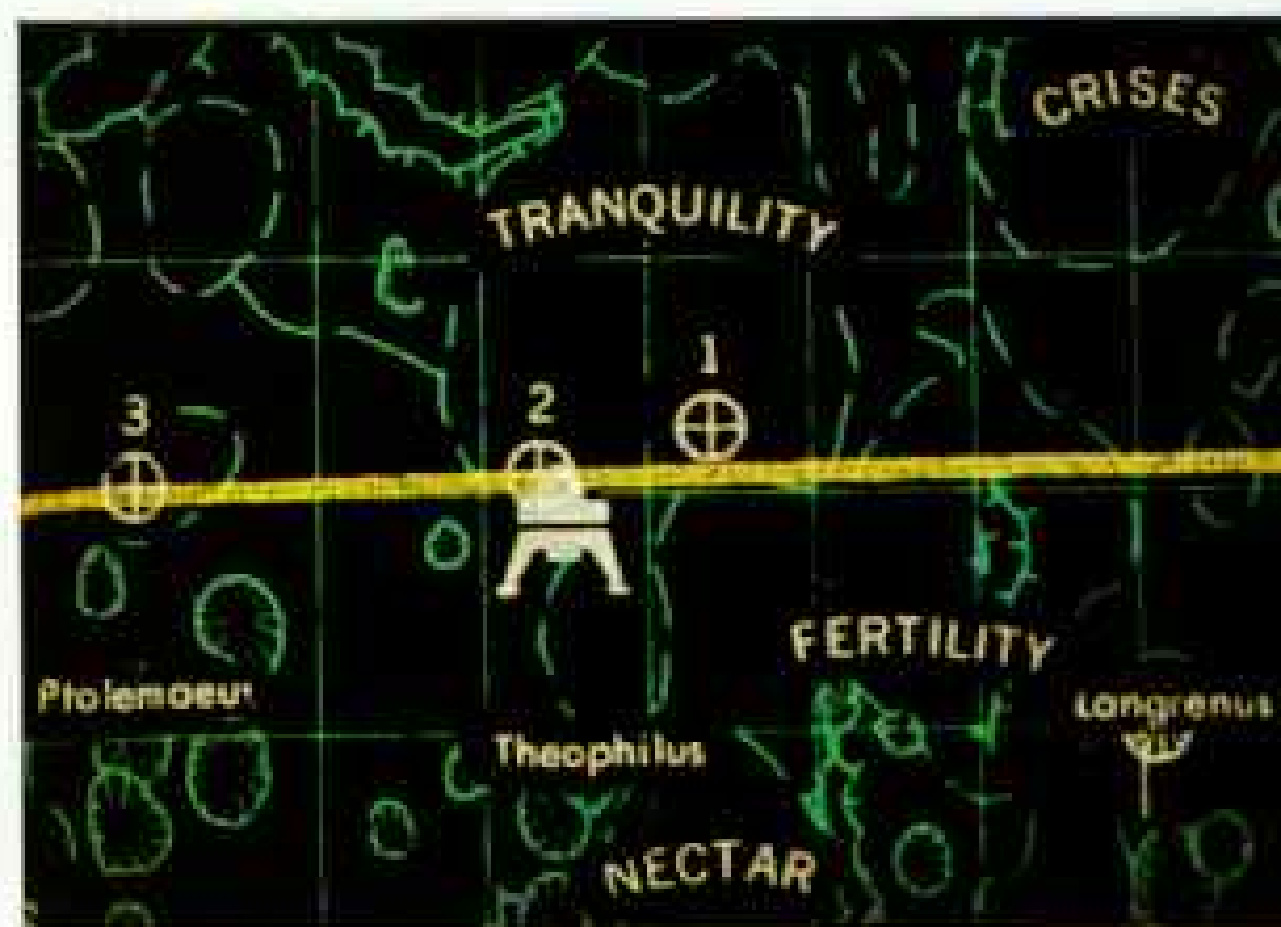
When only 60 seconds remained, the countdown began. The quivering second hands on stopwatches began the single sweep that would spell success or failure.

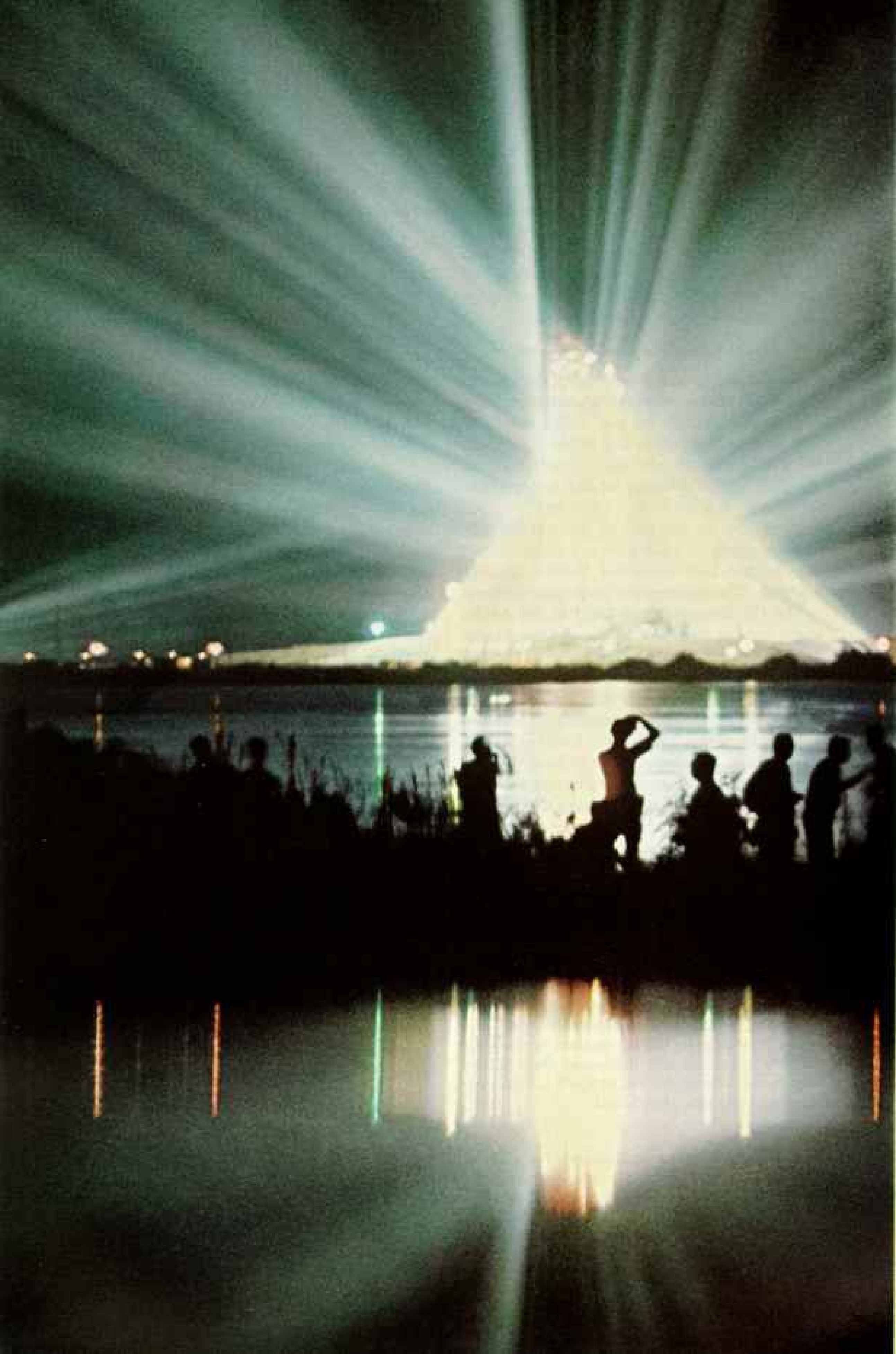
“Sixty seconds,” called Astronaut Charles Duke, the capsule communicator (CapCom) in Houston. Sixty seconds to go. Every man in the control center held his breath.

Failure would be especially hard to take now. Some four days and six hours before, the world had watched a perfect, spectacularly beautiful launch at Kennedy Space Center, Florida. Apollo 11 had flown flawlessly, uneventfully, almost to the moon. Now it could all be lost for lack of a few seconds of fuel.

“Light's on.” Aldrin confirmed that the

(Continued on page 762)







RODACILON (ABOVE) AND DETACHMENTS (FOLLOWING PAGES), NASA, SYDNEY (LEFT) BY OTIS INGOLD © N.S.S.

Sunrise stroll on the way to the moon. Armstrong, carrying an air conditioner to cool his pressure suit, precedes Collins, a technician, and Aldrin (out of picture) across a 320-foot-high swing arm that leads from an elevator to the spacecraft.

In the play of searchlights, Apollo 11 gleams on the pad like a giant star sapphire. Mirrored on a lagoon and reflecting on a car roof in foreground, the rocket thrills some of the half-million launch-watchers who throng beaches and campgrounds.

Atop a pillar of fire, mighty Saturn V blasts off. Unmanned cameras on the launch umbilical tower focus on the world's largest and most powerful rocket as it lifts (page 756) and roars heavenward under the 7.6-million-pound thrust of its five engines (page 757). Escaping liquid oxygen shrouds the tail. ▶





Godspeed!

THEY WATCHED with their hearts in their throats at Kennedy Space Center, Florida, on July 16, those privileged to see Apollo 11 lift off in a fury of flame. Some 8,000 distinguished guests and nearly 2,000 journalists crowded into bleachers 3½ miles from the launch site. Squinting in the searing sun, shielding eyes with hands as if in mass salute, they cheered, cried, laughed, or stood in silent awe—many with fingers crossed (below)—as the silver bird took wing and hurled three men toward the moon.

Lyndon B. Johnson and Mrs. Johnson stood beside Vice President Spiro T. Agnew. Mr. Johnson ardently pushed the space program as Senate Majority Leader in the late 1950's, supervised it as Vice President, and as President continued his strong support.

Behind the Johnsons, with face hidden by his arm, stands former NASA Administrator James E. Webb, a National Geographic Society Trustee; present NASA head Dr. Thomas O. Paine praised him as "the man who knew how to put together this magnificent team."



KODACHROME (RIGHT) BY OTTO BRONDER FOR NASA
KODACHROME BY THOMAS G. SMITH © N.S.S.







“Saturn gave us a magnificent ride”

THUS Neil Armstrong described Apollo 11's ascent from earth in one of his early reports to Mission Control in Houston, Texas. In this series of photographs made from an Air Force plane, the rocket trails a rooster tail of flame as it streaks through the lower atmosphere (left).

At 41 miles altitude (center) the engines shut down, and the first stage separates

amid an engulfing plume of smoke. As the dead first stage drops behind (far right), the five-engine second stage begins its $6\frac{1}{2}$ -minute burn; it will boost the spacecraft to a height of 116 miles before it, too, separates. Then the third stage will burn briefly to put Apollo 11 into a parking orbit around earth at a speed of 17,400 miles an hour.



KODACHROME (BELOW) BY BILL TARR, NASA; CHROMOMEK, NASA



Flawless lift-off evokes a flurry of handshakes at Launch Control in Florida. Dr. Kurt H. Debus (right), Director of the Kennedy Space Center, leans over a console to congratulate Launch Operations Manager Paul C. Donnelly. In the background, directly in line with the bank of consoles, stands Dr. Wernher von Braun, Director of the Marshall Space Flight Center in Alabama, which designed the superlative Saturn V rocket.

(Continued from page 753)

astronauts had seen the fuel warning light.

"Down 2½ [feet per second]," Aldrin continued. "Forward, forward. Good. 40 feet [altitude], down 2½. Picking up some dust. 30 feet. 2½ down. Faint shadow."

He had seen the shadow of one of the 68-inch probes extending from *Eagle's* footpads.

"Four forward . . . 4 forward, drifting to the right a little."

"Thirty seconds," announced CapCom. Thirty seconds to failure. In the control center, George Hage, Mission Director for Apollo 11, was pleading silently: "Get it down, Neil! Get it down!"

The seconds ticked away.

"Forward, drifting right," Aldrin said.

And then, with less than 20 seconds left, came the magic words: "Contact light!"



REPRODUCED BY MICHAEL COLLINS, NASA

"The *Eagle* has wings," Armstrong radios after separating from the mother ship. Collins made this picture from *Columbia* while inspecting the LM to be sure it functioned properly.

"It looked more like a praying mantis than a first-class flying machine," Collins said of the craft, "but it was a beautiful piece of machinery."

The spacecraft probes had touched the surface. A second or two later Aldrin announced, "O.K., engine stop."

Still later, the now-famous words from Neil Armstrong: "Tranquillity Base here. The *Eagle* has landed."

And, with joy in his voice, CapCom replied: "Roger, Tranquillity, we copy you on the ground. You got a bunch of guys about to turn blue. We're breathing again. Thanks a lot."

It was 4:17:43 p.m., Eastern Daylight Time, Sunday, July 20, 1969.

Feat Watched by the World

Man's dream of going to the moon was fulfilled. The most exciting adventure in human memory now neared its climax as the two men prepared to step out on the lunar surface, while their fellow crew member, Mike Collins, kept vigil in his orbiting command module, *Columbia*, 70 miles above.

To me, it is impossible to compare this exploit with the epic feats of the great 15th- and 16th-century navigators, of the 20th-century polar explorers, or of Lindbergh in 1927. The differences are too profound, and one of the most important of those differences is that the whole world was watching.

According to estimates, one out of every four persons on the face of the earth watched or heard the astronauts by television or radio as they ventured to the moon. Nearly 850 foreign journalists, representing 55 countries and speaking 33 languages, reported the story from Cape Kennedy and Houston.

Americans abroad were thrilled by the impact of the flight on foreign peoples. Dr. Louis B. Wright, former Director of the Folger Shakespeare Library and a National Geographic Society Trustee, observed the effect firsthand in Italy. With 25,000 other people he was attending a performance of *Aida* in the Roman Arena at Verona on that Sunday night.

"At the first intermission," Dr. Wright recalls, "an announcement was made in four languages: 'The Americans have just landed on the moon at 10:17.' My watch said 10:28.

"The crowd applauded wildly. Here and there spectators pulled little United States flags from their pockets and waved them. And for days afterward, when Italians met me on the street, they all had one word for the flight—'Fantastico!'"

And so it was—with different inflections—in Buenos Aires and Sydney, Tokyo and Delhi, Dublin and Madrid.

The thrill of a race had added to the excitement. Since 1961, when President John F.

Kennedy had announced the goal "before this decade is out, of landing a man on the moon and returning him safely to the earth," many people had firmly believed that the Soviet Union was racing to put a Russian on the moon first.

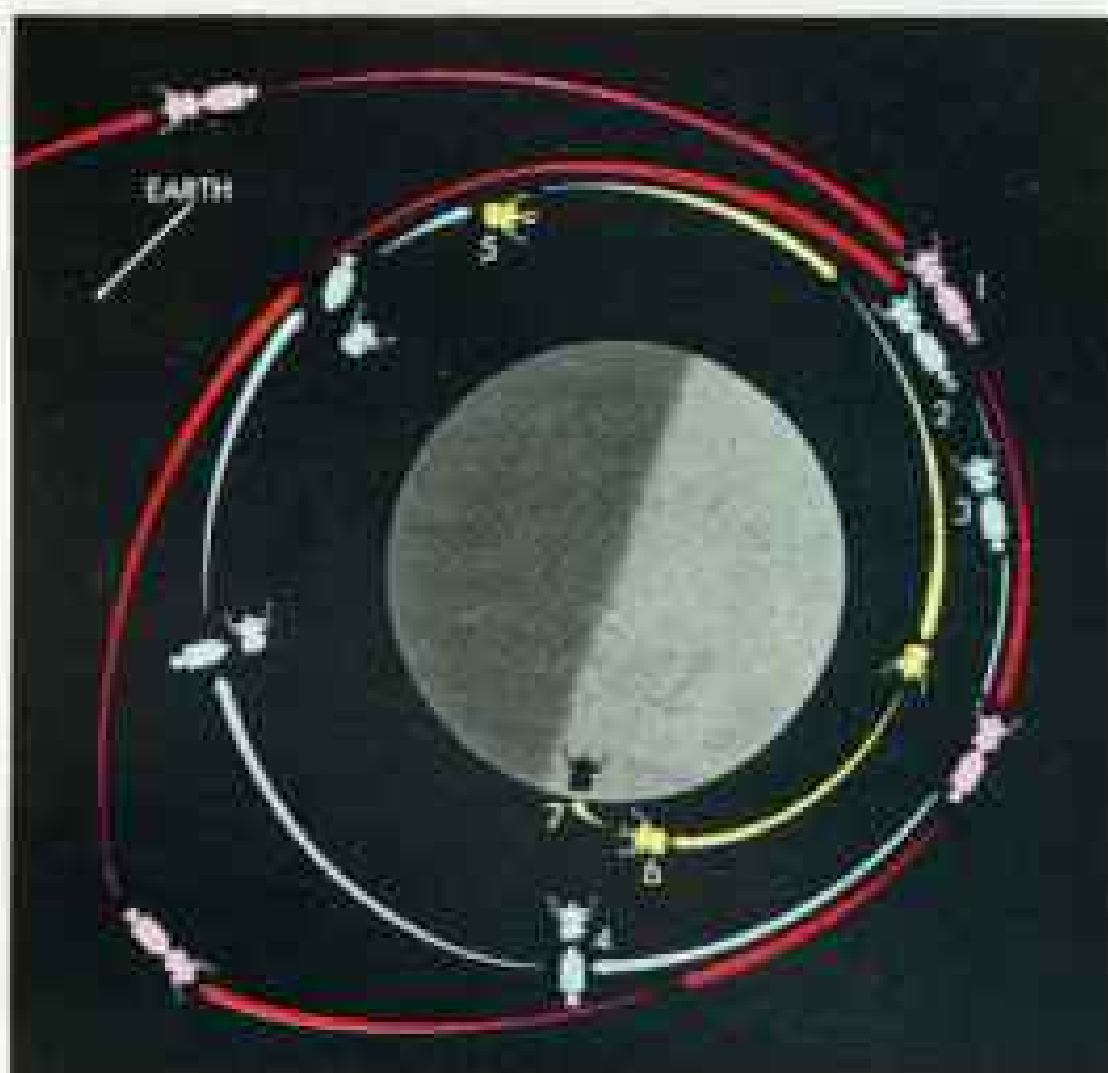
In the past year or so, Soviet chances had seemed to dim, but as Apollo 11 approached the moon, the news that Luna 15 was already in lunar orbit lent color to the suspicion that the Soviets hoped to land an unmanned craft, scoop up some lunar soil, and rush back to earth before the American moon samples could get home. Only when Luna 15 crashed in Mare Crisium—the Sea of Crises—some 500 miles from Tranquillity Base, was the way clear for the U. S. triumph.

That triumph was an especially heady one for those who argued the advantages of manned space flight. Without a man at the controls, they pointed out, *Eagle* would almost certainly have crashed into an unforgiving field of boulders.

The full story became known only after the astronauts returned to earth. When Neil Armstrong first spotted the landing site through the grid on his window, he did not really know where he was. Actually the crater toward which he was heading—later identified as "West Crater" (an unofficial name)—was just within the southwest edge of the planned landing ellipse, a bull's-eye 7.4 miles long and 3.2 miles wide. But most of the landmarks the astronauts had memorized so carefully before the flight were several miles behind them, and were of no help now.

Armstrong had no doubts, however, about what to do; he had faced problems like this many times before in the simulators.

Taking over partial control from *Eagle's* autopilot, he ordered the computer to keep the craft at a steady altitude and gave *Eagle* its head, reducing the braking effect of the



GEORGIAN ART GALLERY © R.A.S.

PRINTED FOR NATIONAL GEOGRAPHIC SOCIETY BY FRANCIS J. BRADY



Prelude to touchdown: In upper diagram Apollo 11 brakes into elliptical lunar orbit (red, 1). Two revolutions later the service module engine fires again (2) to make the orbit circular (blue). *Eagle* and *Columbia* undock (3), and *Columbia* inspects *Eagle* to make sure everything is ready for descent. The two craft draw apart (4); *Eagle* fires (5) to lower its orbit (yellow) and enter the final approach. Second firing (6) eases *Eagle* to touchdown (7) on the moon.

Cutaway painting (right) shows Collins alone in *Columbia*, Armstrong and Aldrin together in *Eagle* just after separation.



20,000 FEET Aimed through one of *Eagle's* two triangular windows, a 16-mm movie camera captures the moonscape as Armstrong and Aldrin's craft moves forward and downward for a landing.

100 FEET A last small crater looms below *Eagle*. Less than two minutes' fuel remains. Craft's computer flashes alarms; for heart-stopping seconds, earth hears no words from the crew.

EXTREMES, NASA



Across a rocky crater to touchdown

ARTIST'S re-creation of *Eagle's* drama-filled descent depicts the craft at 200 feet above the lunar surface. Descent-stage engine controls speed downward and forward; reaction-control jets are fired to change the LM's attitude.

Armstrong at the controls looked out his window at the projected target site and saw a crater strewn with boulders as big as automobiles. Increasing forward speed to 55 miles an hour, he cleared this crater and a smaller one before landing gently on level ground 200 feet beyond. Had Armstrong not taken control to guide the craft past the hazardous craters, *Eagle* might have overturned or smashed on alighting.



PAINTING FOR NATIONAL GEOGRAPHIC SOCIETY BY PIERRE MÜHN © N.S.A.

10 FEET One of *Eagle's* footpads, with its lancelike probe, casts a shadow on the moon. Dust stirred up by the engine blurs surface features just before touchdown.



descent engine and letting the craft surge forward at high speed.

Only when he had shot over West Crater and its frightful rocks ("as big as Volkswagens"), and had cleared a second, smaller crater 100 feet in diameter, did he bring the descent engine's braking power into full play again and drop to a level, relatively clear spot (pages 764-5).

During the last forty feet or so of descent, the rocket-engine exhaust sent the dust of the moon flying. Not billows of dust; instead, the disturbed particles flew out at low angles and high velocity, like rays of light, with no atmosphere to buoy them or impede them. Armstrong later described it as "much like landing through light ground fog." The moment the engine shut off, however, the view out the window was completely clear again.

Armstrong's maneuver took him more than 1,000 feet beyond where the autopilot would have set him down, cost an extra 40 seconds, and left only about 2 percent of usable fuel—about 400 pounds—for the descent engine.

But it meant a safe landing, and a gentle one—so gentle that the two men hardly felt it. Armstrong says that their downward speed was probably no more than one foot a second. And the footpads of the eight-ton craft (it weighed only a sixth of that on the moon) settled just an inch or two into the surface.

Space Suits Balk Lunar Hazards

Inside the spacecraft, Armstrong and Aldrin set calmly about making sure they could get home again. They carefully worked through their check lists to assure that all the systems were working, that the supplies of oxygen and fuel were satisfactory, and that the ascent engine would be ready when needed.

Then history's first lunar explorers completed the laborious task of suiting up for their excursion onto the moon's surface. To their many-layered space suits, marvels of engineering that work like Thermos bottles and that can stop micro-meteoroids traveling at 64,000 miles an hour—30 times the speed of a military rifle bullet—they added other ingenious protections against the hazards of the moon's environment:

Heavily corrugated plastic overboots that can resist temperatures from 250° above zero F. to 250° below; gloves covered with fine metal mesh (a special alloy of chromium and nickel), worth \$1,000 a yard, to protect the glass-fiber and Teflon material from abrasion;

hoods for their transparent bubble helmets, with double visors (both of them coated with gold) to block the sun's intense glare, heat, and ultraviolet radiation (page 737).

Finally each donned a remarkable backpack known as the PLSS (portable life-support system) to provide cooling water, electric power, communications, and oxygen enough to last four hours outside the lunar module without replenishing. The men had become, in effect, independent spacecraft.

All this added nearly 190 pounds to each man's earthly weight. Although that means only about 32 pounds on the moon, it alters the center of gravity and hampers activity. The suit, when pressurized, becomes so hard that hitting it with the fist would be like striking a football. Bending over to the ground is extremely difficult.

I have some idea of how all this paraphernalia must feel: I once tried on Astronaut Gene Cernan's suit and helmet. Under earthly conditions, I found them heavy, cumbersome, and slightly claustrophobic. But no astronaut complains. Should his space suit lose pressure, he would keep useful consciousness, as pilots say, for only 8 to 12 seconds.

First Step Beamed to a Waiting World

About six and a half hours after *Eagle* landed, its hatch opened and the Apollo 11 commander backed slowly out to its little porch. On the ladder he paused, pulled a lanyard, and thus deployed the MESA, or modularized equipment stowage assembly, just to the left of the ladder. As the MESA lowered into position with its load of equipment for lunar prospecting, a seven-pound Westinghouse TV camera mounted atop the load began shooting black-and-white pictures. Fuzzy and scored with lines, the pictures nonetheless held earthlings spellbound (page 738).

No one who sat that July night welded to his TV screen will ever forget the sight of that ghostly foot groping slowly past the ladder to *Eagle's* footpad, and then stepping tentatively onto the virgin soil. Man had made his first footprint on the moon.

Neil Armstrong spoke into his microphone. And in less than two seconds the message that will live in the annals of exploration flew with the wings of radio to the huge telescope dish at Honeysuckle Creek, near Canberra, Australia, thence to the Comsat satellite over the Pacific, then to the switching center at the Goddard Space Flight Center outside

Washington, D. C., and finally to Houston and the rest of the world:

"That's one small step for a man, one giant leap for mankind."

Lunonauts Move Easily on the Moon

At last man was seeing before his eyes answers to a host of riddles that had perplexed and divided scientists and intrigued other mortals. Could man perform at the moon's $1/6$ g ($1/6$ of earth's gravity)? Would he sink into a sea of soft, smothering dust? Would fatigue quickly claim him?

And what about the lunar material? Would it be young or old, hard or soft, black or brown or gray? Would it be volcanic? Would it duplicate material on the earth? Would it tell the story of a hot moon or a cold moon?⁹

Obviously the lunonauts had little difficulty performing in $1/6$ g. After gingerly testing the soil and the best ways of moving, they frolicked about like colts, or—as Apollo 8 Astronaut Bill Anders remarked—like a pair of Texas jack rabbits. They tried two-legged kangaroo jumps; that technique proved tiring. They floated across the long-shadowed scene in a lazy lope, six to eight feet at a stride, with both feet in the air most of the time. It felt like slow motion, Armstrong reported, but it was a comfortable way to cover ground—if they remembered to plan their stops three or four steps ahead.

At times they seemed, in their

⁹See "That Orbed Maiden... the Moon," by Kenneth F. Weaver, NATIONAL GEOGRAPHIC, February 1969.

Armstrong's shadow stretches toward *Eagle* as the astronaut photographs the moonscape. The sun's glare turns the lunar surface garishly white and almost blindingly bright. Armstrong uses a Hasselblad camera with a specially designed lens. Crosses on each picture enable geologists to make precise photogrammetric measurements of all objects recorded.

bulky suits, like dancing bears; at other times they were marionettes. And now and then it was a ballet, with a graceful pas de deux.

Their exuberance was seen not only in their lively actions but also in Armstrong's excited query right after Aldrin came down the ladder (page 739): "Isn't it fun?"

But it was hard work too, with many scientific observations to make and tasks to perform in a tightly limited schedule.

As for the surface, at least in the Sea of Tranquility, the *Eagle* crew said it was somewhat slippery and described the soil as seeming like graphite, or soot, or almost like flour. It stuck

DESCRIPTION BY NEIL A. ARMSTRONG, 1969





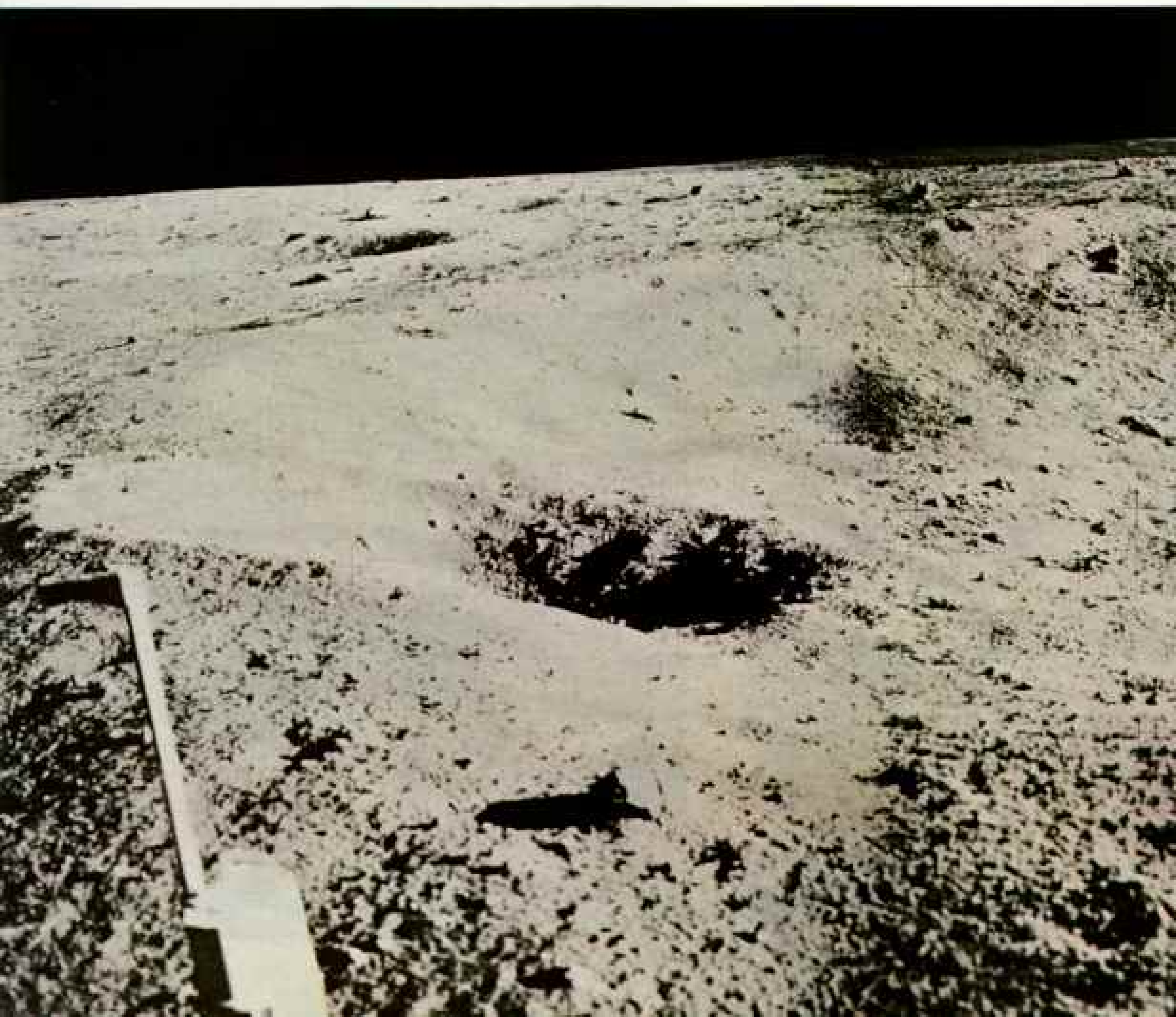
to their boots, but because of the moon's lack of air, it never billowed up to hamper work.

They said that their boots pressed in only a fraction of an inch in most places, although on the edges of small craters they sank as much as six or seven inches and tended to slip sideways.

In fact, the two men discovered a strange paradox: When they planted the United States flag in the lunar soil, they had to press hard to force the staff down, yet it would fall over easily. The soil showed great resistance downward, but little sideways. Aldrin found that he could pound a core tube only about five inches deep, even with repeated blows (left).

The men remarked on the variety of the moon rocks. The surface of some showed vesicles, or tiny pits, formed by gas bubbles

Hammering a core tube into the moon's surface, Aldrin gathers part of the 48 pounds of lunar material that the astronauts brought back. Earlier he set up the solar wind collector beyond (page 770).



as the rock cooled. Some were pitted with little glassy craters as though they had been struck by BB shot.

Colors varied from chalky gray to ashen gray, with hints of tan or cocoa brown at times, depending on the angle of view.

Moon Rocks Hold High Priority

In every direction, the lunar surface was pocked with thousands of little craters and many larger ones, five to fifty feet across and littered with angular blocks (below).

It had been decided in advance that the most important single thing the astronauts could do—scientifically speaking—would be to bring back samples of the moon.

Shortly after stepping onto the surface, Armstrong took a “grab sample,” or contin-

gency sample, scooping it up into a Teflon bag on the end of a light collapsible rod. The pole he discarded, but the bag of soil he rolled up and—with some difficulty—tucked into a pocket above his left knee.

As Astronaut-scientist Don Lind commented in Houston during the flight, “He is certainly going to get back in the spacecraft with his pants on, so we will have this sample for sure.”

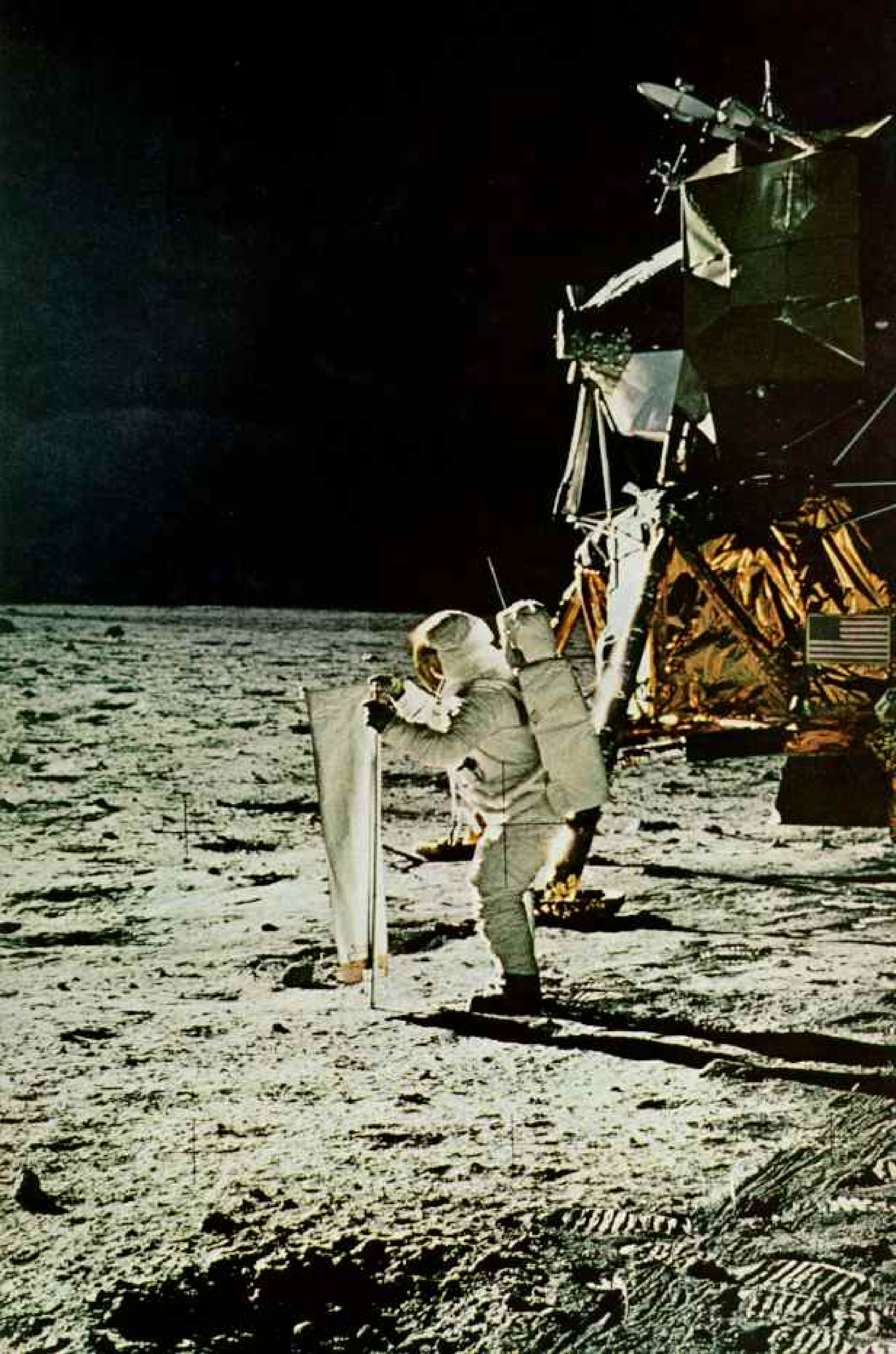
With a specially made aluminum scoop on an extension handle, and with a pair of long aluminum tongs, Armstrong later gathered a larger quantity of the dark lunar soil and representative samples of the lunar rocks. These he put into two boxes, each formed from a single piece of aluminum. A ring of soft metal, indium, lined the lip of each box;

Crater that *Eagle* swooped over just before touchdown (page 764, lower) is 100 feet wide, 15 feet deep, and floored with rocks. Armstrong walked about 200 feet from the landing craft to make the photographs assembled here in a three-part panorama. Stereo camera for close-ups of the surface appears at left. “We had very much hoped that this crater would be deep enough to show the lunar bedrock,” Armstrong said later, but he could not see it.

769

EXTENSION: BY NEIL A. ARMSTRONG; NASA







when the box was closed and the straps drawn tight around it, a knifelike strip around the edge of the lid bit deeply into the indium, thus helping to seal the samples in a vacuum and to protect them against contamination.

All told, the astronauts brought back about 48 pounds of lunar material. In addition, they undertook to gather a bit of the sun. To be sure, it was a very small sample, less than a billionth of an ounce at best, but presumably it was enough to tell a great deal about the solar furnace. The sample was gathered by trapping particles of the solar wind.

Swiss Scientists Count Sun Particles

The solar wind is an ionized, or electrified, gas constantly streaming away from the sun at speeds of 200 to 400 miles a second. Ordinarily we do not detect the wind on earth, because the magnetosphere—the magnetic field around our planet—deflects the electrified gas. We see its effects only when a little of the solar wind occasionally leaks into the magnetosphere in the polar regions, becomes accelerated by some process that scientists do not yet understand, and causes the brilliant aurora high in the atmosphere.

The moon lacks a strong magnetic field, so the solar wind flings against it a steady barrage of atomic particles that, scientists believe, may slowly erode the lunar rocks. The device to trap these infinitesimal particles is ingeniously simple, compared to other more sophisticated instruments designed for lunar research. It amounts to little more than a strip of aluminum foil about a foot wide and four and a half feet long that Aldrin unfurled and hung on a slender mast stuck into the moon near the lunar module (left).

This sheet was left exposed to direct sunlight for an hour and 17 minutes, then rolled up like a window shade and stored inside one of the lunar sample boxes. Scientists hope that during exposure the sheet received the full force of the solar particles. Many of them—perhaps as many as 100 trillion—may have embedded themselves in the foil, penetrating several times their own diameter—as much as a millionth of an inch.

As this is written, Swiss researchers led by Dr. Johannes Geiss are attempting to extract the solar particles at the University of Bern and the Federal Institute of Technology in Switzerland.

Their technique is to melt and vaporize the foil in an ultrahigh vacuum. Then, in a device known as a

To catch the solar wind—atomic particles from the sun that constantly bombard the moon—Aldrin unfurls a 12-inch-wide, 4½-foot-long strip of aluminum foil. Left exposed for 77 minutes, the sheet was designed to trap particles for scientists to study back on earth.

mass spectrometer, the atomic particles of the gases they are seeking may be separated according to their mass. The process faintly resembles that of the cream separator which drives the heavier milk particles to one outlet and the lighter cream particles to another.

Unmanned satellites outside our atmosphere have already investigated the solar wind, and from these studies scientists have found that it holds particles of hydrogen, helium, and probably oxygen. Theoretically it should also contain particles of all the other chemical elements making up the sun—some 92 in all. The Swiss researchers do not expect to detect all these; rather, they seek to measure the gases helium, neon, and argon, known as “noble gases” because they normally do not react with other substances.

Dr. Geiss hopes to find isotopes, or varieties, of these elements in the foil-trapped solar wind sample. Knowledge about the proportions of such isotopes will add to our understanding of the origin of the solar system. Particularly it may tell us something of how the earth and its atmosphere were formed.

Unique Instruments Gleam Like Jewels

The solar wind collector came back to earth with the astronauts, but two other important scientific instruments were left behind on the moon. One is a seismometer, a device for detecting tremors and quakes. The other is a super-mirror to reflect laser beams sent up from earth. Together they form the EASEP, or early Apollo scientific experiments package.

I was privileged to see these two instruments a few days before they were placed aboard the lunar module. As befits all hardware going on moon flights, they were kept in a “clean room,” where all dust is carefully filtered out. Before going in, I had to thrust my shoes into a mechanical brusher to remove dust, then cover my clothing with a white nylon gown and my hair with a nylon cap.

The two instruments stood in solitary splendor in the middle of the floor, completely dominating an otherwise nearly empty room. A barrier surrounded them, keeping me at a discreet distance. Lights bathed the scene from a high ceiling, reflecting on white walls

and an aluminum floor. I felt as though I were in a sultan's treasury, looking at his crown jewels. And, in truth, the two devices shone and glittered like jewels—the seismometer because of its amber-gold thermal covering, and the reflector because of the crystalline beauty of its 100 glistening prisms.

Inside the golden cylinder at the heart of the seismometer were mechanical combinations of booms, hinges, and springs that respond to vibrations, and electronic devices to record the intensity of the vibrations and transmit the information by radio to earth. Two large solar panels, producing as much as 40 watts, could provide the necessary electric power during the two-week-long lunar day. During the moon's night the instrument was to fall silent, but nuclear heaters, fueled with radioactive plutonium 238, would keep the transmitter warm.

Device to Measure Lunar Tides

Dr. Gary V. Latham of Columbia University's Lamont-Doherty Geological Observatory, the principal investigator for the seismometer experiment, told me that this kind of instrument has given us most of what we know about the earth's interior, and should do the same for the moon.

“However, the lunar seismometer is ten to a hundred times more sensitive than those we use on earth,” he explained. “The moon fortunately lacks the constant vibrations from ocean tides, wind, and traffic that plague instruments on earth.

“With this device—actually four seismometers in one package—we should be able to detect the impact of a meteorite the size of a garden pea half a mile away on the moon.

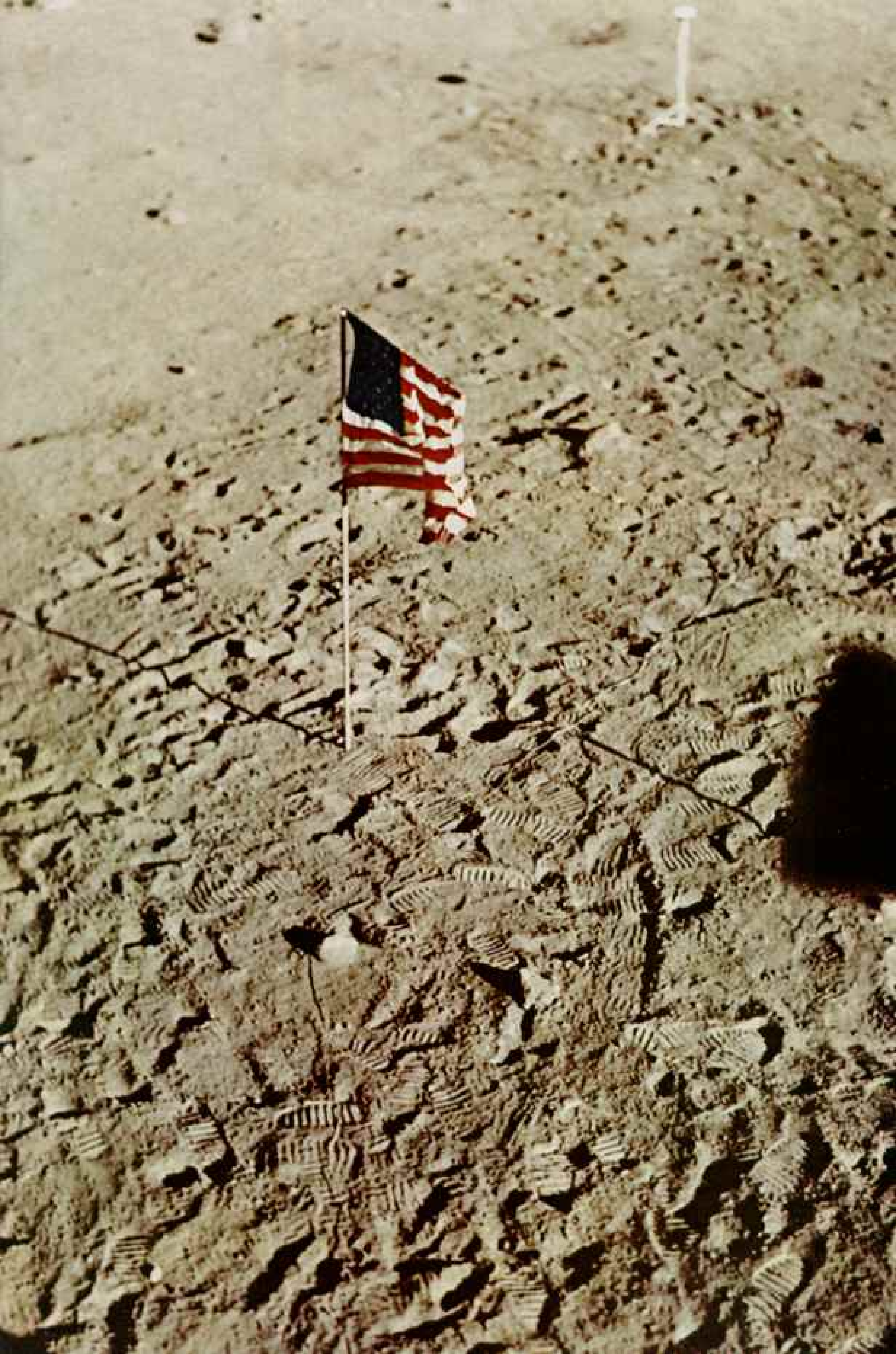
“Also, in time we should be able to tell if there are small tilts in the surface caused by tides in the lunar material itself. If a rigid bar 300 miles long were lifted at one end by one inch, this seismometer could record it.

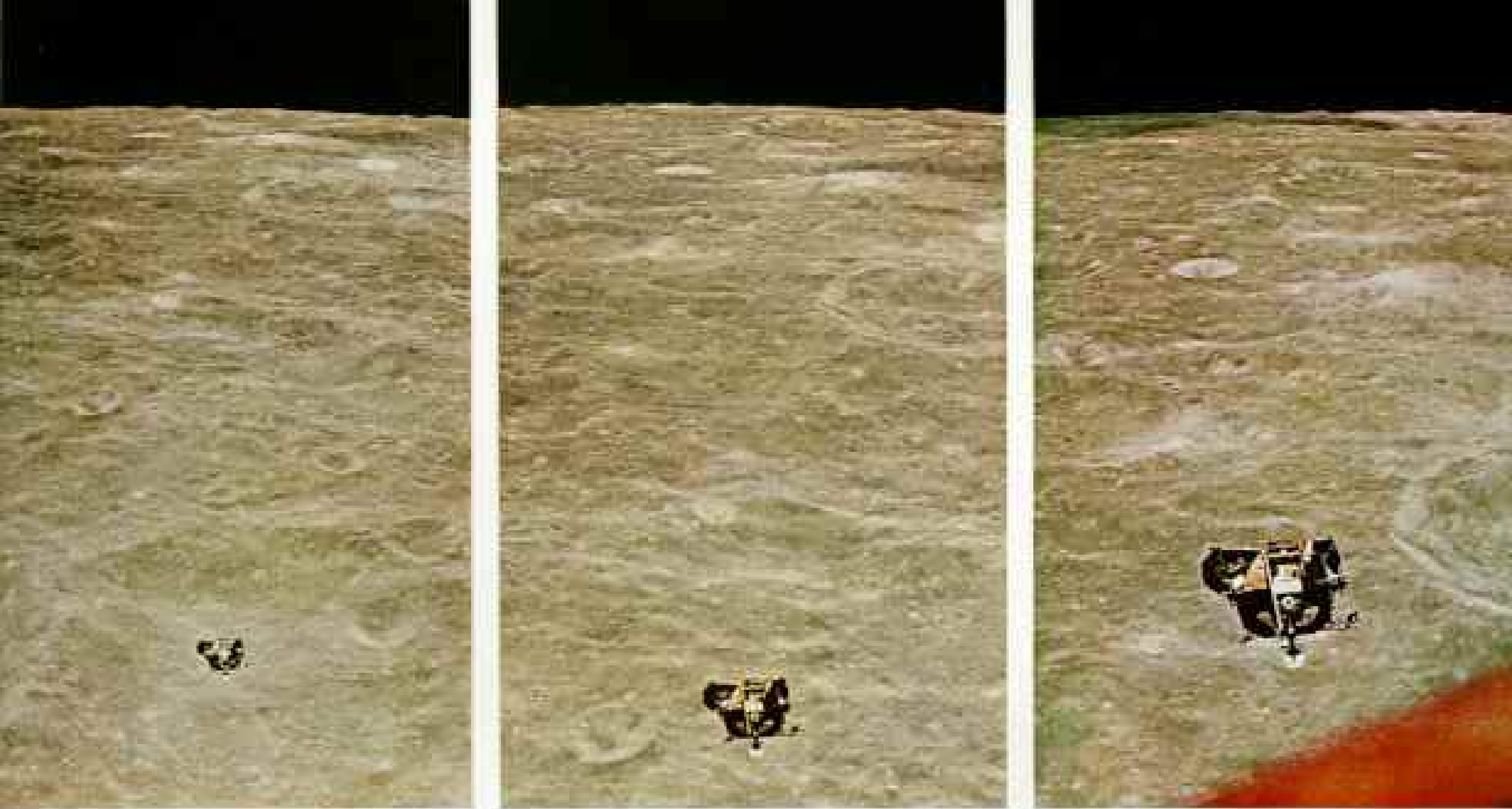
“And the instrument can record tremors about one million times smaller than the vibration level that a human being can feel.”

I asked Dr. Latham how he could tell the difference between a moonquake and a meteorite impact.

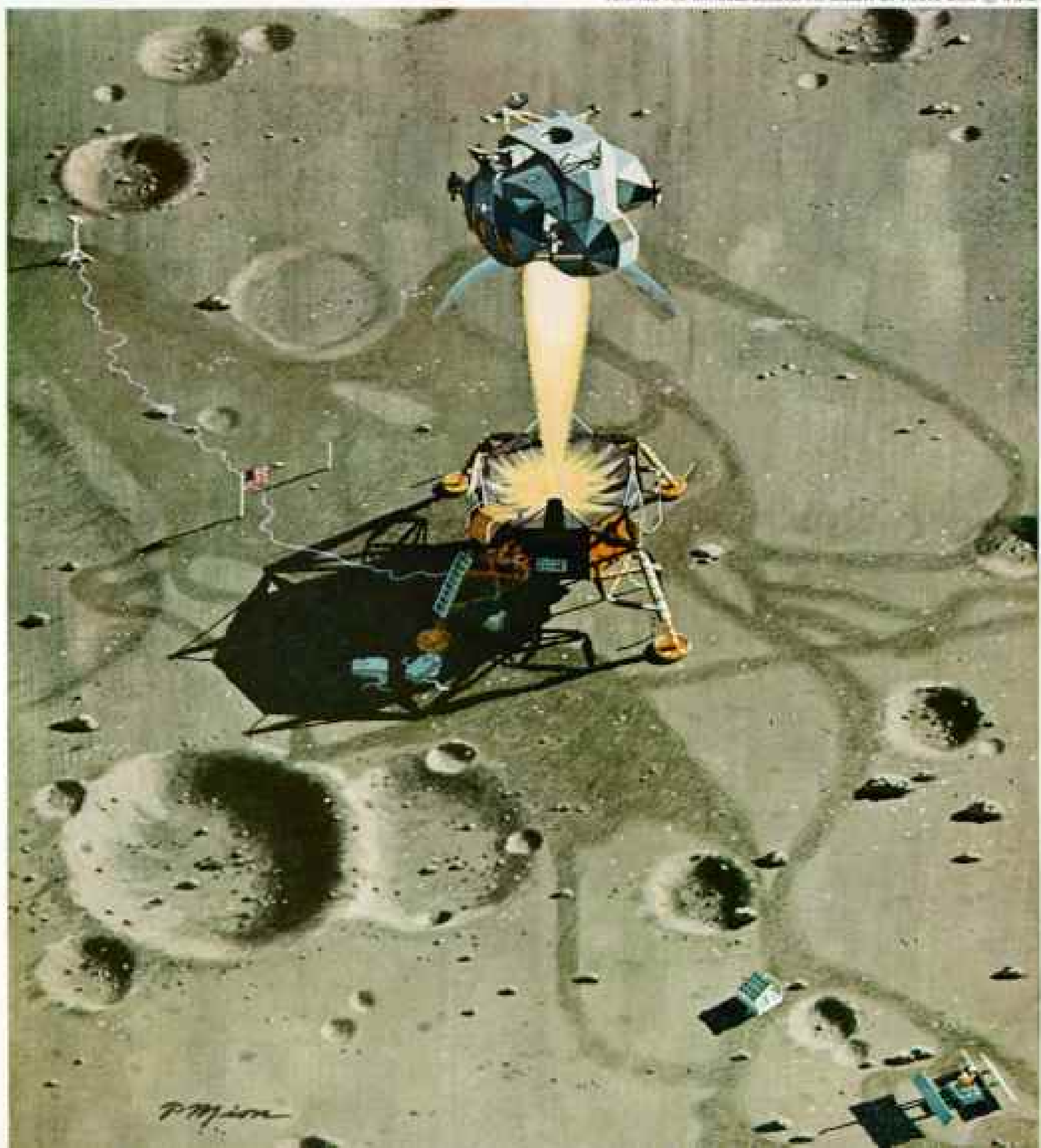
“It's not easy,” he admitted, “but that's

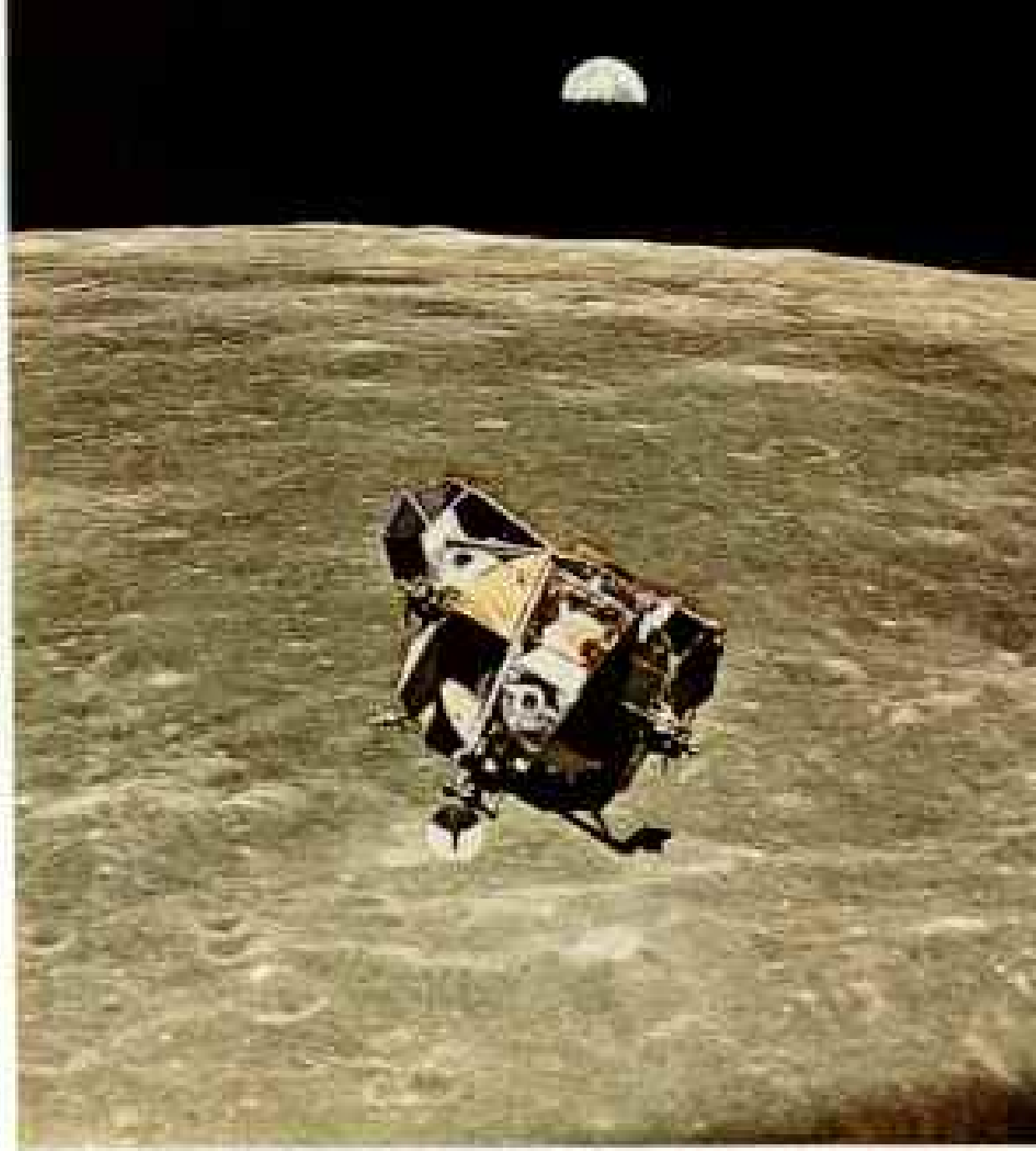
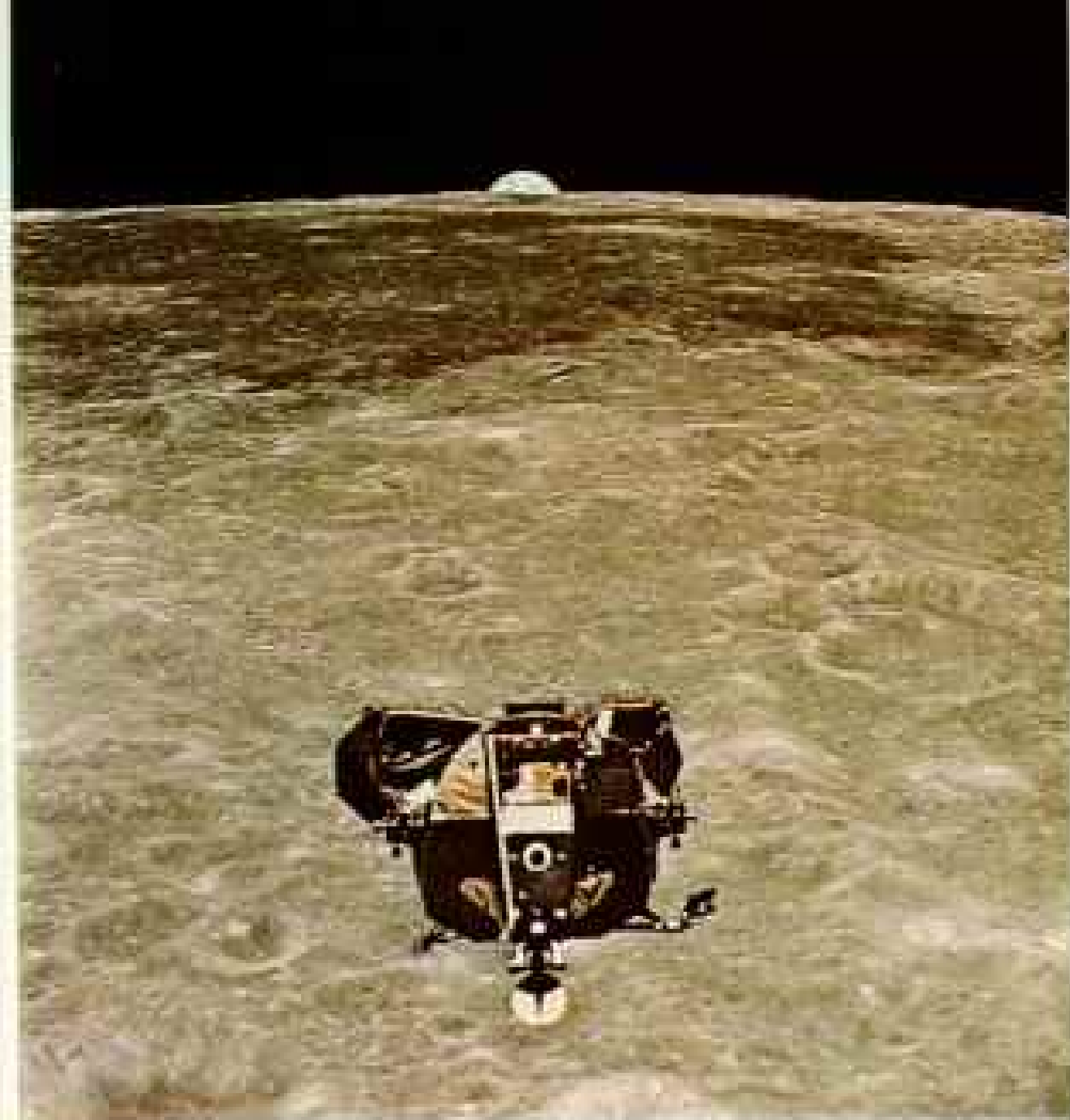
“Those footprints belong to each and every one of you . . .” Aldrin said on his return to earth, “a symbol of the true human spirit.” The American flag, stiffened by a slender rod, appears to flutter in a photograph taken from inside *Eagle*. In the background is the television camera that showed to a fascinated world the astronauts gamboling across the moon.





PHOTOGRAPH BY NATIONAL GEOGRAPHIC SOCIETY BY PIERRE MATH © N.G.S.





ENTRICHIMES BY MICHAEL COLLIER, NASA

“They came up from below as if riding on a rail,” Collins said of *Eagle*’s ascent from the moon. Here he photographs the craft as it approaches *Columbia*. As the ships speed on in orbit, earth comes into view.

“This was a very happy part of the flight for me,” Collins remembers. “For the first time I really felt that we were going to carry this thing off.”

Artist’s portrayal of the lift-off (left) reveals the equipment left behind. The flag and the solar wind mast cast long shadows beside the discarded descent stage; beyond it, cable still plugged in, stands the TV camera. The astronauts’ backpacks and a bag of jettisoned gear lie at the foot of the LM’s ladder. Seismic unit and laser reflector appear at lower right. Darker areas trace the paths of Armstrong and Aldrin. Their routes, together with such lunar features as craters and larger boulders, were mapped by U. S. Geological Survey specialists from photographs, TV tape, and observations of the astronauts themselves.

about the same problem seismologists have been facing for years in deciding whether a tremor on earth is caused by a quake or by a nuclear test in some remote place. We can do it because the waves caused by a bomb or an impact are richer in high-frequency vibrations than those caused by a quake.”

On the moon, Buzz Aldrin opened an equipment bay on the back of the lunar module and lifted out the two instruments—weighing a total of nearly 170 pounds—as though they were light suitcases. He carried them easily, with both arms bent at the elbows so the packages would not chafe his suit (page 741). He deployed the seismic package about 60 feet away from *Eagle* while Armstrong set up the laser reflector nearby, where they would presumably not suffer from the blast of the ascent engine.

A few minutes later, a radio command from earth uncaged the seismometers and turned on their transmitter. Immediately—to the joy of scientists on earth—the instruments began recording the footfalls of the astronauts on the moon.

Inked Squiggles Record Moon’s First Visitors

In the control center at Houston, I watched signals coming in from the seismometers. Inked pens traced endless lines on long strips of paper issuing from strip-chart recorders; heated styluses did the same on waxed paper on drum recorders.

Dr. Latham explained that when the lines were straight, the moon was quiet. When the pens and styluses began to vibrate and trace squiggly lines, something was happening on the moon. The nature of the squiggles and their amplitude suggested to Dr. Latham and his colleagues what was happening. For example, rapid vibrations of the pens, tracing designs like fuzzy caterpillars, recorded the movements of the astronauts.

The moon seems to be quieter internally than earth—but the instruments have nonetheless recorded trains of high-frequency waves lasting from one to nine minutes. These, say the scientists, may be landslides, perhaps in West Crater. It is a new enough crater for such slides to be expected from the stresses caused by constant shifts from extreme heat to extreme cold.

The seismometers also seemed to detect several fairly strong

shocks with lower frequencies than the landslide tremors. At first these appeared to be moonquakes. But peculiarities in the signals have led the seismologists to suspect that the "tremors" may have been caused by venting of gases from the lunar module, or by abnormalities within the instruments themselves. Only further experiments will tell.

The Apollo 11 seismometers survived the oven heat of one lunar noon and the bitter cold of one lunar night, but the electronics in their command receiver gave out from overheating on the second noon. Dr. Latham expects the instruments carried on future missions to last longer because they will be protected with a heat-radiating thermal blanket.

Laser Hits a Far-off Target

As soon as Neil Armstrong had put the laser reflector in place and carefully aimed it at earth, scientists began firing powerful pulses of ruby laser light at it.* The second and third largest telescopes in the world (after Mount Palomar's)—the 120-incher at Lick Observatory, on Mount Hamilton, California, and a brand-new 107-incher at McDonald Observatory, Fort Davis, Texas—were used to concentrate the beams. Light passing backward through one of these telescopes spreads out to a spot only a few miles wide by the time it hits the Sea of Tranquillity.

At first no detectable light returned; the

*See "The Laser's Bright Magic," by Thomas Meloy, NATIONAL GEOGRAPHIC, December 1966.

brilliance of reflected sunlight obscured whatever laser light might be struggling back. But shortly before lunar night, the telescope at Lick began to pick up signals, and McDonald has since detected them repeatedly.

Unlike the seismic package, the laser reflector has no moving parts and requires no power supply. It consists simply of a hundred fused-silica prisms, each about the width of a silver dollar, set in an aluminum frame 18 inches square. Each prism is the corner of a cube. When light enters and strikes one face, it must, by the laws of optics, bounce off two other faces as well, and then come right back out on itself.

Professor Carroll O. Alley, Jr., of the University of Maryland, who is in charge of the experiment, showed me one of the prisms. As I looked into it, the image of my eye filled the corner where the three planes intersected.

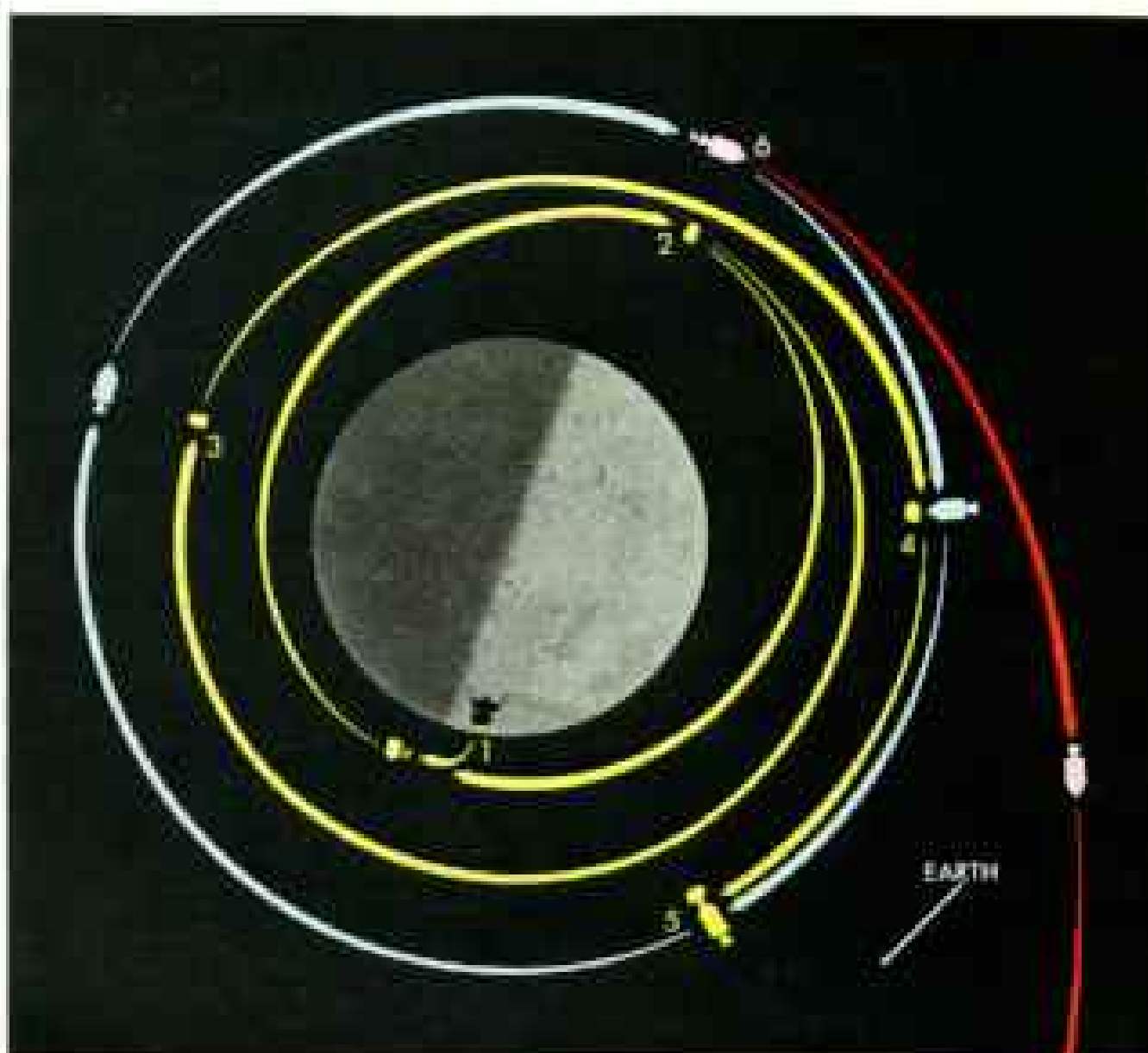
"Now tilt the reflector a few degrees in each direction," suggested Professor Alley.

To my surprise, my eye kept looking straight back at me no matter which way I tilted the piece of silica. It was uncanny that I could not escape its fixed stare.

"That's why the corner reflector works so well for our purposes," explained Professor Alley. "These prisms are the most accurate reflectors ever made in any quantity. Yet, of course, the beam is severely attenuated in its half-million-mile round trip."

How much, I wondered.

"We send out about 10 billion billion pho-



Reunion

AS soon as *Eagle* and *Columbia* link again (painting, right), Collins floats headfirst into the tunnel to greet his colleagues. Diagram at left details the critical lift-off and rendezvous maneuvers. *Eagle* follows yellow path in lift-off (1), while *Columbia* waits in circular orbit (blue). *Eagle*'s orbit is made circular (2) and is raised (3) to altitude of command module, where they rendezvous (4) and dock (5). LM is jettisoned one revolution later. *Columbia*'s engine fires (6), sending the craft into an earth-bound trajectory (red).

tons [units of light]," he said. "If we are lucky, 10 photons will return to our detector. That's far too few for the eye to see, but our instruments can measure them."

Knowing the speed of light, and timing the round trip (about $2\frac{1}{2}$ seconds) to an accuracy of one billionth of a second, Professor Alley and his colleagues can figure the distance to the reflector with an exactness never before possible. They expect to refine that distance, as measured at any given moment, to an error of only six inches—and that's exactly the point of the experiment.

"Once we can determine the moon's distance from two observing spots on earth simultaneously," Professor Alley continued, "then by simple calculation we can find out exactly how far apart those two spots lie. If distances between observatories in Europe and the Americas tend to increase over a period of years, then we will have strong evidence that those continents are slowly drifting apart, as many scientists now believe."

Within a decade the laser experiment will also help scientists check on how fast the moon is receding from the earth, examine the wobble of the earth on its axis, and test new theories of gravity.

Professor Alley expects that the reflector will continue to give good results for at least ten years, maybe a hundred. During that time anyone can use it who has the appropriate laser and telescope equipment. It is truly an international experiment.

Even before Armstrong and Aldrin had finished their observations, photography, and scientific chores, the flight controllers in Houston were getting nervous that the two men would overstay their time on the surface of the moon.

At one point Armstrong loped some 200 feet to photograph the smaller of the two craters he had overflowed (pages 768-9). "When he returned he was really puffing," one of the men in the control room at Houston told me later. And when the Apollo commander hauled the rock-sample boxes through *Eagle's* hatch with a line-and-pulley arrangement, the exertion sent his pulse up to 160 beats a minute—four beats faster than it had been during the lunar landing.

Those Who Follow Will Stay Longer

But the controllers' fears were groundless. Armstrong entered the LM and locked the hatch just two hours and 20 minutes after he had stepped out of it, almost exactly according to plan. He did not feel particularly tired.

"It was nothing at all like the exhaustion after a football game," he said later.

In fact, the metabolic rate for both men stayed considerably lower than expected. Half their oxygen supply remained unused in their portable life-support packs, as did ample water and battery power. For that reason, the astronauts of Apollo 12 were given permission to stay substantially longer on the moon.

When Aldrin and Armstrong re-entered







SPRUCING UP FOR SPLASHDOWN: *With a safety razor Collins whisks off the beard he grew in space but keeps his "moon mustache." He finally shaved it before appearing in parades in New York and Chicago and at the Presidential dinner in Los Angeles.*

CONTINENTS OF THE BEAUTIFUL BLUE PLANET *appear brown in this striking portrait of earth from 115,000 miles. Northern Africa and the Arabian Peninsula stand out, bathed in sunlight.*

"I'LL SHOW YOU, I HOPE, how easy it is to spread some ham while I'm in zero g," the homeward-bound Aldrin says in a telecast. He let the slice of bread hang in front of him, applied ham paste from a can, and floated the open-face sandwich across the cabin to one of his comrades.

(EXTACHROMES, NASA; CBS NEWS PHOTO (BELOW))





Blazing return

"THE FIERY OBJECT... exploded in a brilliant white cloud with a long tail of orange fire... Out of this hurtling ball of fire came a spectacular shower... a mammoth 4th of July display." So an Air Force pilot described the jettisoned service module incinerating itself over the Pacific. His crewmen photographed it with a camera that can record an object as small as a baseball five miles away.

Meanwhile, a glowing *Columbia* (right), bearing the moon explorers, streaked toward successful splashdown.



ENTRAGEDER, NASA

Eagle, one incident aroused momentary apprehension among TV watchers back on earth. One of the backpacks, which barely cleared the hatch entrance, struck a circuit breaker just inside and snapped its end off. It was needed to arm the ascent engine—a necessary step before the engine could be fired to get the men off the lunar surface.

Fortunately, the circuit breaker could still be pushed in. More important, there were other ways in which the astronauts could arm the engine. Almost everything in Apollo can be accomplished in two or more ways for safety's sake.

Before leaving the moon, the two men opened the hatch once more and jettisoned their backpacks and other items not destined for return to earth. (The lunar seismometers dutifully recorded the impacts.)

Million-dollar Museum on the Moon

Any future explorers who reach Tranquillity Base will find an expensive museum. There remain the two lunar instruments, the United States flag (which does not, incidentally, constitute a territorial claim by the United States), *Eagle*'s descent stage with the plaque on one leg announcing that "We came in peace for all mankind," and a symbolic olive branch in gold (page 747).

And scattered about lie a million dollars' worth of discarded items that had to be left behind to save weight and space: cameras, backpacks, tools, lunar overboots, bags, containers, armrests, brackets, and other miscellaneous gear.

In addition, the crew left an Apollo shoulder patch commemorating the three astronauts—Gus Grissom, Ed White, and Roger Chaffee—who died on January 27, 1967, in a spacecraft fire, and medals honoring two Soviet cosmonauts who have lost their lives—Yuri Gagarin and Vladimir Komarov.

A final memento carried messages of good will from leaders of 73 nations. Etched on a 1½-inch disk of silicon by the same process used for making miniaturized electronic circuits, the messages have been reduced in size 200 times and are invisible to the naked eye.*

Eagle's climb back into orbit took less than eight minutes of firing by the ascent engine. Mike Collins, who had been the solar system's most isolated man in his orbiting command module, watched his companions return with undiluted joy. *Eagle* started as a pinpoint of light as its

*See "Crystals, Magical Servants of the Space Age," by Kenneth F. Weaver, NATIONAL GEOGRAPHIC, August 1968.

tracking beacon flashed, but grew rapidly in size till it swung grandly into position for rendezvous (pages 748-9 and 774-5).

For a few moments during docking, the two craft failed to align themselves properly, but skillful jockeying by the pilots solved the problem. Then Collins floated into the tunnel between *Eagle* and *Columbia* to shake hands with his colleagues.

The three men, reunited in the command module, set the ascent stage adrift in lunar orbit, where it will remain indefinitely, and began the 60-hour journey home. As uneventful as the trip out, the coast back ended on July 24 with a fiery but totally successful re-entry in the Pacific, 950 miles southwest of Honolulu.

Emerging from the blackened command module, the three men began a period of earthly quarantine. Wearing biological isolation garments—coveralls with gas masks—they went immediately from the helicopter to a specially adapted vacation trailer known as the mobile quarantine facility (pages 784 and 786-7). Carried by ship to Hawaii and thence by plane to Houston, they entered living quarters in the Lunar Receiving Laboratory, where they underwent the most intensive medical scrutiny.

None of the tests of the men or of the lunar samples they brought back revealed any organisms that could harm life on earth—or indeed any organisms at all. So, late on August 10, the three Apollo crewmen were released to their families and a waiting world.

What Did Apollo Mean?

Amid all the excitement and hyperbole, what was the real significance of Apollo 11?

In a minor sense, perhaps, it was the coming of age of the space program, for it was the 21st manned space flight for the United States.

(Continued on page 787)

The epic voyage done, a charred *Columbia* rides the blue Pacific 950 miles southwest of Hawaii, after its parachutes lowered it through the dawn (inset). Cocooned in BIG's (biological isolation garments) to guard against the possibility of bringing back lunar micro-organisms, the astronauts transfer to a hovering helicopter that will shuttle them to the recovery ship U.S.S. *Hornet*. As a frogman snaps pictures, far right, Aldrin boosts Collins aloft on a hoist.

Balloons that righted the craft when it capsized after splashdown bob gaily above a flotation collar.





ETCHING BY LDC JONES, NAAS, AND LTJG JOHN B. MULLIGAN, U. S. UNDERWATER DEMOLITION TEAM NO. 12, NAAS (1987)



Ecstasy erupts at

FOR THE ASTRONAUTS it is a simple walk-on role (left) as they stride from the helicopter onto *Hornet's* deck, heading for quarantine. But at Mission Control (above), the words "Task Accomplished" and this first televised view of the crew safe on the carrier end an agony of work and suspense. Weary technicians leap from their consoles waving American flags and shouting.

As enthusiastic as anyone was Dr. Robert Gilruth, Director of the Manned Spacecraft Center



DETACHMENTS (LINER LEFT), NAVAL DETACHMENTS BY OTIS JIMMISON FOR NASA

Mission Control

(right, middle). His face mirrors his agency's pride and relief. At far left stands John H. Glenn, Jr., first American to orbit the earth.

The Apollo crew paid heartfelt tribute to the enormous national effort behind the voyage: "This operation is like the periscope of a submarine," Michael Collins said over TV on the flight back. "All you see is the three of us, but beneath the surface are thousands and thousands of others, and to all those I would like to say, 'Thank you very much!'"





Aglow with triumph, the lunanauts greet the world from the quarantine trailer on *Hornet*. They wear the NASA insignia and an Apollo 11 emblem depicting an eagle bearing an olive branch—symbol

Armstrong Born at Wapakoneta, Ohio, in 1930 (the same year as his crew mates), Neil Alden Armstrong already gazed skyward at 6, when he persuaded his father to take him for an airplane ride. On his 16th birthday he fulfilled a dream by winning his pilot's license.

A Navy pilot in the Korean war, Armstrong flew 78 combat missions. Graduating from Purdue as an aeronautical engineer, he soon was test-flying NASA's rocket-driven X-15. As the first civilian astronaut, he coolly piloted Gemini 8 to safety after a runaway thruster threatened disaster.

Collins The nomadic life of his career Army father molded Col. Michael Collins's youth—his early years in Rome, then Oklahoma, New York, Maryland, Texas, Puerto Rico, and Washington, D. C. There, as a popular and noticeably easygoing prep-schooler, he won his best marks in mathematics and captained the wrestling team.

Graduating from West Point, Collins became an Air Force test pilot. Finally he found his ultimate challenge in the space program. Flying with Gemini 10, he twice walked in space, at one point tumbling out of control for a horrifying moment.



RETIAROUND BY ROBERT W. HALLIDAY © R.S.S.

of peace—to the moon. The carrier crew dubbed the recovery operation “Hornet plus three.”

Aldrin Colleagues call Col. Edwin Eugene (Buzz) Aldrin, Jr., “the best scientific mind in space,” and say he could correct a computer. All his life he has striven to excel: as studious high-schooler and football center in Montclair, New Jersey; as mathematics-loving West Pointer, graduating third in his class; as an Air Force pilot who downed two MIG’s in Korea.

Earning his doctorate at MIT in 1963, Aldrin wrote a thesis on orbital rendezvous that materially advanced the space effort. During the flight of Gemini 12, he walked in space for 5½ hours.

as well as the 21st launch in the Saturn series. And if life begins at 40, that too is symbolic, for the day after the flight began marked the 40th anniversary of Robert Goddard’s first launching of an instrumented rocket, complete with thermometer, barometer, and camera.

Apollo 11 was in addition a momentous adventure, the most widely shared adventure in all history.

It was, as well, a technological triumph of the highest order, made possible only by the sustained effort during the past decade of hundreds of thousands of persons and the expenditure of some 22 billion dollars.

It involves so complex a technology that no one man can begin to comprehend what lies behind it: the tons of blueprints; the 20 thousand contractors; the 20 million pages of manuals, instructions, and other material printed monthly by the Kennedy Space Center alone; the rocket and spacecraft encompassing more than five million separate parts; the engines—most powerful in the world—that gulp 15 tons of kerosene and liquid oxygen a second and get five inches to the gallon; the telemetry that during launch sends back to Houston each second enough information to fill an encyclopedia volume.

Man’s Long Reach to the Unknown

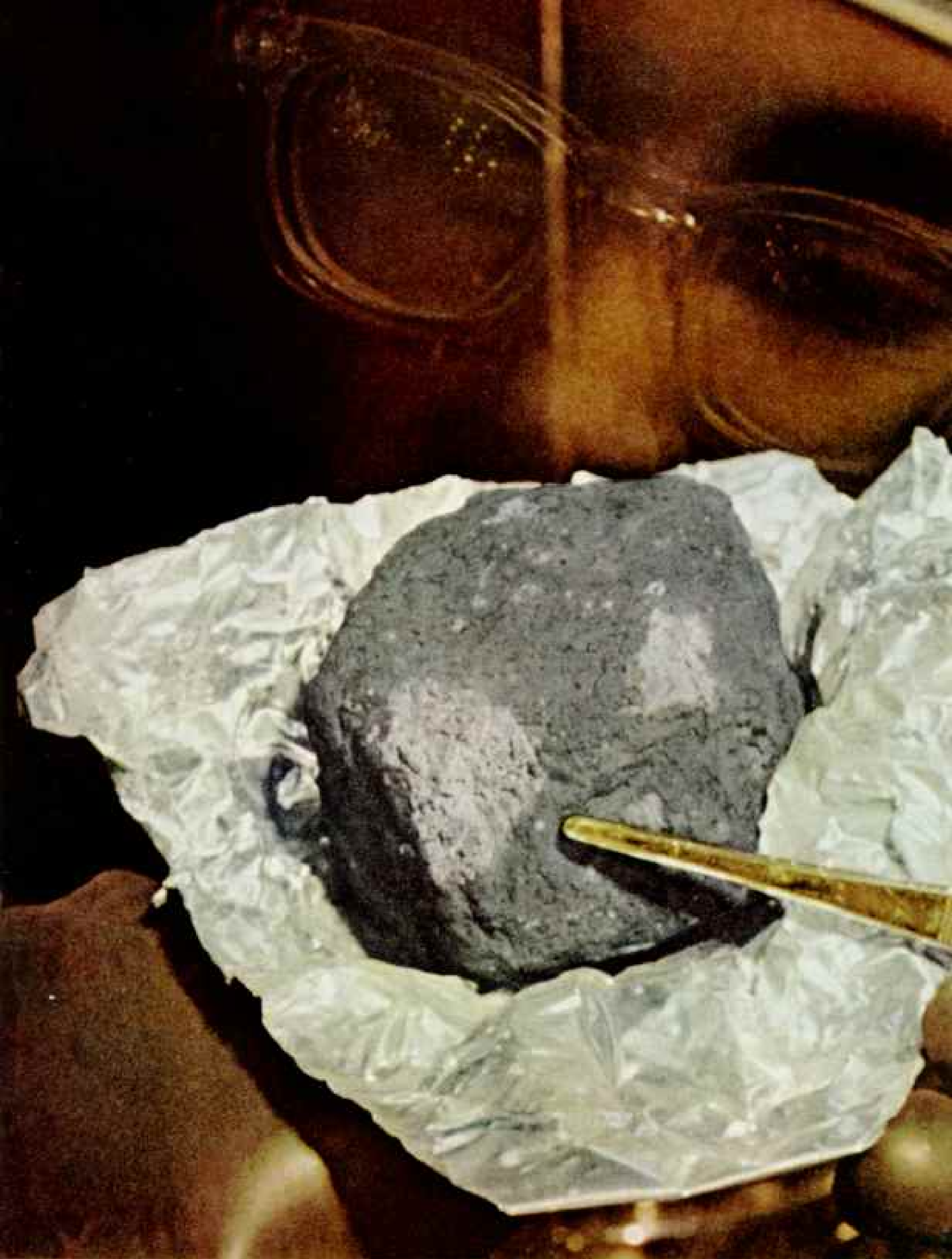
But above all, Apollo 11 was a triumph of the human spirit. As Buzz Aldrin said in a TV broadcast while coming home from the moon, “This has been far more than three men on a voyage to the moon. . . . This stands as a symbol of the insatiable curiosity of all mankind to explore the unknown.”

At the President’s dinner honoring the astronauts shortly after their release from quarantine, Neil Armstrong brought tears to the eyes of many when he said, in a voice filled with emotion:

“We hope and think . . . that this is the beginning of a new era, the beginning of an era when man understands the universe around him, and the beginning of the era when man understands himself.”

But with all the congratulations, and all the pride of accomplishment, Buzz Aldrin struck perhaps the finest note of all when, on the way home from the lunar conquest, he read to a listening world this moving passage from the eighth Psalm of the Old Testament:

“When I consider thy heavens, the work of thy fingers, the moon and the stars, which thou hast ordained; What is man, that thou art mindful of him?” * * *



Treasure beyond value: a piece of the moon. Cradled in aluminum foil, a nugget of moon matter nestles in an isolation cabinet at NASA's Lunar Receiving Laboratory in Houston. Blotchy surface of the fragile 1¼-pound chunk shows it to be breccia, an agglomerate of rock and mineral fragments. Tweezers point to one of many glassy pinhead-size craters that micro-meteorites may have blasted.

IV: What the Moon Rocks Tell Us

By KENNETH F. WEAVER

Assistant Editor

“WHEN WE OPENED that first box of moon rocks, the hushed, expectant atmosphere in the Lunar Receiving Laboratory was, I imagine, like that in a medieval monastery as the monks awaited the arrival of a fragment of the True Cross.”

Such keen anticipation, as described by Dr. Robin Brett, a NASA geologist on the team that first examined the lunar samples, is understandable. These were the most sought after, the most eagerly awaited, of all specimens in the history of science. Moreover, as some 500 scientists have labored in recent months to make every conceivable kind of test on them, the moon rocks and soil have become the most intensely studied of all scientific specimens.

At first glance, when the box was opened, the excitement hardly seemed warranted. On that historic moment on July 26, scientists clad in surgeons' gowns and caps, and carrying gas masks for use in case they should be exposed to any moon dust, crowded together to peer intently through a glass port in the lab's high-vacuum chamber. From the opposite side of the stainless-steel chamber, a technician working through stiff gloves raised the lid of the sample box and laid back the Teflon bag inside.

“What we saw,” wryly recalls one observer, “was not much different from a bag of charcoal. The rocks were so covered with dark-gray dust that no one could tell a thing about them.”

But later, when the dust was cleaned off and the minerals could be clearly seen, the rocks began to tell their story. It was a story full of surprises. It revealed that no one had been totally right in his ideas of the moon, and it raised more questions than it answered.

Sometime in January, the lunar scientists will gather to report the story of the first moon samples in formal detail. Meanwhile, here are the preliminary highlights, based on interviews with a number of scientists:

- Moon dust holds no threat to life on earth. The samples show no fossil life, no living organisms, and no organic material (except minute traces believed to be almost entirely contamination from the rock boxes or the lunar laboratory).

To test for pathogens, or disease-causing agents, biologists inoculated 200 germ-free mice with finely ground particles of lunar material. These mice had been bred in a completely sterile environment and lacked almost all immunity to disease.



EXTENDING BY A. PAINELEY, NASA

Moon dust, magnified 15 times, includes gem-like spheres of glass.



EXTENDING BY A. PAINELEY, NASA

Astronauts brought back 48 pounds of moon stuff. Early tests showed its age to be about three billion years.



Full of holes as Swiss cheese: When this moon rock cooled from molten material, gases within formed bubbles, or vesicles. The texture tells petrologists that the rock cooled quickly near the lunar surface, but leaves unanswered a tantalizing question: whether melting resulted from volcanism or from meteorite impact.

The drab 3/4-inch-wide chunk of rock explodes with color when a section only as thick as a man's hair is illuminated with polarized light (below). Magnified about 110 times, the wafer reveals minerals familiar on earth but combined differently—ilmenite (black), pyroxene (purple, yellow, and blue), and plagioclase feldspar (white). Identification of minerals by polarized light was described in the January 1966 *GEOGRAPHIC*.



EXTRACOLOR FROM NASA, LOWER BY EDWIN ANDERSON



NASA, 3 2/3 TIMES ACTUAL SIZE

Glossy-topped lumps (right), photographed on the moon, appear glazed by great heat. They suggest to Professor Thomas Gold of Cornell that a giant flare-up of the sun within the past 100,000 years scorched the moon. The earth escaped scorching because of the protection of its atmosphere, equivalent to about 10 feet of rock. Professor Gold thinks the solar outburst may have been caused by an asteroid or huge comet striking the sun. Moon explorers Armstrong and Aldrin noted many such glassy-topped protuberances in small craters whose steep sides would have focused the heat. Armstrong shot this and 16 other pictures with a close-up stereo camera (page 768) made by Eastman Kodak to specifications of a team of scientists headed by Professor Gold.

Yet they showed no ill effects whatever. This and other experiments indicate that the rock-sample containers were no Pandora's boxes after all, despite early qualms.

- The age of the Sea of Tranquillity appears to be extremely great—almost as old as the moon itself—to the surprise of many geologists. These rocks, dated by the rate at which radioactive potassium has been converted into argon, seem to have crystallized in their present form about three billion years ago.* (The moon, like the rest of the solar system, is estimated to have been formed about 4.6 billion years ago.)

- High temperatures—higher than 2,200° F.—attended the birth of these rocks. The material filling the Sea of Tranquillity is igneous (fire-formed), and was once molten, but whether it erupted from volcanic fires below the sur-

face or was melted by cataclysmic impacts of meteorites is not settled.

- The moon is virtually paved with bits of glass, much of it in irregular fragments. Glass makes up fully half of the moon-soil sample brought back to earth. About 5 percent of the glass consists of delicate globules and teardrops that show beautiful shades of brown, green, wine-red, and lemon (page 789).

- Erosion processes that may be like sandblasting have rounded and smoothed the surfaces of rocks. Most of the specimens show tiny glass-rimmed pits or glassy splotches. Is this from a continual rain of meteorites? The explanation is still not clear, says Dr. Paul W. Gast of the Lamont-Doherty Geological Observatory, chairman of the group of scientists

*See "A Clock for the Ages: Potassium-Argon," by Garniss H. Curtis, *NATIONAL GEOGRAPHIC*, October 1961.



EXTREMES BY A. FETREY, NASA

"Fertilized" with moon dust, plants undergo close watch at the Lunar Receiving Laboratory. The experiment tests whether moon stuff harbors micro-organisms—none detected—and its effect on plants. Growth was enhanced in some species, inhibited in others.

in charge of distribution of the moon samples. But the rocks and soil show abundant evidence of impact shock.

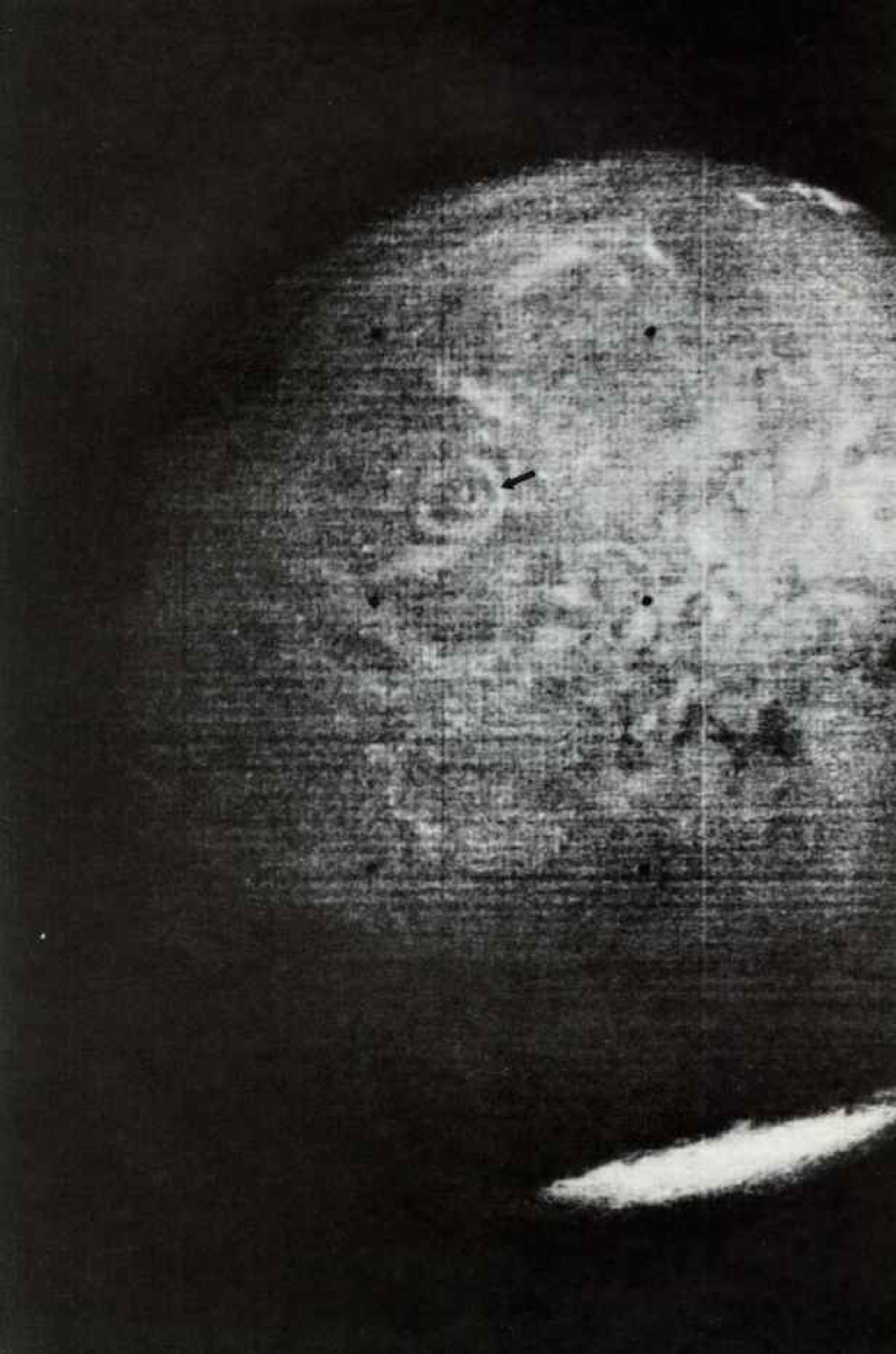
- Any question of surface water in the Sea of Tranquillity at any time since the rocks were first exposed may be dismissed. The rocks are now extremely dry and show no evidence of rounding by water. Moreover, their mineral makeup indicates that the liquid from which the rocks crystallized had negligible amounts of water chemically bound within it.
- Moon stuff from the Sea of Tranquillity resembles earthly basalt, yet there are no earth rocks just like it. It does have the same constituents—notably oxygen, silicon, iron, aluminum, titanium, calcium, and magnesium—but the proportions are different.

For example, Dr. S. Ross Taylor of the Australian National University burned bits of

the lunar dust in an electric arc; a white halo around the flame immediately betrayed the presence of titanium. Lunar basalt seems to be rich in this and other refractory elements—those with high melting points—and is at the same time relatively poor in the more volatile elements with low melting points, such as sodium and potassium.

As new samples come back from succeeding Apollo flights—eight more are scheduled after Apollo 12—scientists will have their hands full comparing the *maria* with one another, and the *maria* materials with those from the highlands.

Even the historic Apollo 11 samples will probably not all go on museum shelves for a long time. As Dr. Taylor says, "The moon rocks are different enough from earth rocks to keep us busy for years." * * *



v: Next Steps in Space

By DR. THOMAS O. PAINE

Administrator
National Aeronautics and Space Administration

MANKIND ENTERED A NEW ERA at Tranquility Base—an era in which travel will be reckoned not in thousands of miles but in millions and billions. Space is an endless frontier for our children, and for all future generations.

I believe that men will drive onward in the years ahead to Mars, to the moons of Jupiter, and to other new worlds in our vast solar system. Some of these destinations are attainable in this century, some even within the next two decades. If we give full rein to our growing space capabilities, we can rapidly establish a bridgehead in the heavens in the next dozen years.

In the mid-1970's, for example, we could begin to assemble in earth orbit a permanent manned station. Gradually enlarged, it would become the work site of perhaps a hundred scientists.

In the late 1970's we could establish on the moon a base camp that could be occupied for months or even years.

In the 1980's we could send men to Mars—a voyage that would test our technology and equipment for travel to Venus and other planets later on.

In addition to these manned ventures, we will learn

And now the planets. Scarcely had Apollo 11 returned when twin unmanned spacecraft, Mariners 6 and 7, flashed TV close-ups of the next space objective—Mars. Photograph at left, taken from 293,200 miles, reveals a glinting south polar cap. Arrow marks Nix Olympica, a crater 300 miles across. Dark smudge at right center is the mysterious Tithonus Lacus, whose shape continually changes. View from 3,100 miles includes two craters (far right) dubbed "the Giant's Footprint."



Robot scout: Unmanned Mariner extends seven-foot-long solar panels.



PHOTOGRAPH FROM NAAS, DACTAR © N.A.S.A.

more about our solar system from unmanned probes. Several already are scheduled for the 1970's. These include flights to orbit Mars, others to land there, flybys of Jupiter, and the first multiple-planet flight, for which the targets will be first Venus, then Mercury.

All these are exciting prospects. But they raise the most fundamental of questions: To what goals in space should we now commit ourselves as a Nation?

My own belief is that we should press forward vigorously with a balanced program—scientific and technological development as well as exploration. Of course our goals, and the pace at which we strive to attain them, must reflect our national will, and there are well-informed and reasonable men who feel we should proceed more slowly.

Rewards of Program Already Great

It has been said that we should concentrate all our resources on problems here at home. But I believe it would be a tragedy to foreclose our future in space. I believe our Nation can and must do these things simultaneously—not just one at a time.

Space exploration already has made life better on earth. Satellites, to mention just one development, have been of enormous benefit. They provide more accurate data to weather forecasters, aid mariners and aircraft pilots in fixing their positions, and give map makers hitherto unobtainable details of the earth's surface. In the years ahead, they will find undiscovered mineral deposits and sources of fresh water; make global agricultural surveys and detect diseased crops; and even help in the fight against pollution of air and water.*

And the conquest of space is everywhere lifting men's horizons and spirits. Not only have global satellite communications brought nations closer, but—as Col. Frank Borman's warm reception in the Soviet Union showed—space achievements are crossing the barriers that divide men on earth.

Although other targets will come within reach, the moon will occupy man for many years. The eight additional Apollo flights that are scheduled into 1973 will land our moon explorers in areas that are quite different geologically. Next March, Apollo 13 is scheduled to be launched toward a highland region, the Fra Mauro. Other Apollo destinations include supposedly volcanic peaks, rilles, and the craters Tycho and Copernicus.

*See "Remote Sensing: New Eyes to See the World," by Kenneth F. Weaver, *GEOGRAPHIC*, January 1969.

We have other immediate tasks: to make space travel simpler, more reliable, and much cheaper. How can we achieve these goals?

First, we must develop re-usable rocket planes, able to shuttle hundreds of times between earth and earth orbit. Even a Volkswagen would be prohibitively expensive if we threw it away after each drive—and each Saturn V rocket costs \$150,000,000.

Second, we should harness the great potential of nuclear power for deep-space flight—that is, beyond earth orbit. Our most powerful chemical rockets cannot deliver to far-off destinations the heavy payloads manned flight demands. Nuclear rockets can.

Third, a permanent station in earth orbit would enable us to conduct needed research in many fields and would serve as an operations base for deep-space ventures.

Designers already can envision the re-usable craft we will need to shuttle between earth and the orbiting space base. These large rocket planes would take off vertically from earth, fly to orbit, discharge their cargo, return to earth, and land horizontally, using wings, like conventional aircraft. They could carry a dozen passengers—physicists and

Setting up shop in space

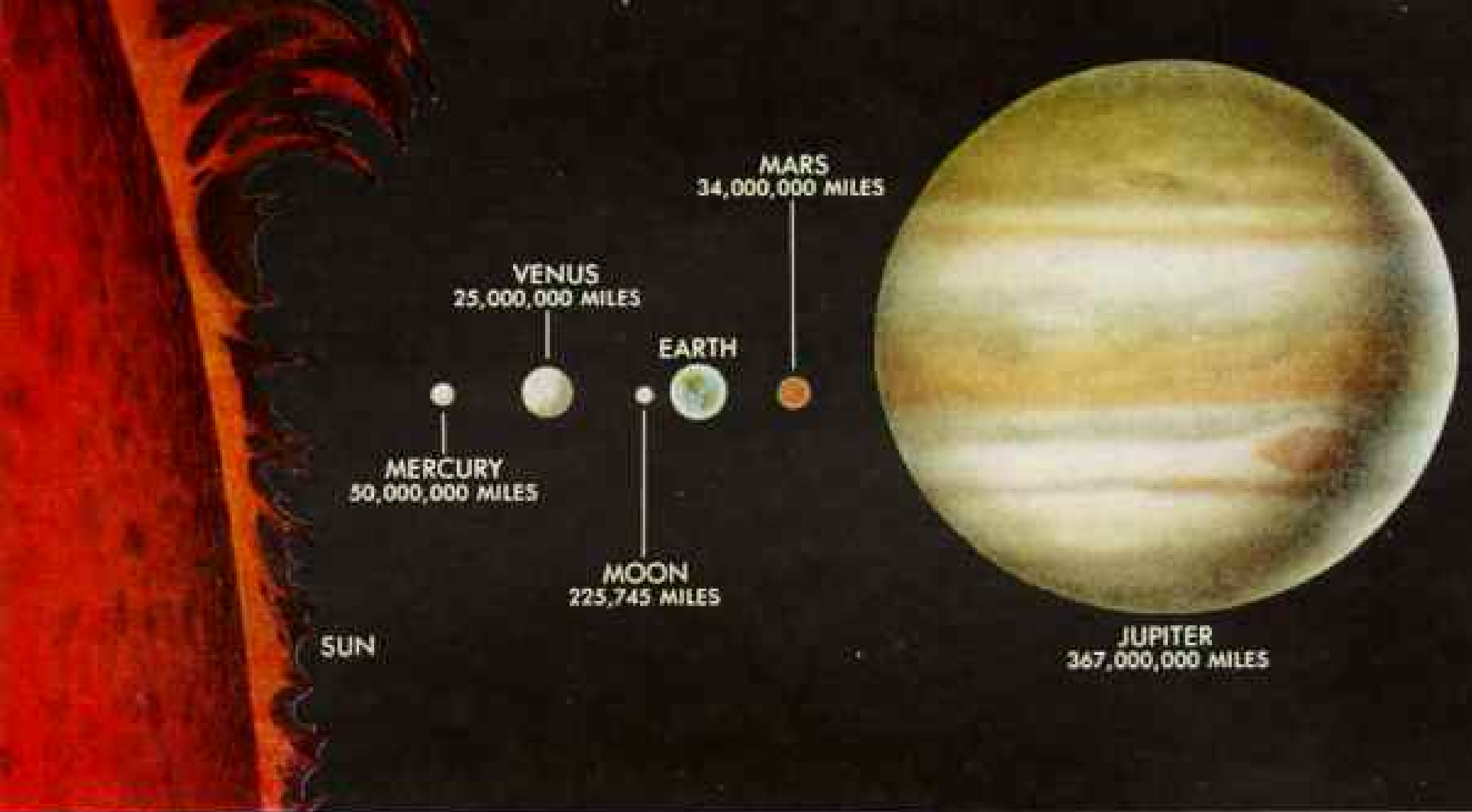
IN 1972, NASA plans to launch a rocket with a historic payload: Instead of fuel, its third stage will contain a prototype space station. It will orbit earth 250 miles up.

Portrayed with its three-man crew (lower), the station sprouts winglike solar panels for power; others extend from a solar telescope like stationary windmill vanes. Shields protect the 50-foot-long cylinder from meteoroids. Inside are instruments for astronomical studies, devices to test man's capacity for prolonged space travel, and living facilities. Forward of the station rides a command and service module to return the crew to earth.

In a mock-up station at NASA's Marshall Space Flight Center in Huntsville, Alabama (upper), a technician rides a bicycle exerciser for registering metabolism. Another demonstrates shoe cleats that hook into the deck grating, giving traction in the weightlessness of space; the crew also will try jet-powered shoes as a way of controlling movement. At the rear, a third technician tries out a rotating and reclining chair that will test man's ability to keep his balance during long periods without the aid of gravity to tell him up from down.

ILLUSTRATION BY ROBERT C. WEBB, GEOGRAPHIC ART DIVISION, WASHINGTON
BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ERIC M. BRANTON © U.S.G.





Frontiers of the future, the planets of our solar system beckon with staggering challenges. A spacecraft traveling at today's speeds, for instance, would take at least $8\frac{1}{2}$ years to reach Pluto. (Even at the small scale of this painting, a true representation of the distance between the sun and Pluto would require a sheet of paper 1.7 miles wide!)

Environments are varied and hostile. Tiny Mercury broils only 36 million miles from the sun. Venus bakes beneath dense clouds that trap solar heat and hide her features. Beyond cratered Mars:

astronomers, perhaps—into space. They could haul 10 tons of supplies and deploy and recover unmanned satellites. Similarly, re-usable nuclear shuttles would link the space base to a base in lunar orbit, and to other stations.

Research would be a major task in the earth-orbiting space station, with flight operations increasing as more men traveled outward from earth. Scientists would investigate the effects of zero gravity on men, animals, and plants; study the heavens without the interference of earth's atmosphere; and develop new uses for earth-scanning satellites.

Nuclear Rockets to Probe Deep Space

Our first experiments with long stays for men in space are planned for 1972, using a laboratory built into the empty third stage of a Saturn rocket (preceding page), a cylinder with as much room as a small bungalow. The first crew, three astronauts, will remain in orbit 28 days; later crews will stay 56 days. These missions will tell us more about man's ability to work in space for long periods, and will help determine what kind of equipment and facilities the permanent space station should have.

Assembled from modules launched from earth, the permanent base would initially

accommodate a crew of 12. As activities increased, other modules would be added.

The nuclear rocket promises to be the work horse of deep-space flight. At the NASA-Atomic Energy Commission test center in the Nevada desert, a prototype already has achieved twice the thrust per pound of fuel of our most powerful chemical rockets.

We call the prototype NERVA—nuclear engine for rocket vehicle application. Perhaps its most astonishing characteristic is its diminutive size; the reactor is no larger than a household refrigerator. Yet it generates more horsepower than Hoover Dam.

The nuclear rocket develops its great thrust by transferring the extreme heat of uranium fission— $3,640^{\circ}$ F. in our prototype—to hydrogen propellant. The superheated hydrogen then exhausts at great velocity through the rocket's nozzle. The rocket probably will be ready in the 1980's for a manned trip to Mars and return—an odyssey that will span a year and eight months.

Although Mariners 6 and 7 provided us with a wealth of new data as they flew by Mars last summer, we still do not know if there is, or ever has been, life there. We expect to learn more from two additional Mariner spacecraft scheduled to orbit Mars in 1971,



THE PLANETS
SHOWN IN RELATIVE SIZE. FIGURES
GIVE CLOSEST APPROACH TO EARTH.

PAINTING BY WILLIAM H. BURR, GEOGRAPHIC ART DIVISION © N.A.S.A.

mighty Jupiter whirls inside cloud bands of frozen ammonia, and Saturn spins glittering rings that reach 47,000 miles outward. In chill remoteness from the sun, the near-twins Uranus and Neptune watch over Pluto, whose eccentric orbit between now and 2009 will bring it closer to earth than Neptune. These nine planets have a total of 32 known moons; Ganymede, largest of Jupiter's 12 satellites, is larger than the planet Mercury. Between Mars and Jupiter orbit some 50,000 miniature planets called asteroids; the largest, Ceres, is only about a fifth the diameter of earth's moon.

and from two unmanned Vikings which will attempt to soft-land instruments in 1973.

Every two years Mars swings into a favorable position for travel from earth. In the 1980's, an excellent Mars launching date, or "window," will open on October 3, 1983.

Two Craft Would Make Mars Voyage

Although NASA has no plans now for a manned voyage to Mars, the general procedure for a trip beginning on that date is clear.

We would propel from earth orbit (to avoid radioactive contamination of the earth) two spacecraft about 250 feet long, each fitted with three nuclear rockets. Each would carry a crew of six—and some 1,800 meals per man. Two of the three rockets would be shed after launch and "parked" in space for reloading and future use.

On the 251-day journey to Mars, the two spacecraft would be joined nose to nose; thus one craft would be evacuated in case of trouble. A slow spinning motion would create centrifugal force to relieve the effects of weightlessness on the crew.

Separating, each ship would briefly retro-fire its unused rocket, braking to enter Mars orbit, on June 9, 1984. The ships would remain for 80 days, each sending down a three-

man laboratory for a month's exploration on the surface.

Firing their rockets again to leave Mars, the two spacecraft would swing around Venus on the way home, letting the pull of that planet's gravity hasten their homeward trip. On May 25, 1985, they would reach earth orbit, 601 days after leaving it. The crews would then catch the shuttle to earth—rather like men catching a bus home from work. The deep-space ships would remain in earth orbit; resupplied, they would be ready for a new voyage with a new crew.

What surprises would the astronauts bring home from Mars? No one can say—just as no one can say what explorers eventually may find on the moons of Jupiter, or on Pluto.

Such uncertainty inevitably attends the conquest of new horizons; explorers since the beginning of time have been unable to envision the full impact of their achievements.

Often, like Columbus, they made confident assessments which time proved wrong. It usually remained for those who followed to find the real significance of the explorer's effort, and to reap benefits far greater than were anticipated. There is little doubt in my mind that the benefits of space travel will emerge in the same way. **THE END**

Yankee Cruises Turkey's

By IRVING and
ELECTA JOHNSON

Photographs by
JOSEPH J. SCHERSCHEL
National Geographic Staff

WE HAD IGNORED our only warning. Just two days earlier, as the ketch *Yankee* was rounding Turkey's Cape of Gelidonya, we'd read Pliny's 1,900-year-old words: These were waters "fraught with disaster for passing vessels." Yet our charts showed no perils and the day was clear, so *Yankee* sailed on confi-

"Hoş geldiniz—Welcome!" Traditional Turkish greeting salutes the Johnsons' ketch at Kızkalesi. In medieval times strong garrisons manned Maiden's Castle, on an island at left, and another castle



History-Haunted Coast

dently along the southern Turkish coast.

We were moving easily under full sail—mainsail, mizzen, mule, and jib. Winds were fair and the sea was smooth. Half a mile abeam sprawled the sand hills of Selimiye, the site of ancient Side. I

was sewing in the after cabin, and Irving, having set the automatic pilot, was overhauling a pump below. Then, crash! *Yankee* jarred violently.

Irving shot on deck. He started the engine and gave her the gun—trying

on the mainland; attacking Turks overwhelmed the defenders in 1482. Maiden's Castle takes its name from the legend of a Christian princess who died there while pining for her Moslem suitor.

799

BRIDGMAN © P. S. S.



to overrun the obstruction with the combined force of sail and diesel. She started to go, then settled, hard aground.

For most yachts, such a grounding might be mortal. But Irving had prepared *Yankee* for running aground. After years of roaming four oceans and 50 seas under other rigs, he had insisted on a truly versatile craft—one that could sail canals and rivers, shoulder her way past barges, jolt through tunnels with folded mast—a sailing vessel that could penetrate continents and even wade ashore.

So *Yankee's* bottom is one-inch alloy steel—comparable to a destroyer's armor. And within her hull, fuel and water tanks provide a complete inner bottom. Voyaging up the Nile, *Yankee* ran aground 120 times, often on rocky cataracts.* This grounding had probably done no more than scrape away barnacles.

"We'll try twisting her off," Irving told me. "Can you and Helen handle the mule?"

We were not only grounded, but acutely short-handed. The other men in our volunteer crew—NATIONAL GEOGRAPHIC photographer Joe Scherschel and Allen O'Brien of Newport Beach, California—had gone ashore

*See "Yankee Cruises the Storied Nile," by Irving and Electa Johnson, *GEOGRAPHIC*, May 1965. The *National Geographic Index* lists 10 earlier voyages by the Johnsons.



FOODCOURTESY BY ALBERT HOCITAT © R.E.E.

to inspect an archeological site. So Helen O'Brien and I were Irving's only deck hands. Even so, we managed to douse all sail for a try with the motor. But *Yankee* held fast.

"Hooked on our forward centerboard slot," Irving guessed. He launched the dinghy and carried an anchor back for a good holding, off our port quarter. Electric and jib-sheet winches pulled our line taut. The motor churned. *Yankee* pivoted—but would not come free.

Sweating furiously, Irving carried out a second anchor, this time off the starboard quarter. Again we heaved at big lines with cranks and winches. *Yankee* pivoted again, uncertainly. Then, after a two-hour struggle in the midday sun, *Yankee* got off.

Romans Left a Navigational Hazard

Days later we were still puzzling over the uncharted obstruction. "Not a reef," Irving reasoned. "Even the ancients would have drawn it onto their charts of Side. And we weren't on any of the charted rocks."

History told of other ocean hazards—the famous Cilician pirates, and "their evil business . . . trafficking in slaves," as described by Strabo, the great Greco-Roman geographer who sailed these shores at the dawn of the Christian Era. We read of the naval battle off Side in 190 B.C., when Hannibal's fleet lost to Rome's ally, Rhodes.

Irving even looked up old descriptions of ancient Side's twin harbors—but he didn't solve our mystery until we explored the city's extraordinary ruins. In its massive Roman theater, Irving climbed to the top rows, looked out to sea, and announced, "There's where *Yankee* went aground. It looks like an old Roman breakwater."

The incident had a certain justice. We were cruising a coast where history seems far more plentiful than modern charts or travelers. We

Shish kebab on the hoof earns a livelihood for nomadic peoples of southern Anatolia. Wool from their flocks feeds the looms of Turkish rugmakers.

Tradition bequeathed the shepherd woman at left her multibraided coiffure, but winds of modernism have torn the once-mandatory veil from her face. Likewise, a Western-style cap replaces the fez that might have been worn in days past by her fellow tribesman (right); a pounded-felt garment called an *aba* shields him from wind and rain.



Greek way-stop on *Yankee's* cruise, the isle of Kastellórizon perches within two miles of Turkey's southern coast. Scores of other Greek islands bead the Aegean shore of Turkey. Abandoned buildings on the hillside signal the decline of a local economy based on fishing and sponge diving.

Three's no crowd, even under a single umbrella, for small ones sharing a portable patch of shade near Alanya, on the Turkish Riviera, or "Turquoise Coast."

PHOTOGRAPHS BY JOSEPH J. SCHERROCK © 1965



were retracing some of the earliest sailing routes of civilized man (map, pages 808-9). The currents against *Yankee's* bow, the prevailing westerlies captured in her sails, had moved much of mankind's early history.

This was Asia Minor, nursery of the Ionian Greeks, home of Homer and Herodotus, and site of Troy. Along our course sped the life stream of the ancient world, the ports that built three of its Seven Wonders, the markets that enriched Kings Midas and Croesus, the mints that yielded the world's first coins.

We would visit great shrines and oracles, some sacred to Apollo and Artemis, others to Christ and His Apostles. Our coastal course would embrace a land of ancient conquerors, politicians, and traveling salesmen: Xerxes,

Alexander, Romans, Crusaders, and camel caravans from deep in Asia. On *Yankee's* charts, the route had an exciting shape: from the mountainous Cilician coast near the Syrian border to the blue and busy Bosphorus—a course curving like a scimitar with the perimeter of Turkey.

Quiet Cove Resembles Lake Louise

In fact, our voyage took us twice along Turkey's southern coast, for we entered Turkish waters from the Aegean side, slipping in past Greek islands to an uninhabited cove beyond Fethiye. A mild, early-summer breeze brought us toward the towering Turkish shore—gray rocky mountains with touches of green brush, backed by snow-capped peaks.



We tacked into a cove within a bay; our anchorage seemed to be completely circled by mountains and pines—quiet teal-blue water hidden from the open sea.

“Just like Lake Louise!” the O’Briens exclaimed. So it seemed as it reflected a waxing crescent moon. We tied the bow to a sturdy fragrant pine, and Irving lassoed a rock for a stern line. We had made a good start.

Our luck held, for next morning we bowled along with a fair wind, wing and wing. *Yankee* steers herself at those rare and lucky times when she’s dead before the wind. With main-sail on one side and mizzen on the other, we moved eastward beneath the high, hard profile of the Taurus Mountains.

Half a mile off the mouth of the Koca River

(the ancient Xanthus), we again consulted Strabo, who wrote of sailing beyond the Xanthus “to Patara . . . a large city . . . [with] a temple of Apollo . . .”

The depth finder showed the water shoaling to 18 feet, but we kept going and the bottom came no nearer. Then we saw the ruins of Patara, perched on a hill.

Our landing spot was a long, hot hike away. As we climbed one dune—our feet numb from scalding sand in our shoes—five youngsters appeared out of nowhere to guide us. The trail headed up and inland, past dry fields of waving wheat, to a crest from which we saw a small marble theater.

We could not be sure of Strabo’s temple, but we found what might have been Apollo’s

famous oracle. It was a smooth-walled pit, some 30 feet deep and 50 across, with a tall column rising from its center, an oracle as fit as ever for consultation.

"Apollo, tell me of the future," I tested. Only the distant waves answered me.

"But, Exy," said Helen, "the sea is your future."

"I believe Apollo is right," I acknowledged.

Kaş Accepts Cash, not Checks

We cleared Turkish customs at the village of Kaş (pronounced Kosh), a mountain-girt port of perhaps a thousand people. Irving found the paper work especially lengthy, with our limited Turkish. No one in Kaş would accept our traveler's checks, but we changed enough U. S. dollars to buy squash, oranges,

Caribbean—revealed the ruins of cisterns, ceramic-pipe systems, stairs carved from solid limestone, even the outlines of rooms and sarcophagi.

Apparently in medieval times Kekova supported a coveside Christian city; a gradual settling of the coast must have lowered these sturdy buildings beneath the tide.

In swim suits and masks, we explored for submerged debris. Even our casual swim yielded broken bits of amphorae—old wine or water jugs. Like fishermen tossing the little ones back, we were careful not to break Turkish law by taking the antique ceramics with us.

Across the narrow inlet we saw the proud walls of a castle lording it over the stony fields near Üçağız. We climbed up for the view, and were joined by three polite, handsome young



REPRODUCED BY ALBERT HOLLAND (GRUVE) AND JOSEPH J. SCHERAGHEL (C) N. A. S.

Holy gift giver, St. Nicholas of Myra looks out from the gilded lid of a Byzantine chest (left) in the Museum of Antalya. Tradition paints him as a fourth-century bishop who helped the poor and saved sailors by calming stormy seas with his prayers. Time gave him a paunch and jolly character to create Santa Claus.

His tomb, now isolated in a land more than 95 percent Moslem, rests in the partially renovated church of St. Nicholas (right) at Kale, site of ancient Myra.

and lemons in the local *çarşı*, or bazaar.

Even though Kaş was unaccustomed to visitors, the villagers were helpful. Helen and I admired the functional fashions of the women, especially those droopy Turkish trousers called *şalvar*. Their fullness gave a graceful sway as the women walked; *şalvar* provided freedom and modesty.

As soon as the Kaş officials had ceremoniously served Irving his last demitasse of Turkish coffee and formally cleared us, we hurried on to an idyllic anchorage. Behind Kekova Island we slipped into steeply sheltered Sera Cove (pages 806-7).

Before us stood a crumbling Byzantine church; in its shade a cow was chewing her cud. Nearby, the ruins of old stone houses rimmed the shore, and just below the surface, the remarkably clear water—limpid as the

farm boys who gave us a short course in Turkish with their friendly small talk.

"Old fort, name 'Genoese,'" said one of our young friends in English when we had reached the hilltop walls. Inside we discovered a tiny, wonderfully preserved Greek theater. The view was wide: a cultivated plain with grazing donkeys, black cattle, goats, and two camels solidly loaded with bags.

All of us took special note of the sarcophagi that were long ago looted by man and tumbled by time, lying at random on the slopes. These were mementos of the old Lycians, the warlike nation mentioned in Homer's *Iliad*.

Three baggy-trousered peasant women walked by, carrying big bundles of grass for the family cow.

"Wait!" shouted Joe, raising his camera. "Fotografçı!" The women laughed and walked





Intrepid skipper, having threaded *Yankee* into the ruin-studded shallows of Sera Cove at Kekova Island, plucks a fragment of the Byzantine past, the top of an amphora, from submerged rubble (left).

The ocean-roving Johnsons have sailed through the pages of the *GEOGRAPHIC* in 10 memorable articles since 1942. The 50-foot ketch *Yankee*, built in 1959, is the third of their vessels to bear that name.



RESEARCHED BY JOSEPH J. VERRILLI © NATIONAL GEOGRAPHIC SOCIETY



Where history sleeps: A time-encrusted mooring ring (left) holds *Yankee* secure in Sera Cove (above). Few visitors disturb the ruins of the Christian settlement that once thrived here. Near the water's edge the sole upright remnant of a church stares into a past millennium.

Many ancient towns—built and razed by successive waves of Greeks, Romans, Byzantines, Crusaders, and Turks—lie strewn among the stones and olive trees of the Anatolian coast. Most slumber peacefully, waiting to be awakened by the crunch of archeologists' spades.



on, each modestly covering her face with a white head scarf, or *eşarp*, a rural substitute for the outlawed veil.

We returned to *Yankee*, and to Strabo's travels: "Then one comes to Myra . . . above the sea, on a lofty hill." The hill today seems less lofty. We hiked several sun-beaten miles from the mouth of a small river to old Myra, now called Kale.

"I am Guide," a friendly man in a rumpled

uniform announced when we reached the center of town. "I am Guide to St. Nicholas Church." We were happy to have his help, since St. Nicholas was our chief interest here.

So, in the battered but partly restored Byzantine church, we learned more about the remarkable fourth-century bishop of Myra, the holy man named Nicholas. By church tradition, the good bishop's prayers calmed storms at sea, and even restored dead

WINDS OF HISTORY fill Yankee's sails on her island-threading route along Turkey's coast. Hittites and Assyrians, Greeks and Persians shuttled armies across the land. Rome annexed it from Alexander's feuding heirs. Byzantines

defended this eastern bastion of Christianity against Arabs and Mongols. Crusaders marched through. Islam triumphed when Ottoman Turks captured Constantinople in 1453. Through-out history, trade lured merchants

from afar—even Vikings. Tsarist Russia thrust repeatedly for control of the Bosphorus and Dardanelles. Allied soldiers helped defeat Turkey in World War I; thereafter, Kemal Atatürk forged the modern republic.



children to life. Once the bishop anonymously gave three purses of gold to serve as dowries for three impoverished virgins of Patara to save them from a life of prostitution. But the good works of Bishop Nicholas won only scorn from the Emperor Diocletian, who jailed and tortured him.

Nicholas nevertheless survived to great age, grew his familiar flowing beard, and died a gentle death. Although the Vatican recently

dropped his feast day, the Greek Orthodox Church stands stoutly beside St. Nicholas as the diversified patron of virgins, Russia, children, pawnbrokers—whose three-ball sign memorializes those purses of gold—and of sailors like ourselves.

"Restoration work here is very recent," said our friend, as he led us through the old church. The lowest floors and walls, lying well below the present level of the town, survive

"Peace in our land! Peace throughout the world!" At Youth and Sports Day in Alanya, a Turkish Sea Scout turned orator echoes the oft-expressed sentiments of Mustafa Kemal Atatürk, whose bust dominates the podium.

Turkey's greatest hero and first president (1923-38), Atatürk freed his people from the straitjacket of the past by compelling adoption of Western dress, the Latin alphabet, the Gregorian calendar, and universal education.

as authentic mementos from the era of the original Santa Claus (page 805).

We asked our guide to show us some Lycian tombs beyond the town. He replied in elaborate Turkish, so we followed uncertainly. We dodged Kale's heavy traffic—gaily painted farm carts, donkeys, and camels—then walked past groves of citrus and loquats. At last we saw the Lycian tombs, shadowed in a harsh noonday sun. Dozens of tombs, each fashioned like the façade of a temple, had been carved into a cliff here some two millenniums ago.

By now we were hot and tired, and Joe Scherschel—lugging his heavy camera gear—started talk of hiring a car to ride back. Suddenly our guide turned and shouted, "*Merhaba*—Hello!" A brightly painted farm cart creaked as the young driver reined up. The guide explained our needs.

"Twelve lira?" suggested Allen. (The amount was about a dollar.) The driver accepted with a flourish, as cheerful as a winning charioteer. We all piled into the cart—gratefully, though it lacked seats—and off we jounced, seeing rural Turkey on its own terms.

Exploring the Wild South Coast

Back aboard *Yankee*, we watched the scenery change sharply during the next stretch of coastline. We rounded Cape Gelidonya—the tip of a promontory 3,000 feet high. Four cliffy islands, one of them towering 480 feet, combed the current with their rocks. Here the waters of the open Mediterranean meet the Gulf of Antalya. Strabo compared these perilous islands to "outskirts of a mountain."

Uncounted ships have foundered here—including one Bronze Age craft wrecked on an undersea ridge 33 centuries ago and discovered in 1959. Even now the vessel remains the oldest shipwreck ever found.*

Porpoises joined us, cavorting off our port bow. In the late-afternoon sunlight, the high

*Peter Throckmorton described the exciting discovery in two *GEOGRAPHIC* articles: "Thirty-three Centuries Under the Sea," May 1960, and "Oldest Known Shipwreck Yields Bronze Age Cargo," May 1962.



Taurus Mountains grew taller and bluer. The coast offered us a wide choice of wooded coves. Thus we enjoyed the best of two worlds: the sailor's comforts of galley and bunk, and the camper's unshared wilderness.

Still I am always on the lookout for fresh supplies, and we were anticipating the urban dazzle of Antalya, population 129,000, third largest port on the southern shore after Mersin and İskenderun (map, preceding pages). Once capital of ancient Pamphylia, Antalya sits on a shelf of coastal cliffs high above



PHOTOGRAPH BY ALBERT ROZOVAT © N.Y.S.

the sea. Its tiny keyhole harbor still seems curiously part of the ancient world. Breakwaters embrace the small, circular basin. Tile-roofed houses, walls, and a ziggzag street march up the cliff behind the little harbor toward a wonderful fluted minaret.

Yankee slipped in past ore boats and a hulking black freighter anchored just outside; lighters, skillfully sculled by local men, worked in and out with giant loads of baled cotton. Several brilliantly painted caiques—coastal freighters with deeply swooping deck

lines—swung gawkily around the quayside.

While Irving dealt with port officials, Allen and Joe headed toward Hadrian's Gate, a passageway through the second-century Roman wall around Antalya. They also arranged to hire a car for an inland trip to Konya to see the archeological dig at Çatal Hüyük with its 8,500-year-old artifacts.

Helen O'Brien and I went shopping. Though the butcher had run out of beef, we found lots of lamb, and the marketplace offered a delicious variety of vegetables and fruit from

newly irrigated truck farms and orchards.

"But our real future is tourism," claimed one young travel agent who had just learned English. "We have eight hotels here, and we call this the Turkish Riviera—or do you like better the Turquoise Coast?"

Neither name does justice to the place. Its charm lies in its natural beauty—the simple, unspoiled scenery, ruins, and space, far from the disturbing modern world.

"It's like our Pacific voyages on the old brigantine *Yankee*," Irving remarked. So what would we name this coast? Irving turned to history: "I guess Pirate Coast would discour-

the seas, turned to piracy," wrote the great Greek historian Thucydides. "This was... even considered an honorable profession."

Lycian and Cilician pirates flourished here for centuries, preying on the growing trade. But a great help in controlling piracy was the development of triremes, low-lying fighting ships with linen sails and some 170 oars mounted in three decks. The best of these triremes could sprint at seven knots.

"But they rarely used slaves in the galleys," Irving told us. "Slaves weren't trustworthy—and they had to be fed year-round."

When Greek power weakened after the



age modern tourists—but what about the Sailing Coast?" He documented his suggestion with a book he had been reading on deck, Lionel Casson's *The Ancient Mariners*.

"We know the ancient Egyptians traded here. Their cattle came from Asia Minor," Irving said. Tomb paintings show us the frail long lines of those early Egyptian ships. But sailors from Crete used a more seaworthy design, as did the Phoenicians.

All was not honest commerce: "In ancient times both Greeks and non-Greeks... once they found out how to make their way across

Peloponnesian War, law and order vanished for a time. Pirates and slave merchants ruled this coast—trading human livestock for olive oil and wine—and even raided seaports as far away as Italy itself.

Rome wearied of the menace, and in 67 B.C. gave Pompey the problem and the power to fight it. He divided the Mediterranean into 13 sectors, each with its own fleet. All the fleets attacked at once, while Pompey swept eastward from Gibraltar with a force of 60 vessels. On the coast of Cilicia the pirates made their last stand, at the port of Coracesium.

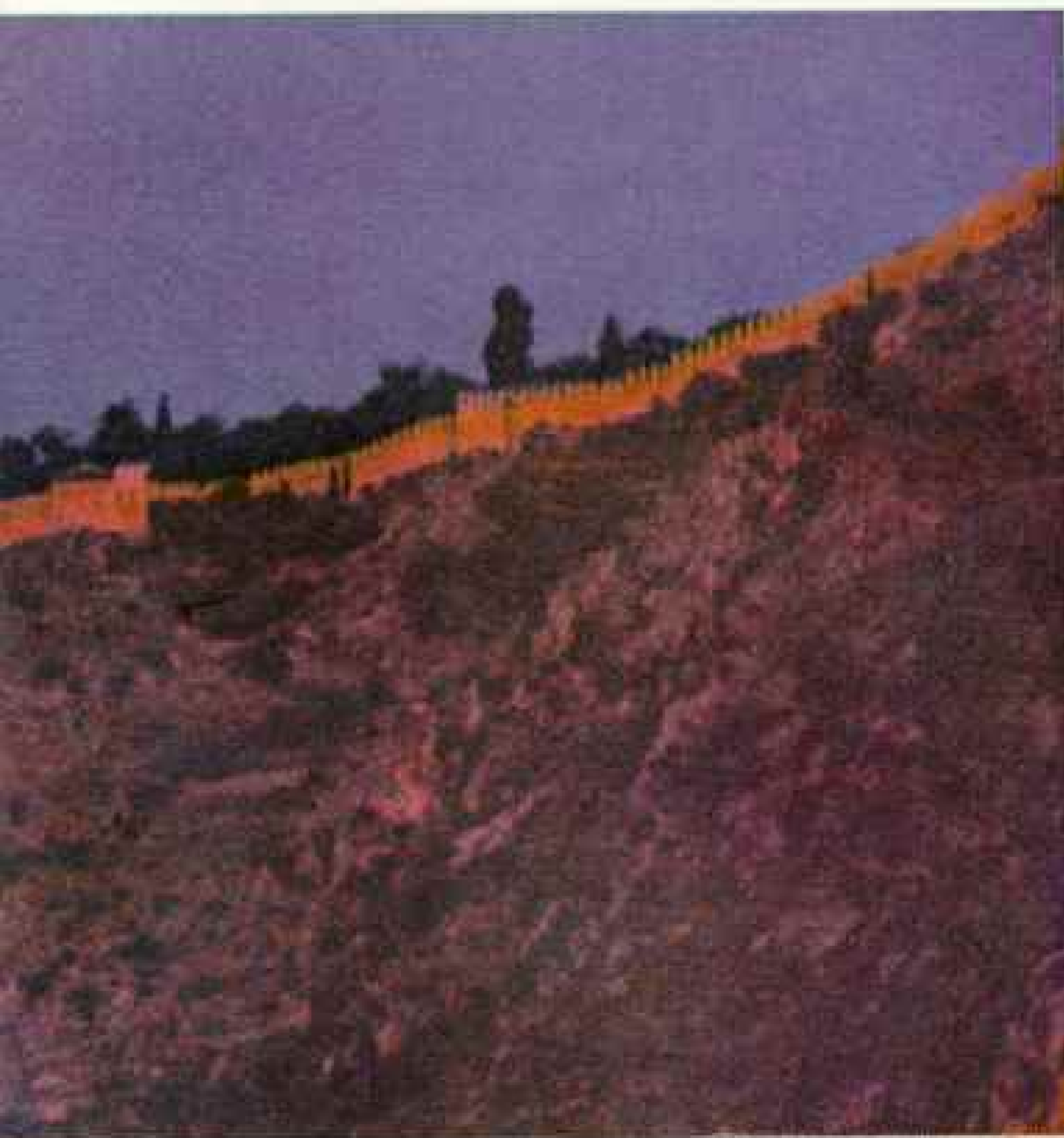
Yankee now followed the course of Pompey and the pirates. "Pompey the Great," reported our venerable guide Strabo, "...set fire to more than thirteen hundred boats and laid waste their settlements."

New Highway Brings Prosperity

As *Yankee* moved landward, a sunset ignited the landscape of the same Coracesium, now the port of Alanya, population 12,000. The approach was the most spectacular we had seen on the whole coast. On a steep cliff of red rock, 780 feet up, stood a huge 13th-century Seljuk-Turkish fort (below). We

"Now up this road—so terrible because our road builders sleep—is our old fort," Madame Erkan said, escorting us with verve from Hellenistic to Byzantine to Seljuk ruins, and then along the new coastal highway.

"Before World War I, these little ports had a good many Greek people, later exchanged for Turks living in Greece," she said. "But Alanya did not prosper until eight years ago. One boat came every month. Then the highway arrived and farmers began raising bananas—much money... See the two bottles sitting on top of the chimney? That homeowner has two daughters ready for marriage.



EPICRYONIS BY ALBERT WOLFF © R.E.S.

Tangerine moon rides a purple evening over Alanya, whose battlements hug the crest of a promontory 780 feet above the Mediterranean.

In antiquity, the city of Coracesium perched on the same strategic height. Just offshore, in 67 B.C., Pompey the Great annihilated a Cilician pirate armada that for decades had waxed fat on plunder from merchant vessels. Mark Antony later gave the city to his beloved Cleopatra, who cut the cedar trees of nearby slopes for timber to build her fleets.

Sultan Keykubad I, in the 1200's, erected the magnificent crenelated fortifications, whose imposing walls today enclose a town of 12,000.

rounded the point and entered the port, guarded by a massive octagonal tower.

Here Allen and Joe rejoined us after traveling 600 dusty miles of mountain roads, and we went ashore for dinner at a pleasant little hotel. The food was anonymous-international, and the place bustled with German tourists.

"But you want to see things truly Turkish," said Madame Nermin Erkan, the enthusiastic guide we met next day. Daughter of an Austrian mother and a Turkish father, Madame Erkan had learned an ensemble of languages at a French convent in Istanbul.

But see *that* one—a broken bottle? A widow or divorcee lives there. It is like advertising."

The zestful Madame Erkan gave us directions to Alanya's market—especially to one street shaded by a living tent of grape leaves. After the midday heat, people filled the sidewalks, men outnumbering women at least twenty to one. In shops and kiosks we found eggs, bread, vegetables, even beautiful fresh crabs. And we got a chance to observe the simple old-fashioned life in the port of Alanya.

In restaurants, men played backgammon and sipped coffee or *raki*, the national anise-

flavored aperitif. A cinema's poster pictured Turkish actors with big hats and six-guns in a *cowboy filmi*. A fire truck sprinkled dusty streets, scaring a squadron of pigeons.

Tractors pulled red farm wagons filled with women laborers. Horses festooned with *maşallah*—necklaces of blue beads to ward off the evil eye—munched grain from nose bags. A farmer's caravan moved past us: two small donkeys quick-stepping, heads down, followed by two tall camels of undulating step and snobbish mien. They, like us, were loaded with bundles and headed home.

Yankee enjoyed beautiful weather as north-westerlies pushed us south and east around the Cilician promontory that bulges closest

to Cyprus, a mere 50 miles to the south. Here during the 12th and 13th centuries determined bands of Christians established a small kingdom, one of the most remote from Christendom and one of the most embattled. Stout castles and massive churches still stud the rugged terrain.

“Most Romantic Anchorage in the World”

At Kızkalesi we anchored off an island dominated by the Maiden's Castle. The name derives from a legend that a Christian princess died here of grief after her father barred her marriage to a Moslem. The 12th-century structure and a matching castle on shore loomed in the night. As a full moon

Easygoing tempo of İskenderun makes mighty events of the past seem remote indeed. Where cab horses clip-clop, the fiery steed Bucephalus in 333 B.C. bore a triumphant Alexander the Great, fresh from decisive victory over the Persians at Issus, 22 miles away. Here he established Alexandria and



rose, the great walls and turrets seemed to float on watered silk. *Yankee* rode between the castles, and we wrote in her log this unqualified statement: "Kizkalesi, the most romantic anchorage in the world."

Next day we had an easy run to Mersin, where the O'Briens left us. Joe and I hired a car for a 17-mile trip to Tarsus, birthplace of St. Paul.

Tarsus once offered all the glitter of the ancient world. Plutarch describes the most glamorous Tarsian moment, when Cleopatra's barge glided up the ancient Cydnus River for the Egyptian queen's first well-staged meeting with Mark Antony. The scene had everything—a barge with gilded stern, purple sails,

and silver oars . . . Cleopatra dressed as Venus under a canopy of cloth of gold . . . the music of flutes and harps . . . the air scented with perfume, and the hard-drinking Mark Antony waiting in the marketplace, as Plutarch reports, "while the word went through all the multitude that Venus was come to feast with Bacchus for the common good of Asia."

Well, Tarsus has changed. It has a Roman "St. Paul's Gate" and a "Cleopatra Gate" and a bustling population of 65,000—but little remains of its ancient grandeur.

Off to an early start next day, *Yankee* covered 85 miles, crossing the big Gulf of Iskenderun to the port once called Alexandretta. Great mountains rose up to starboard.

Issum, or Alexandretta—Iskenderun in Turkish.

Tempting array of fruits and vegetables in Iskenderun's market appears as beguiling as any spoils of conquest that might have attracted Alexander's battle-weary troops. Electa Johnson chooses farm-fresh bounty for *Yankee's* galley.



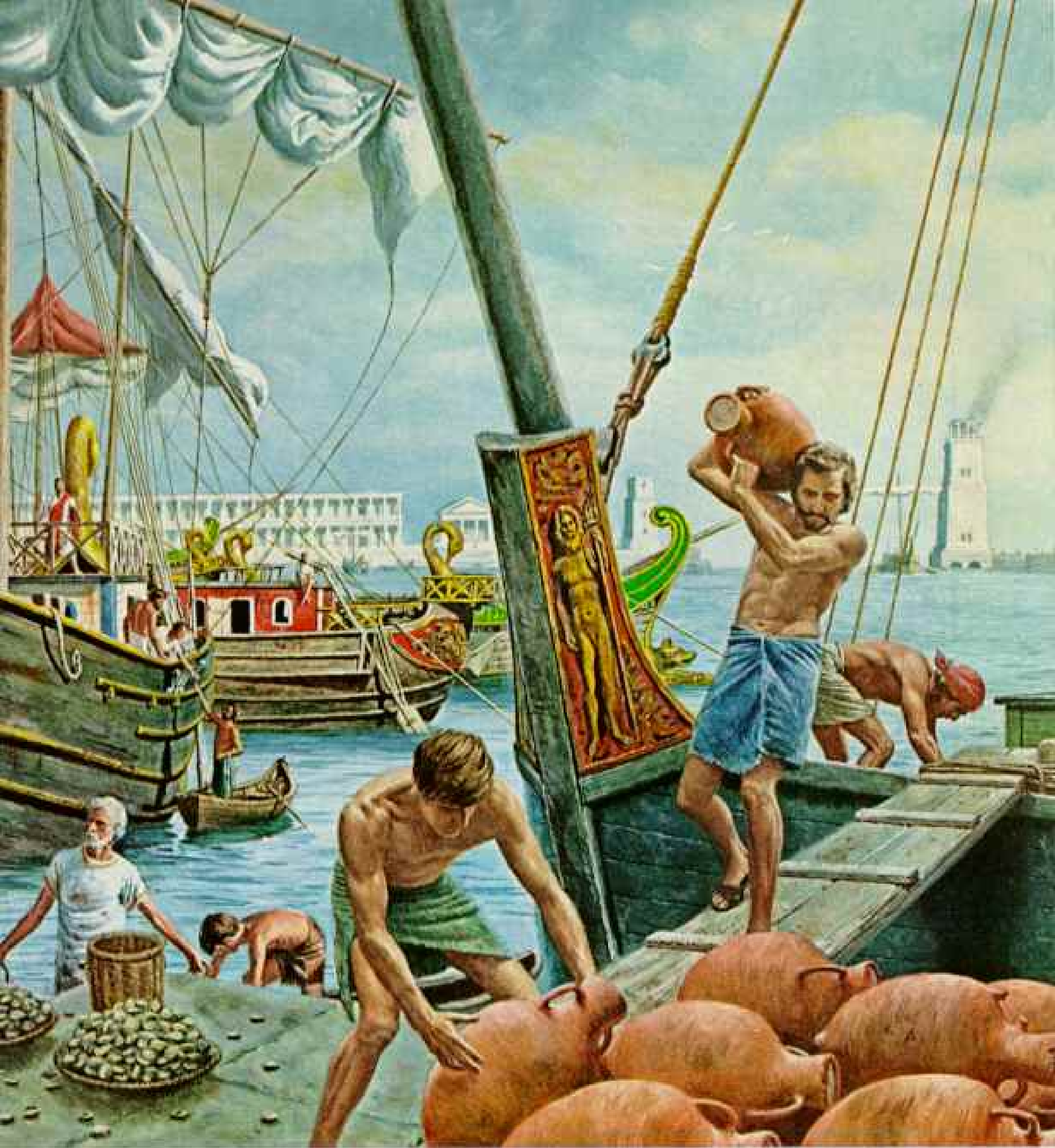


On the waterfront: A.D. 250. Muffled staccato of an imminent thunderstorm speeds the pace of wharfside activities at Seleucia Pieria, the port of ancient Antioch—today's Antakya. To create this specially commissioned painting for NATIONAL GEOGRAPHIC, the artist adapted diagrams and photographs of reconstructed ruins and artifacts of a similar port from the same era, Leptis Magna in Libya. Longshoremen lug wine amphorae, right, from a Roman vessel.

Coming aboard here was NATIONAL GEOGRAPHIC staff man Bart McDowell, who forthwith joined us for a 35-mile drive to Antakya, the Antioch of old. Our road led upward, twisting toward the Syrian Gates. Through this historic pass in the Nur Mountains came the soldiers of Christ and Mohammed to victory and defeat at Antioch.

"Just look at the map," said Irving. "This was the shortest land route around the bend of Asia Minor. Virtually all the caravan routes converged near here. Think of the cargo—silks, spices, jewels!"

Near Antakya we saw a mountainside shrine where, tradition tells us, St. Peter preached. Archeologists, however, save their



PAINTING BY MORTON SHARPLEY © R.S.A.

A servant girl, center, queries the price of clams for her Greek master's table. Vendor, left, buries with his unplucked wares to the marketplace. Beyond, workmen unload a Corinthian capital; column base and yet-to-be-fluted central section rest on the stone-paved dock. Temple and warehouses flank the harbor, guarded by a watchtower and lighthouse at its entrance. Today, a plain of silt, tilled by Turkish farmers, covers the site of both port and harbor.

enthusiasm for the brilliant mosaics in the local museum—rich mementos from the days when Antioch ranked below only Rome and Alexandria among great cities of the world.

We drove downward again, past the scarlet blooms of pomegranates, following the Asi River to Antioch's port of Seleucia Pieria. The harbor, now filled by silt and tilled by farmers,

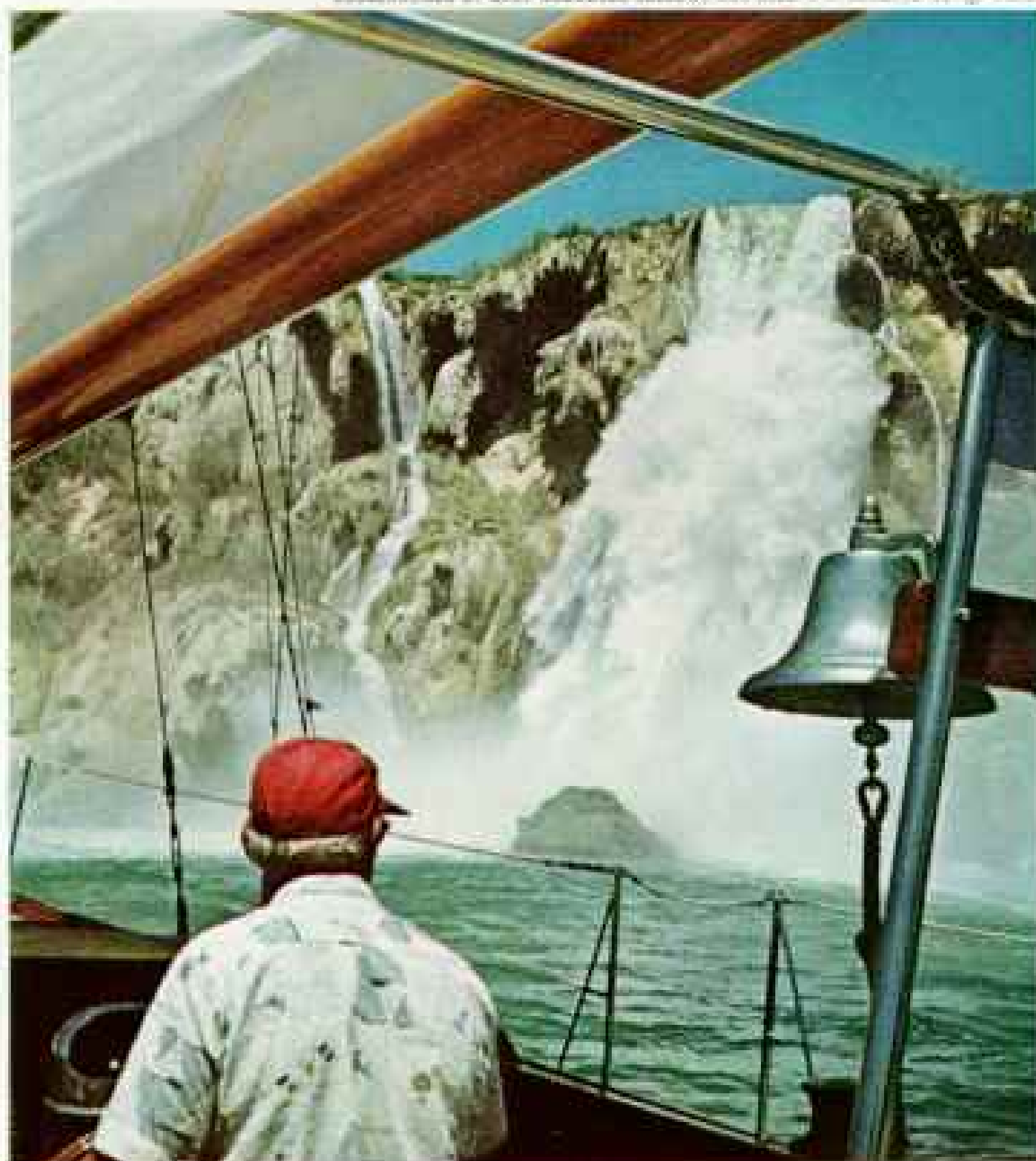
spreads out invisible to most eyes, but Irving climbed the base of a ruined Roman lighthouse, and called, "Come look at this! You can read the harbor like a blueprint—see the outline of the old docks?" We could.

We drove back to Iskenderun, and *Yankee* headed westward, to give Joe's cameras a second look at this rarely photographed coast.

On his private island near Fethiye, Egyptian Prince Abd El-Moneim shares a few hours of exile with *Yankee's* voyagers. The prince, second from right, served as regent of Egypt between King Farouk's abdication in 1952 and the founding the next year of a republic that banished the royal family. His father drained the isle's malaria-ridden swamps and transformed them into prosperous farmlands. Aviaries and sea-encrusted amphorae add to the charm of seaside living.

Fresh-water spray mingles with salt air as Captain Johnson daringly pilots *Yankee* past falls where the Duden River leaps 200 feet into the churning Mediterranean near Antalya.

REPRODUCED BY SAHJ NICKERELL (BELOW) AND JOSEPH S. BERENSON (THIS PAGE)



Two days out, we encountered an unseasonal east wind—the sun rose clear with “a soldier’s wind,” as Irving called it, “since even a soldier could sail with that.”

It was my trick at the wheel and, as the wind rose, I saw Irving studying the sky. “She must be blowing 40 to 50 knots,” he said. “But it’s those gusts I don’t like.”

We were both conscious of the williwaws, those on-again-off-again winds blocked and funneled by the mountains and valleys. We remembered Greek islands where we had suddenly found 40 percent more wind on the leeward side than on the windward. These Taurus Mountains create the same freak gusts.

As Irving put it, “You can get your hair

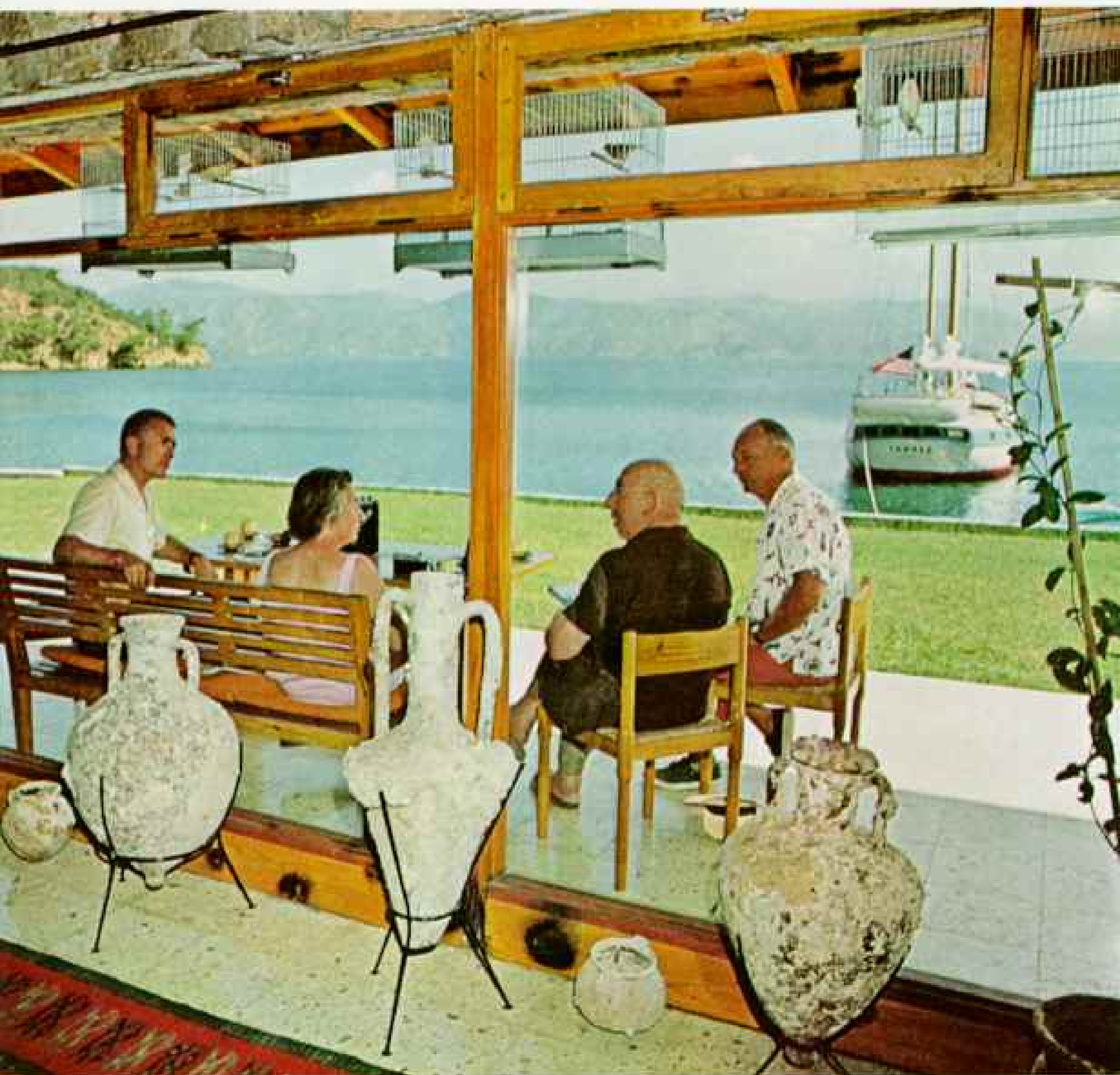
blown off.” Then he said, “Think I’ll take a reef in the mainsail.”

Only twice before had we ever reefed the main on the ketch *Yankee*.

“Careful steering,” Irving ordered. “Put her off. Dead before it.”

Yankee turned, releasing the wind pressure on the sail. Now Irving slacked the halyard and rolled the sail down a few inches; he then repeated the operation. It was a pleasure to watch the smooth Dacron furl neatly around the boom.

The wind grew no worse, but still shot *Yankee* westward like a racer. Two days later we saw what the same wind had done to another ship. Joe was the first to notice it.



"Right on the shoreline—is that a shipwreck?" he asked. A ribbed jumble of planking lay limp as a dead fish. We dropped anchor and landed for a slow dictionary-chat with a fisherman mending his nets.

"New motor and planking," Irving noticed as he prodded the smashed coastal freighter.

Using an English-Turkish dictionary, we asked the fisherman, "*Ne zaman?*—When?"

Tediously we deciphered his reply: "Two days ago she came ashore."

The same day we got that blow!

With this vivid navigational warning fixed in our memories, we sailed on, alerted.

Even on this second sweep of the southern coast, we continued to make discoveries. We

could pick up the binoculars almost any time and find some ancient ruin—a wall, an arch, perhaps a whole theater. Except for Egypt, we could remember no comparable concentration of ruins, and certainly no other Greek and Roman relics so rarely visited.

Skipper Gives *Yankee* a Shower Bath

Nature was generous. Our weather was flawlessly clear and fair; early-morning winds often moved *Yankee* so quietly we could hear the bells of goats ashore. Near Antalya *Yankee* got a cooling shower bath. Here we found a spectacular system of waterfalls where the Düden River dives straight from a 200-foot cliff into the frothy sea (opposite).



A few days' sailing brought *Yankee* to a region of fine conifer forests and fiords. The breeze carried a scent of pine mixed with salt, and each anchorage was an idyl. By the time we sailed into Fethiye, that port of 9,000 people seemed like a great metropolis. As freshly provisioned *Yankee* slipped away from the pier, we noticed stacks of logs awaiting shipment to timber mills.

"I believe one of the conquerors built his ships near here," Irving recalled. Suleiman the Magnificent prepared part of his fleet nearby for the siege of Rhodes in 1522.

Yankee Crew Greeted by Royalty

Obviously the great Ottoman sultan's shipwrights left the forest thriving, for conifers still bristle to the water. Seeking an anchorage, we slipped into an appealing cove. There, on an island, we sighted a fieldstone villa, private pier, and golf-green lawn. The setting reflected a noble taste: A picture window focused upon a sweep of mountain, forest, and sea; a terrace, lined with amphorae and aviaries, suggested contemplation (pages 818-19).

An impressive gentleman moved out to the pier, studied us with glasses, then waved us in. Servants darted out to help. Two fetched fenders, another rowed out in a dinghy to take our stern lines, and in a moment we stepped ashore to a courtly greeting from Prince Abd El-Moneim, former regent of Egypt.

"And a member of the National Geographic Society," he added with a smile. "Yes, this was my father's island. Domuz Adası means 'pig island'; we have wild pigs here—they swim in the sea." As the prince gave us a tour, he pointed out a waterside ruin beside his home. "A German archeologist told me that was a Byzantine bath for a queen.

"Once malaria raged here," he continued, "but my father drained the swamps and made this a prosperous place for maize. Now people raise cotton and tobacco too. Come along, and I'll show you the neighboring area." We stepped into the prince's motorboat while he lighted a long cigar. Then his royal highness piloted us personally at roaring speed.

The roar stopped short as the prince cut the engine. "This island is called Tersane—meaning 'shipyards.' It was here that Sultan Suleiman built his ships to conquer Rhodes."

And so we found Suleiman's shipyards—with our own royal guide. We continued to follow Suleiman's trail next day, for we stopped at Marmaris for more paper formalities. From this port Suleiman's fleet had embarked for the invasion of Rhodes. Once our red tape was snipped, we did the same.

We encountered a stiff breeze and rough seas that afternoon. But with the wind abeam, *Yankee* really made time. Wearing oilskins against the spray of 10-foot waves, we reached Rhodes in three hours—for 30 miles. We passed the site where four months earlier the Navy destroyer U.S.S. *Bache* had been blown onto the rocks and grounded. Three windmills to port now peacefully whirled their canvas vanes as we slipped into the fine old harbor at sunset, the very instant that a white cruise ship turned on its lights. Dead ahead lay the clean white marketplace, and behind loomed the tower of those noble Crusaders, the Knights of St. John.

Castle Built From a Wonder's Ruins

Elsewhere the glories of antiquity had vanished, but one of the most awesome may rise again. We learned that the city of Rhodes plans to replace the Colossus of Apollo, one of the ancient Seven Wonders, completed around 280 B.C. Historians say an earthquake toppled the mighty bronze less than a century after its completion; eventually its pieces were shipped away to Asia Minor as scrap. Drawing upon coins and ancient writings for the details, American sculptor Felix de Weldon will re-create the Colossus, 105 feet tall. The task may take 10 years.

We sailed from Rhodes with enthusiastic reinforcements. Dr. Melville Bell Grosvenor, Editor-in-Chief of the NATIONAL GEOGRAPHIC, came aboard with his wife Anne and their 12-year-old daughter Sara. Joe and Bart now became amphibians, preceding *Yankee* by ferryboat and station wagon to arrange our shore expeditions along the way.

Our first joint beachhead was Bodrum, the ancient Halicarnassus. We entered the harbor as the day's last sunshine played on the towers of Bodrum's 15th-century castle.

"Sara, come and look!" Mel Grosvenor called. "That castle is all that's left of another of the Seven Wonders of the Ancient World."

Expressive hands and face help Suat Şakir Kabağaç tell a story. The gifted raconteur and notable citizen of the little town of Selimiye often entertains visitors with tales from his store of local lore and history.

Then Mel told young Sara the story of Mausolus, the Persian satrap who built a viceroyalty here on the Carian coast early in the fourth century B.C. When he died, his grieving wife Artemisia commissioned five great sculptors to decorate his memorial, the Mausoleum, a tomb so famous that its name entered general currency. Though earthquakes had toppled the Mausoleum, its ruins endured until the Knights of Rhodes came. The knights "admired closely" the marble reliefs, as one chronicler wrote, then "pulled down, cracked, and broke up" the stones to build their castle.

"But not all the marbles," Irving pointed out. "Some were found in the last century."

Ancient Tunnel Leads to a Live Turk

Irving had been reading about the 19th-century excavations here by the diplomat-archeologist C. T. Newton. In that quieter time, the British Navy aided research with the loan of a corvette, a crew of 150, and a detachment of sappers. Digging near the foundation of the Mausoleum, the men came across some underground passages. One corporal explored the distant recesses of the tunnel and "on probing the roof of a gallery," wrote Newton, "... he detected a soft place, and his crowbar suddenly finding its way upwards, lifted up the hearthstone of a grave sententious Turk, who was sitting quietly smoking his chibouque in his own house."

More productive probes yielded the famous collection of marble statues and friezes Irving had mentioned. They are displayed in the British Museum.

The director of the Bodrum Museum, Dr. Haluk Elbe, and his assistant Hakkı Nalbantoğlu showed us around the attractively landscaped castle grounds.

"Yes, the original Mausoleum stood 135 feet high, just beyond that minaret [page 824]," said Mr. Nalbantoğlu. "We have been digging there the past two years with Kristian Jeppesen, from Denmark. Now we've encountered the foundations—the courtyard was 105½ meters by 242½ meters [346 by 796 feet]." Thus scholars learn about yesterday's 12-story skyscrapers by studying holes in the earth.

We lingered in the museum over historic treasures lifted from ancient hulks off these coasts. Artful displays spotlighted Bronze Age copper ingots and Byzantine pottery, recovered with National Geographic Society support by Peter Throckmorton and Dr. George F. Bass of the University of Pennsylvania Museum.*

If some of us enjoyed Bodrum for its fascinating past, young Sara found camels more exciting.

"Hey, neat!" she shrieked one morning, leaping up from her breakfast. Through *Yankee's* stern windows she had

*See "New Tools for Undersea Archeology," by Dr. Bass, NATIONAL GEOGRAPHIC, September 1968.

Oilskin weather—despite clear skies—sprays *Yankee*. Below, life offers most of the amenities of home, plus the company of hosts Irving and Electa Johnson, left and right—here joined by NATIONAL GEOGRAPHIC Editor-in-Chief Melville Bell Grosvenor, Mrs. Grosvenor, and daughter Sara. Pancake mix arrived from the States with 16-year-old Edwin Grosvenor, who came aboard at İzmir.





EXTACHROME (BELOW) BY EDWIN STUART BROOKHUISER; KODACHROME BY JOSEPH J. SCHERER © H.S.S. 823



seen a working caravan, half a dozen camels taking freight to a brightly painted little cargo carrier up the pier.

A moment later, Sara was covering the Bodrum waterfront. A fisherman scrubbed ink from his fresh-caught octopus—to Sara's wry-faced disgust. Nearby, spongers had spread out their sun-dried wares, ranging from round sponges the size of one's hand to giant baroque sponges as big as Sara herself.

Joe cut our shopping short. "We'll lose the early-morning light," he insisted. Joe wanted pictures of *Yankee* sailing out of Bodrum's harbor; he had picked a mountaintop vantage point and had a walkie-talkie to direct *Yankee's* maneuvers. We followed orders, even leaving the harbor a second time when Joe's radio voice squawked, "One more, please" (below).

824 As *Yankee* slipped out of radio range, we

had no way of knowing the rest of the story that day. But three Turkish soldiers appeared and arrested Joe, Bart, and guide Yamaç.

"This is a military reservation," one soldier explained. "Your radio is illegal."

Years before, Joe had briefly seen the inside of an African jail because of a diplomatic mixup.

"Bodrum looked a lot like Africa for a few minutes," he told us later. "Then we got the soldiers to call the museum, and we got sprung. They even brought us cold drinks."

As *Yankee* plied Aegean waters, we found the west coast of Turkey almost a different country from the south coast. For weeks we had wandered off the beaten track, gunkholing as sailors say—or shunpiking, as our shore party put it. Along the southern coast we'd usually found either westerly breezes or calms.



Fragment of a frieze from the Mausoleum, prototype of lavish tombs, adorns the garden of the Crusader castle (below, right) at Bodrum—ancient Halicarnassus.

The castle builders mined the ruins of the Mausoleum, which lay on a hill above the minaret at left. They mortared this panel, showing a Greek slaying an Amazon, into a wall—its face hidden. Other segments found their way to the British Museum. In 1964 this “missing link” was discovered after 450 years as a building block.

Yankee, carrying a striped genoa, tacks through the entrance of Bodrum’s harbor.



DOMINICONS BY NICHOLE BOLL BRIDGEMAN (ARTIST) AND JAMES J. SCHROEDER, © R.H.S.





Now—especially in the afternoon—strong northerlies blew from beyond the Dardanelles, forerunners of the fierce *meltem*, which sweeps this coast during July and August. These winds complicated our course among the coastal islands. Behind us lay Kos, home of Hippocrates, the Father of Medicine, and thus a cradle of the medical arts. Ahead bulked Sámos, the birthplace of mathematician Pythagoras.

"In his honor," said Mel, "we ought to take a short cut through these islands—maybe follow that famous Pythagorean hypotenuse."

But short cuts can be dangerous. To port we saw the dry shores of Yassı Ada—Flat Island—famed for ancient shipwrecks. Here, with support from the National Geographic Society, a team of archeologists headed by Dr. Bass had been probing the wreck of a Roman wine carrier sunk in 140 feet of water.

As we sailed on, we found history at every landfall. Skrophes Bay, for example, led us inland to Didymi, home of the famous oracle and temple of Apollo.

We climbed its steps and listened to cawing crows atop the columns. In this dramatic set-



Sickles flying, farmers near İzmir harvest a field of wheat. Hooked sticks gather the nodding heads of grain for flashing blades to decapitate. Mechanization gradually replaces such venerable methods as Turkey modernizes its agriculture to meet the needs of a nation of 34,400,000.

Kitchen in the fields: Women in billowy trousers, called *şalvar*, bake loaves of bread—often served oven-warm with olives and yogurt.

Many farm families leave their home villages in summer to live in temporary dwellings in the fields. Dwindling numbers migrate with the seasons, as did the *yürük*, or nomads, who crisscrossed the land in times past.



RESEARCHER BY JOSEPH L. SCHERER © N.E.S.

ting we could see why rulers from Croesus to Diocletian consulted Didymi's sacred spring. But fabulously wealthy Lydian King Croesus tested the soothsaying by sending messengers to several oracles at once: each asked on a prearranged day and time what Croesus was doing. The Greek oracle at Delphi gave the right answer: The king was boiling a tortoise and a lamb in a bronze caldron. Didymi's oracle failed utterly and fell out of royal favor.

Forewarned by the Croesus consumer survey, we asked no questions. Instead, we sailed northward toward the Temple of Artemis

at Ephesus, another of the ancient world's Seven Wonders—and our third on this voyage.

We anchored at Kuşadası beside a small island castle. We erred, for the castle now houses a late-hour discotheque that cost us all a night's sleep. But this we did not know as our shore party set out for Ephesus.

Kuşadası means "bird island," and driving inland along the Küçük Menderes River, we saw some of the birds for which the place was named: ibis, stork, and a large blue-green roller. On rocky hillsides grazed herds of goats. In the valleys, platoons of field hands—



75 at a time and mostly women—hoed tobacco.

The fertile valley was built by the silt that ruined old Ephesus. For centuries that Ionian port made the region prosperous enough to maintain its great pilgrim attraction, the Temple of Artemis; we know her better today as Diana. Construction, according to Pliny, "occupied all Asia Minor for 120 years. It was built on marshy soil so that it might not be subject to earthquakes. . . ."

Only the marsh survives at the site of the temple, but since Austrian archeologists began work here around the turn of the 20th century, Ephesus itself has been transformed. Few ruined cities in all the world can match the grandeur of its colonnades, its broad streets and stairs, its fragmented palaces,

temples, arches, and carved reliefs (above and opposite).

The hillside theater evokes memories of St. Paul, a three-year resident among the Ephesians. Here the idol sellers shouted, "Great is Diana of the Ephesians." In the anti-Christian riot that ensued, St. Paul was persuaded to withdraw; soon after, he left town.

So did we. Irving and I headed back to *Yankee*, while Mel and Anne detoured to the National Geographic Society-supported archeological dig at Aphrodisias.*

When the Grosvenors returned, we continued along the Ionian coast, searching for an anchorage. We recalled Strabo's tales of "a

*See "Ancient Aphrodisias and Its Marble Treasures," by Kenan T. Erim, NATIONAL GEOGRAPHIC, August 1967.



BOB D'AMICO © NATIONAL GEOGRAPHIC SOCIETY



City conquered by silt: Ephesus, whose grandeur vied with Rome's, overlooked the shining Aegean until river sediment plugged its harbor and marooned its marble avenues. Ships once docked within earshot of noisy crowds in the theater, seating 25,000. St. Paul preached here, provoking a riot among Ephesians, who worshiped the goddess Artemis (Diana to the Romans) in a 117-columned temple—one of the Seven Wonders.

Latin inscription (left) proclaims that two freed slaves, Mithridates and Mazaeus, dedicated this gate of the agora, or marketplace, seen above at right, to their former master, the Emperor Augustus, and members of the imperial family at Rome.

rugged and harbourless country" as we rolled at anchor one night in a small cove south of the Strait of Khios.

"Thousands of ships must have waited here before us," Irving mused, "hoping for a favorable wind to get them into the Bay of İzmir."

The Grosvenors' son Edwin was flying in to İzmir, and we wanted to meet his plane. "But no one has a valve on the wind," Irving noted. So we waited, doing jobs we save for such moments: Change the engine oil. Repack the rudder-post stuffing box. Gam over coffee. And speculate about the weather.

We wrote letters and logs. And we read old Strabo's *Geography*. Then came our break, and we continued "to another gulf, on which is the old Smyrna." As the author described that most beautiful city, "a part of it is on a mountain and walled, but the greater part of it is in the plain near the harbour. . . ."

Much has happened since. Here in 1922 the Turks at last pushed a Greek army into the sea, setting off one of the greatest transplants of humanity in history. Within three years the two nations exchanged almost two million people in a sorting out of nationals who had been intersettling since medieval times.*

The victory by the Turks also ensured the success of the revolution that modernized their homeland. Smyrna, rebuilt, is the thriving port of İzmir.

"New City" Dates From Alexander's Time

New as İzmir seems, an ageless identity endures. Ruins on a site chosen by Alexander the Great are called the "new city," because of an even older Smyrna across the bay. We rode up Alexander's hill for its commanding view: a city of high-rises, glass, and modern design.

We joined Mel and Anne on a visit to the U. S. Consulate to see their old family friends the Guy Lees. Mr. Lee, the consul-general, had an office overlooking the waterfront, "the number-one port for Turkish exports," Mr. Lee said with hometown pride. "You see those freighters just there? They're taking on cotton and dried fruit—the leading exports. Down the list we rank tobacco, oranges, chrome."

Yankee took on supplies of her own, so we got to explore the old marketplace, a marvel of crowded walkways and jostling, haggling shoppers. Pushcarts filled with strawberries and lettuce made traffic jams, jewelry shops glittered, saddles exuded a scent of leather. Next to the minaret of the Kestanepazari Mosque we passed the deafening percussion of blacksmiths beating out hinges and hoes in a shower of sparks. Nearby we examined the smoke-smudged remains of an old caravansary, a historic site, for İzmir had been a stop on the Asian caravan routes.

İzmir airport was the final stop on a long trail for young Edwin, just out of school in the U.S.A. and now joining us aboard *Yankee*. He arrived, a handsome

Mighty head and hand from a statue of the first-century Roman Emperor Domitian awe visitors to a museum at İzmir, ancient Smyrna.

Rome ruled Asia Minor from the second century B.C. until A.D. 330, when Constantine the Great shifted the seat of imperial power from the barbarian-menaced Eternal City to Constantinople.

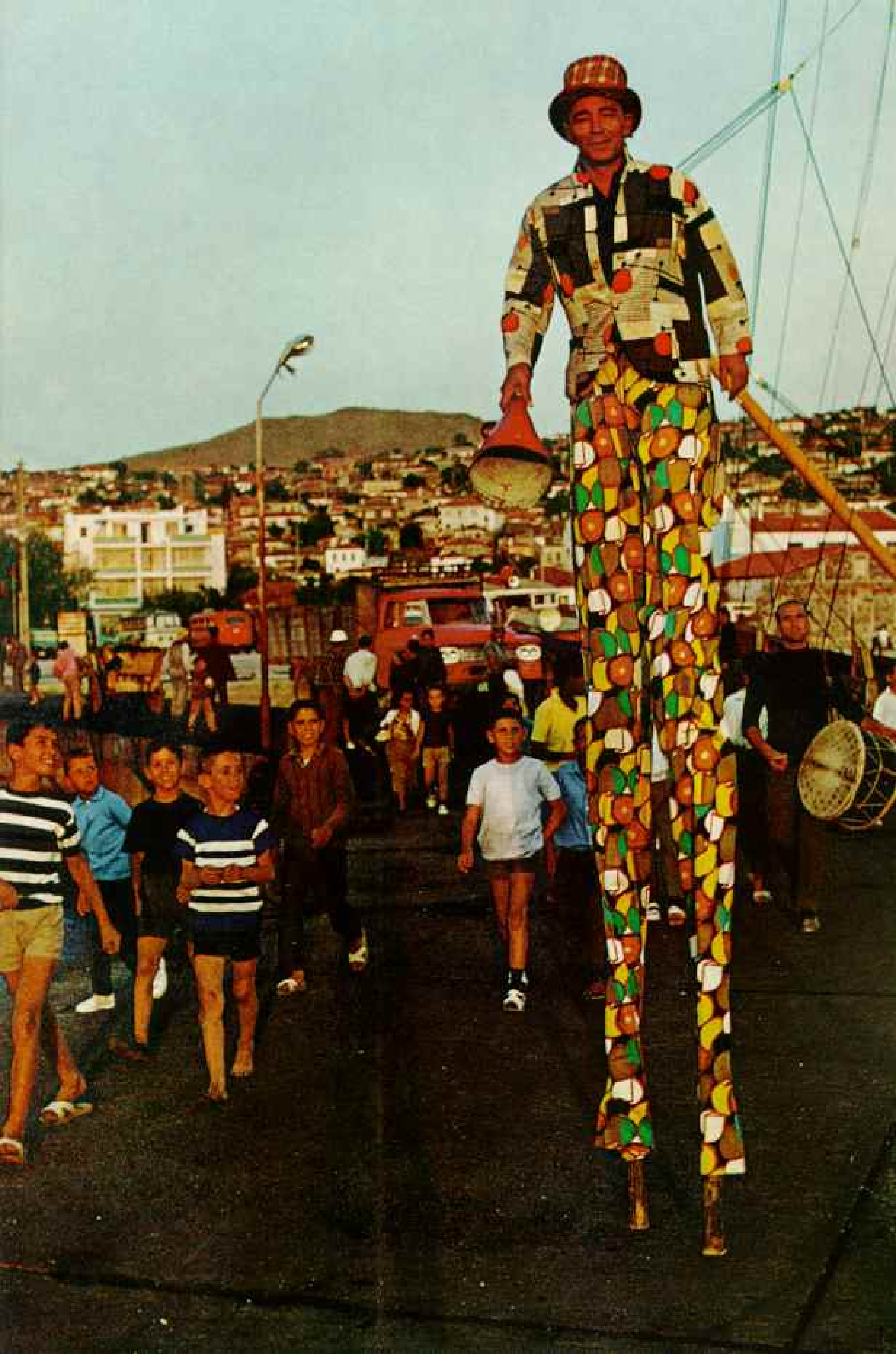


REPRODUCED BY EDWIN STUART GROSVENOR (RIGHT) AND JOSEPH E. SCHWENKEL © N.A.S.

Stilted Pied Piper, advertising a circus, leads children through the streets of Dikili, a small Aegean port that serves as the jump-off point for visits to modern Bergama and the ruins of Pergamum.

Today's circus has violent antecedents in the man-versus-lion combats, mock sea battles, and gladiatorial duels staged by Roman emperors. Enormous theaters, whose ruins can still be seen at the sites of Ephesus, Pergamum, Smyrna, and Side, rivaled those at Rome.

*Melville Chater wrote an eyewitness account of the massive treks in the November 1925 NATIONAL GEOGRAPHIC.





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PHOTOGRAPHS BY MELVILLE BELL CHRISTY © N.A.S.

"Here at last the gods have summoned me deathward." Trojan prince Hector's words from Homer's *Iliad* ring out over the stones of Troy. Young Sara Grosvenor, far right, stands at the foot of walls that may be those the fleeing Hector circled thrice before Achilles caught and slew him.

These layered ruins, discovered by Heinrich Schliemann in 1871, embrace the rubble of nine cities built on this site between 3000 B.C. and A.D. 400. Remains of the sixth or seventh layer are probably those of Homer's Troy—sacked and burned by the Greeks about 1200 B.C.

Sighting Asia's morning shore across the Dardanelles, antiquity's Hellespont, Captain Johnson sails the strait that separates European from Asiatic Turkey. Near here in 480 B.C., the armies of Persia's Xerxes marched across a double bridge of ships on their way to Greece and ultimate defeat.

16-year-old bearing cameras, film, U. S. newspapers, and even some pancake mix for *Yankee's* galley.

But the galley was secured on Ed's first evening, for Mel took us all to a colorful sea-front restaurant called the Abdullah. Seated around two circular copper tables, we tried such delicacies as *biber dolması*, or stuffed peppers, *börek*, a cousin of the cheese blintz, and *yaprak dolması*, stuffed grape leaves.

Ed tasted his Turkish food cautiously. But his tongue grew bolder when he spoke Turkish. With dictionary and phrase book—and some lessons from driver Yamaç Su—he was soon translating for his *baba* and *ana* (father and mother) as we toured İzmir.

We had a lot to see. All of us visited Smyrna's two-story agora, or marketplace, and washed our hands in water that still flows through a Roman ceramic pipe.

Smyrna has a strong traditional claim as the birthplace of the blind minstrel Homer. Though his epic the *Iliad* dealt with the Trojan War of about 1200 B.C., Homer was born perhaps four centuries later.

Book Lovers Owe Pergamum a Debt

Temporarily, the *Yankee* crew now scattered. Mel had an appointment with Professor Erich Boehringer, the German archeologist excavating Pergamum. So the Grosvenors drove north with the Lees.

"We passed Aliğa, where Russians are building an oil refinery for the Turks," Mel reported. "Imagine: Russians and Turks cooperating, after having been enemies for so long!"

For Ed, Pergamum represented the high point of the trip. "Not much sun for pictures," he complained, "but what a hill!" Pergamum rises grandly above fertile farmlands and the town of Bergama at its foot. Near the Temple of Athena, patroness of learning, Dr. Boehringer uncovered the foundations of the famous Pergamum library. Here ancient sages built a vast collection of papyrus scrolls—arousing the jealousy of librarians in Alexandria, according to Pliny.

The Egyptians, fearing the Pergamum library would surpass their own, placed an embargo on the export of papyrus. Since Egypt enjoyed a virtual monopoly on this reed-base paper, Pergamum scribes had to turn to flat pages made from skins—the first books as we know them. Our word parchment comes from this "Pergamene paper." In the end, ironically, the Egyptians won out. Mark Antony gave Cleopatra the Pergamum collection, including all its parchment books.

Yankee's shore parties converged at the little port of Dikili. From there we sailed toward Troy, consulting the *Iliad* as we went: "And Apollo . . . sent them a favoring stern wind . . . and the wind blew into the middle of the sail . . . She ran swiftly . . ."

Apollo sent *Yankee* less wind than he did Agamemnon's voyagers; at times we even used the engine. We nipped in close to the bulk of Bozca Island, and Mel remarked, "Those are the hills that hid the Greek ships." Tradition says that the fleet waited here until



“I order you to die”

ON A FOXHOLE-CRATERED SLOPE of Gallipoli Peninsula (left), Dr. Grosvenor finds a rusty beef tin and crockery from World War I. Here, in 1915, the Allies sprang an amphibious assault to pry open the Dardanelles, controlled by Turkey—Germany’s ally.

Australians and New Zealanders (below) swarm Anzac cove. On other beaches, British and French troops stormed ashore. But a young Turkish officer, Mustafa Kemal, spurred defenders into a frenzy of courage: “I don’t order you to attack; I order you to die.” Die they did—55,000 of them—but not before driving out the Allies. Kemal, later surnamed Atatürk, “Father of the Turks,” won immediate fame.

Snorkelers in the same cove (below, left) hunt for bullets to sell as souvenirs of the campaign.



the Trojans took that wooden horse within their walls.

"Nothing to see—just a few rocks," friends had warned us. So we had gone expecting no real trace of Homer's "strong-walled citadel."

Visiting Troy once more, we found the Grosvenor youngsters experiencing our first-time surprise. From the port of Çanakkale, we drove in two cars. The sun was hot and the country dry. Ed, fidgeting with his cameras, complained about "Dullsville."

Then we arrived, parked, and climbed the hill. Ed looked—at the trenches, at the solidly built rock walls, "the great bastion of Ilion," and beyond, to the "plains of windy Troy" below (pages 832-3). Ed paid the site a teenager's ultimate tribute: He fell silent—then busily took pictures of the ancient gates and

the temple where Alexander the Great had paid homage centuries later.*

Our *Iliad* contained a prophecy by the fair Helen, "Hereafter we shall be made into things of song for the men of the future."

And so they were, Helen, Paris, Hector, Achilles—they and their armies and their gods, all things of song. And we, the men of their future, reviewed their panorama. Cattle grazed, wheat grew ripe, young tannin oaks held up crinkled leaves, and sunflowers leaned toward the light. Beyond stretched the blue waters of the Dardanelles, the fabled "Hellespont where the fish swarm." We turned to Homer and read how the warriors "dashed their shields together and their spears. . . .

*See "In the Footsteps of Alexander the Great," by Helen and Frank Schreider, *GEOGRAPHIC*, January 1968.



and the ground ran blood. . . . So the grim encounter . . . veered greatly now one way, now in another, over the plain. . . ."

On his way to Athens and Salamis, Xerxes passed here, punishing the stormy waters with 300 lashes, then binding 674 ships together with cables, beams, brushwood, and earth. Thus he made twin bridges of ships. It took seven days and seven nights for the army to cross.

Yankee passed this site, ancient Abydos; the setting was beautiful. Fields sloped to the sea; villages tilted on hills; each settlement skewered to the landscape by a sharp minaret. Old wars seemed far away.

"But we have to trace the Gallipoli campaign," Mel insisted. As a midshipman at Annapolis, he had studied the Allied effort to break through the Dardanelles in World War I. Between April 1915 and January 1916, the fighting cost half a million casualties.

Gallipoli Guide Himself a Veteran

"I know just the guide," said Irving, producing the address of Mr. M. S. Dilmen, a gentleman now in his seventies—and himself a veteran of Gallipoli. We met Mr. Dilmen on the European side of the Dardanelles for an auto tour of the peninsula battlefield.

"Yes, I fought here for the first three days," Mr. Dilmen told Mel. "I had been visiting my uncle, a company commander in the 27th Regiment. We expected no battle; I was 20 and about to be called to the colors. But I fought, and three days later they sent me to reserve officers' training camp. So I am alive today. My uncle and his regiment met death."

We walked along the shores where troops of the Australian and New Zealand Army Corps landed on Anzac beach. Miscalculation of strong currents in predawn darkness caused the British Navy to miss the intended landing site by about a mile. This crucial error placed the troops beneath a steep cliff (preceding pages).

"They came ashore over there early on April 25," Mr. Dilmen told us. "By 8 a.m. the Australians were moving up this height—and then came



Not tumbled ruins, but the solid stuff of cities in the making, rectangular sections of marble (right) await transport from the island of Marmara. Red-hatted Captain Johnson looks to the foot of quarry walls, where Edwin Grosvenor focuses his lens on two workmen splitting an unpolished block with a pneumatic drill. The result of the young photographer's effort appears at left.

For more than two thousand years gleaming white slabs from these quarries have added luster to the cities of Europe and Asia. The name Marmara derives from the Greek word *marmaros*, which came to mean "shining stone." The surrounding Sea of Marmara, called Propontis by the ancients, took its modern name from the island.

EXTRAPHONE (ABOVE) BY EDWIN STUART GROSVENOR;
RODACHROME BY MELVILLE BELL GROSVENOR © R.S.L.







Mustafa Kemal. He was later called Atatürk—Father of the Turks—but now he was only a divisional commander." Kemal halted some Turks who had panicked, made them fix bayonets—then stopped the Australians. Near that ridge 50,000 Turkish and Allied troops were to die. Defying both death and protocol, Kemal ordered up reserves.

"Thus he prevented the enemy from advancing," Mr. Dilmen said. "Kemal did not sleep for three days and nights."

"Imagine that fiery eye," said Irving, for most public buildings in the nation display a portrait of modern Turkey's founder: thin lips, hard jaw, piercing eyes (page 811).

Yankee anchored one evening in Mordo Bay, near the peninsula's southern tip, where the collier *River Clyde* brought 2,000 British troops in for the first landings. As fast as the soldiers stormed toward the beach, entrenched Turkish riflemen cut them down. Brigadier H. E. Napier came alongside one landing craft loaded with men and tried to rally them, then realized with horror that all lay dead. Moments later he also died while leading a futile last charge near our anchorage.

"What a fine mirror history is," wrote the future Atatürk in his diary. "In great events . . . how clearly do . . . those who take an active part . . . show their moral character."

Kemal displayed his own forceful character as founder of the Turkish Republic in 1923. He outlawed the fez and discouraged the veil as symbols of religious domination. In 1928 he banished Arabic script—and gave Turks only half a year to learn the Roman alphabet. Schools, railroads, and Atatürk's will power pulled Turkey into the 20th century.

Kismet Sails Around the World

While riding at anchor on Mordo Bay, we found another splendid example of Turkish character in a handsome little ketch.

"A self-steering vane," Irving noted. "And chafing gear in her rigging—she's a deep-sea cruiser." Indeed she was. Her name was *Kismet* and she flew the star and crescent of Turkey at her stern. A bit later *Kismet's* skipper—a trim, dark man with a pointed beard—came alongside. He was Sadun Bora and with his wife Oda he was completing a two-

year circumnavigation of the world—the first such trip for a Turkish yacht.

"Tomorrow we will have ceremonies of welcome at Çanakkale," Sadun told us when he and Oda came aboard *Yankee*, "and later more ceremonies in İstanbul. Tonight is the last moment we can call our own."

Sadun, an İstanbul textile engineer, had built the 34-foot ketch—even much of her hardware. Cotton for the sails had come from the mill where he worked; the attractive German-born Oda had been the sailmaker.

"With the Arab-Israeli war," Sadun said, "the Suez Canal was closed. So we had to complete the trip partly by land. We brought *Kismet* on a trailer from Israel's port of Eilat to Ashdod on the Mediterranean."

We talked late that evening about mutual friends, about their cat Miço—who boarded *Yankee* and looked us over like a visiting yachtsman—and about *Kismet's* coming welcome in İstanbul. We would meet again.

Island Named for Its Famed Stone

A fair wind helped push *Yankee* against the Dardanelles' swift current. The day was sunny and *Yankee* was almost never alone on the sparkling water. Great Russian tankers plowed down from the Black Sea, loaded with Baku oil. We passed a variety of small Turkish freighters, their high, pointed bows and sterns painted in vivid colors. Some carried great barrels of wine on deck. Despite the current—coming from the Black Sea by way of the Bosphorus—we soon reached the Sea of Marmara and the isle of the same name.

"No travel agent could supply a ticket for this kind of landfall," said Mel. We wondered if a cruise ship had ever called here. Marmara Island juts up abruptly 2,000 feet above the sea. We came in cautiously, with Sara calling out the soundings from our depth finder.

"What a strange shore," Anne remarked. White stone glittered in the shallows and the sea looked silver. This isle took its name from the rock called marble.

Irving and Mel climbed over the face of the marble mountain to watch men break the stone with sledge hammers and drills (pages 836-7). How long had this stonecutting prevailed? We consulted Pliny's *Natural History*

Domes of azure artistry roof İstanbul's Blue Mosque, built in the 17th century by Sultan Ahmet I, who hoped that it might surpass all other mosques in splendor. Blue glazed tiles arranged in geometric designs give the mosque its name. Because Moslems touch the carpets with their foreheads during prayer, visitors must remove their shoes before entering.



"A strange spectacle . . . unbelievable . . . except to those who actually did see it." So marveled contemporary Greek historian Kritovoulos at the extraordinary stratagem by which Sultan Mehmet II in 1453 outwitted the Christian defenders of Constantinople. The Sultan's fleet, besieging the Byzantine capital, found the Golden Horn, or inner harbor, barred by an immense chain. Not to be stopped, Mehmet ordered the construction of a huge wooden glideway over the steeply ridged neck of land separating the Bosphorus from the Golden Horn. Across this, teams of



PAINTING FOR THE NATIONAL GEOGRAPHIC SOCIETY BY ARTHUR BURENBAU © N.G.S.

oxen and thousands of soldiers dragged some seventy vessels, each fitted on a wheeled cradle. So intoxicated were Mehmet's men with the boldness of their deed that, as Kritovoulos describes it, "... they manned the ships on the land as if they were on the sea. Some of them hoisted the sails with a shout. . . . Others seated themselves on the benches, holding the oars in their hands and moving them as if rowing. And the commanders. . . . ordered them to row." Defenses thus penetrated, Constantinople—Christianity's eastern capital for eleven centuries—fell to the Turks.



on "the art of cutting marble into thin slabs. . . . The earliest instance . . . the palace of Mausolus . . . decorated with marble from the island of Marmara."

Our next destination was quite a different sort of place. *Yankee* sailed into the Bosphorus, past the seven populated hills, the bulbous domes, the bristling minarets, and the modern glass buildings. The city stands as a conglomerate: old Byzantium, Constantinople, Rome's eastern heir, the seat of sultans, and at last the crossroads city of two million modern Turks, İstanbul. We tied up to the pier beside the royal mosque and Dolmabahçe—*Yankee's* first palace-side berth.

Ours was a view of stone-lace elegance. The Dolmabahçe, built by the Western-influenced sultans of the mid-19th century, might be called an Ottoman Versailles, or "a wonderful wedding cake," as Anne put it.

Young Turk Outwits Christians

Our special tour of the formal rooms took us through a great hall decorated in blue damask with white polar-bear rugs. We marveled at a magnificent four-ton crystal chandelier and silver clocks with ruby hands, at vases brought from China by the camel caravans of Suleiman the Magnificent.

On one upstairs wall, a painting caught



EXHIBITION BY JOSEPH E. SCHERER © W.E.B.

Amid sultanic opulence, dancers of today's republic whirl before guests at a state reception in Istanbul's Dolmabahçe Palace. Raven-haired beauty above adds a radiance of her own.

Before Kemal Atatürk swept out the old regime in 1923, the Dolmabahçe housed Ottoman sultans, their myriad functionaries, and a jealously guarded harem. Atatürk himself died here, on a plain wooden bed, on November 10, 1938. Clocks in the palace were stopped at 9:05 a.m.—the moment of his death—and to this day mark that hour.

Mel's eye. It showed Fatih Sultan Mehmet II directing a curious project: the overland transport of a fleet of galleys. The painting sent Mel to his reference books. "Say!" he exclaimed later, "we're at the very same spot—this palace sits at the entrance to the 'valley of the galleys.'" So we learned the curious history of *Yankee's* anchorage.

Here on April 22, 1453, the young Sultan Mehmet II pulled off a dazzling military trick. As he laid siege to the Byzantine capital, Mehmet found his fleet blocked from the Golden Horn by a harbor chain. Undaunted, he ordered some 70 ships dragged overland—climbing 200 feet over a ridge to bypass the

chain on the Golden Horn (painting, pages 840-41). Thus Mehmet outflanked the city's major defenses. He planned his attack, then addressed his troops: "A great and populous city, the capital of the ancient Romans. . . I give it now to you. . ."

Before dawn on May 29 the attack began. As the defenses crumbled, Constantine XI, unwilling to outlive his empire, threw himself into the battle and perished. The city fell.

Then the plundering began. But when Mehmet entered the gates, he was moved by Constantinople's grandeur and halted the destruction. He granted protection to the handful of citizens and priests who remained.

Mehmet turned out to be a tolerant conqueror. He invited Christians and other non-Moslems to live in his city and keep their own religions, languages, and customs.

Constantinople's fall shook Europe. It intensified the search for new trade routes and sent Greek scholars westward to enrich the Renaissance.

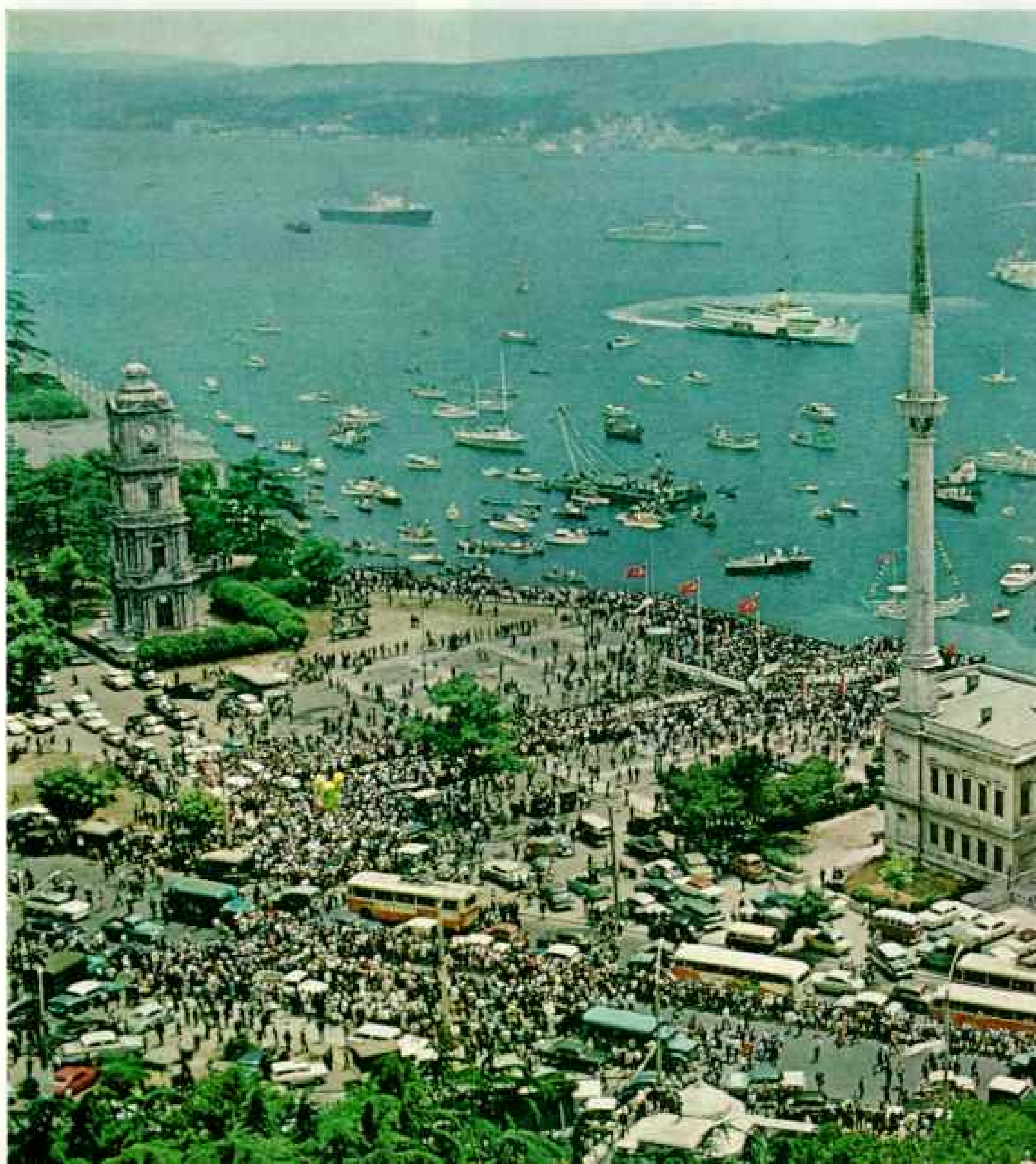
In İstanbul Mel and Anne took the youngsters to the great Hagia Sophia, or Holy Wisdom, long known in the West as Sancta Sophia. They gazed up at the mighty dome,

which soars from a square base, an architectural triumph of A.D. 537. They even walked through the door used by Emperor Constantine on his way to receive Communion on the night before his New Rome died.

Then we followed the victors—seeing the mosques beside which sultans like Suleiman and Mehmet now lie buried. We visited the immensity of the Blue Mosque of Sultan Ahmet I and listened to the *hoca* lead the Moslems in prayer. We squinted at the jeweled treasures of Topkapı, climbed the city's

Mammoth welcome . . . and a fond goodbye. *Yankee*, seen between the minarets of Dolmabahçe Mosque, pauses at voyage's end to pay tribute to another sea-roving ketch, *Kırmızı*, behind left minaret, on her return from a two-year world-circling voyage. Thousands

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seven hills, shopped in the covered bazaar, and photographed the massive walls of old Constantinople. And, as we always do in İstanbul, we feasted in its excellent restaurants.

Celebration Ends a Memorable Cruise

Yankee gave us the grandest vantage in İstanbul on the day the ketch *Kısmet* arrived. Almost 10,000 Turks turned out to greet the Boras. Yachts, warships, ferries, fireboats, and lighters—every floating thing gathered in front of the Dolmabahçe Mosque (below).

"A perfect place," said Irving—"the 'valley of the galleys' to welcome a ketch that took Turkey's flag around the world."

Yankee, too, was completing her voyage that day, so we saluted *Kısmet* with the friendliest fellow feeling. Through binoculars we read the congratulatory signs: "*Hoş geldiniz—Welcome!*"

We recalled the traditional Turkish response, and it seemed to sum up our whole adventure: "*Hoş bulduk—We have found welcome here.*"

THE END

swarm İstanbul's waterfront to salute *Kısmet's* skipper, Sadun Bora, on his circumnavigation—first such feat by a Turkish yacht. A ferry from the city's Asian shore brings still more well-wishers. Beyond the Clock Tower, left, stretches the vast Dolmabahçe Palace.

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ILLUSTRATION © NATIONAL GEOGRAPHIC SOCIETY



INSIDE A HORNBILL'S

WITH EXTRAORDINARY PATIENCE and ingenuity, a husband and wife team of naturalist-photographers has succeeded in recording the nest life of the mother hornbill and her young inside their mud-sealed hollow-tree home.

Kenya residents Joan and Alan Root have long been fascinated by hornbills. Last March, in Tsavo National Park, they encountered a courting pair of red-billed horn-



EXTACHRONES © N.A.S.

***MUD GATHERING** heralds nesting time for hornbills. The birds, 17½ inches long, search for a tree with a large hollow that has an opening capable of being walled against snakes and other enemies. Having found one, the hen picks up pellets of mud from a water hole 40 yards from the home tree.*

***ON POWERFUL WINGS** with a span of two feet, the female makes innumerable trips back and forth, carrying small quantities of mud until she has almost closed the entrance.*



WALLED-UP NEST

Picture story
by JOAN and ALAN ROOT

bills, *Tockus erythrorhynchus*, and determined to photograph the nesting habits that give hornbills a unique place in the feathered world. The female selects a hollow tree and seals herself into her nest; her mate feeds the family through a small opening. Now, thanks to the skill of the Roots, NATIONAL GEOGRAPHIC presents this remarkable series of photographs revealing how life renews itself behind a bird's curtain of mud.—THE EDITOR



TEAMWORK speeds construction. While the female, lower, plasters the nest entrance, the male brings food. Here she accepts an insect. Unfortunately, heavy rains slanting into the hole forced abandonment of this nest. Observing the hen's frequent returns to the ruined nest, we placed a new hollow trunk next to the old. Eventually the birds accepted it. The female almost sealed the hole and, after entering, finished the job with mud that had fallen inside, leaving only a narrow slit through which the male could feed her.

BUSY CATERER, the male starts out with an average of thirty trips a day. This time he thrusts a locust through the slot. Besides geckos and insects, he provides seeds, berries, and, rarely, small frogs and snakes. When the chicks hatch, he increases his feeding trips to seventy a day. Strong claws grip the trunk and he spreads his tail feathers to help steady himself.



BANQUET for his mate: The male hornbill clasps a gecko in his strong beak. He will insert the lizard into the nest through the dark slit, seen just above his claw. Safe within her sanctuary, the female incubates her eggs for twenty days. Hornbills lay from two to five eggs, which hatch several days apart.

Plumage of the two sexes is identical; the slightly smaller female sometimes lacks the dark coloration at the base of the lower mandible.





EXTRAORDINARY © R.L.S.

PICTURE WINDOW: Before offering the new tree trunk for a nest, we cut a hole in its side and fitted it with a pane of glass through which we could observe and photograph the mother and her chicks (page 854).

Secure within, the hen receives food through the slit in the mud wall and feeds her two young, almost hidden behind her body. In the cramped quarters, her tail stays vertical against the nest wall.

SIX-DAY-OLD HORNBILL prepares to swallow a mantis almost too big to handle. The larger nestling, hatched two days earlier, has already been fed, having outmaneuvered the younger for the first bite.

To keep the home clean, the female ejects her excrement through the opening; she uses the brood's droppings to reinforce the plastering. During her 40 days of self-imprisonment, she undergoes a complete molt, shoving shed feathers through the slot.



ARTSCHBINES © W.A.A.

***SPLIT-LEVEL NEST:** The adult moves upstairs as the 18- and 20-day-old birds crowd the quarters. She perches above the horizontal bend of the tree, tending the offspring from her balcony.*

At this age the youngsters are beginning to fend for themselves, and instinct tells the mother that the time has come for her to leave.





BABY-SITTING OVER, the mother pecks away the seal—a four-hour operation—and flies free. Now she rests on an upper perch. For the first few days she takes a vacation, relaxing and eating. Thereafter she lends a helping beak to her busy mate in feeding their young.

Snow-capped Kilimanjaro in Tanzania looms to the southwest.



NESTLING TURNS MASON, immediately beginning to reclose the hole left after its mother's departure. The young use their own droppings and sticky berries and slugs brought by the father. They work without the help of their parents—an amazing achievement for half-fledged birds.

SCRAWNY AND VULNERABLE

without their flight feathers, the 19- and 21-day-olds finish plugging their nest hole—except for a feeding slit—in four days. Like their mother, they keep tails at attention while in the tree. Even when taken from their nest, young hornbills retain this tail posture.



SEED POD to reline the nest passes from father to chick. The pale orange beak of the young bird will turn bright red by adulthood.



ILLUSTRATIONS © W.S.S.

CONTINENT SPANNER. *the red-billed hornbill makes its home in dry scrub and semi-desert country. Of 45 species of hornbills, 43 nest in sealed chambers. Africa claims 21 species, the red-billed being among the smallest and most attractive.*



ADVENTURING into the outside world, the younger fledgling squeezes through the opening at six weeks. When the older bird started breaking out of the nest two days earlier, the younger one became panicky, trying to push him out of the way and repair the damage. When time came for the last bird to leave, the hole had been only partly resealed.



ENTRANCED BY JOHN AND ALAN HOOT © N.S.P.

FREE AT LAST, the fledgling takes off on its initial flight—all flapping wings and flailing feet. The parents, perched nearby, squawked loudly in encouragement. The mother paid a final visit to the nest with an insect offering. Finding no hungry mouth to feed, she ate it herself.



HOW THESE
PHOTOGRAPHS
WERE MADE

THE FIRST PANE of glass we inserted in the tree was painted black so the mother would feel secure in the dark during the incubation of her eggs. We set up the blind with four thicknesses of material that fitted snugly around the

hole to prevent daylight from entering.

Inside the blind we let our eyes become accustomed to the dark. Then we removed the black pane, replaced it with clear glass, and activated a rheostat that very slowly



PEEPHOLE frames a 37-day-old chick. Two fans dissipated some of the 110° heat built up by the flood lamp at left.

DAY'S PLASTERING by the female virtually covers the glass pane. Although not unduly disturbed by the photography, the mother and her brood tried to obscure the glass with excrement. When the chicks were several weeks old, the pane had to be cleaned about every 15 minutes to maintain a clear view for the camera.

turned up a 1,000-watt photo-flood lamp.

At first we set the instrument so it would take several hours for the lamp to reach full power. By the end of the day we could immediately turn it on without disturbing

the birds. Then, behind the lamp where the birds could not see us, we moved freely to take the photographs.

When it became necessary to clean the clear glass, the light would be turned off and a new pane set in its place.

We visited the blind every few days to photograph each stage of the chicks' development. The blind remained in place throughout, except briefly when we photographed the female after she broke out of the nest (page 850).



ETCHINGS BY JOAN AND ALAN ROSE © N.E.S.

ELEPHANT WALK leads to the water hole where the hornbill hen picked up her sealing mud (page 846). Intent on slaking their thirst, these tuskers ignore our blind.

Having launched their youngsters, the parents—believed to mate for life—flew off to the far reaches of the park. THE END





LEGACY FROM THE AGE OF FAITH

Chartres

By **KENNETH MACLEISH**

Senior Assistant Editor

Photographs by DEAN CONGER

National Geographic Staff

IN THE STILLNESS of winter the wide wheatlands of La Beauce lie fallow. Plovers stand motionless on the upturned earth. Crows drift, wind driven, across an iron sky. Here, in the granary of France, the provident peasants till their fields before Christmas, and retreat to the warmth of their earth-walled farmhouses to await the quickening of spring. Then, tractors come snorting and growling from their sheds to impregnate the fecund soil with the seed of next year's harvest. But in winter, there is only stillness.

I pulled my car off the road and walked on, tasting the bitter breeze, searching the horizon for the sight I'd come to see: the great church of Chartres, queen of cathedrals, one of the most beautiful creations of the hand of man and our loveliest legacy from the Age of Faith.

How many before me had crossed this same sad plain, sought this same sacred place? Hundreds of millions, perhaps even

Christ the Saviour is born. Blazing with color, this 12th-century stained glass on the west façade of Chartres Cathedral proclaims Noel. Here in the heart of France, the shrine and its city brilliantly evoke the reverent fervor of the Middle Ages.

a billion, over more than two thousand years. In Caesar's day this region was reckoned the center of Gaul. Legend has it that here, before the birth of Christ, Druids worshiped an image of a virgin who would bear a son.

When Christianity came it was accepted as if it had been long awaited—and who is to say that it had not? Pagan prayers gave way to Christian rites; the Druidic shrine became a church dedicated most particularly to Mary the Mother. The first church burned, and the next, and the next until five times at least Mary's home on earth had been destroyed and rebuilt in increasing magnificence.

Since the Queen of Heaven would never have countenanced the destruction of her house unless she desired a finer one, people throughout France and beyond did their devoted best to provide her with a palace more marvelous than any on earth. For though Mary was kind and loving and full of grace, and provided the simplest means for simple

people to reach her omnipotent Son, she was, after all, the Empress of Empresses; and even earthly empresses generally expected the best.

In the words of Henry Adams, that passionate biographer of Chartres, "The Virgin was never cheap."

Her ultimate shrine, built after the fire of 1194 had ravaged its predecessor, must at last have pleased the Queen of Heaven, for it is still there. Not only does the building stand, substantially unaltered except by the happy addition of the north spire, but it retains more completely than any other cathedral the rich adornment in stone and glass that made it—makes it—the most moving glimpse of Heaven to be beheld on earth.

MY BOOT HEELS CLACKED on the frozen roadway and the small sound blew away across the furrowed fields. Here was the solitude I sought, the mind-clearing simplicity of the sleeping land's un-

Beacon to the faithful now as in ages past, the spired cathedral of Chartres rises from the plain of La Beauce as students march to springtime worship, bearing numbered crosses to mark their place in line. Often meditating in silence, sometimes singing in jubilation, they follow the tradition of medieval pilgrimages when, wrote a monk, "the maidens and the young men . . . said verse or song; even the old start singing again: All have a look of joy!"



cluttered sweep. I had studied the cathedral from every angle. But so dazzling were its details that I had had to start over, to go out and come back; to see the structure, far away and entire, in the context of its country.

And, of course, this was how the cathedral was meant to be seen by those enchanted throngs that have flocked to it across the centuries. They saw what I now saw as I topped a gentle rise: the slow revelation of spires, then the emerging mass of the masonry, then the whole creation floating upon the horizon, weightless as a cloud (pages 874-5). In that soft distance, the shrine of Our Lady of Chartres no longer overwhelms but simply delights the mind and touches the heart—sometimes more deeply than is altogether comfortable.

The silvery vision dimmed as sifting snow curtained it. I turned and trudged up the middle of the road toward the car, lost in a Gothic dream.

That dream haunted me on the drive back

to Chartres. The sight of the town, suddenly revealed as I reached the valley of the Eure River, did little to dispel it. For if its suburbs are unexcitingly modern, the town itself, with steep-gabled houses of wood and plaster lining narrow streets, retains a medieval aspect (following page).

TODAY EVEN THE LIFE in those streets suggested that of medieval times, for it was market day. Countrymen had come into town to sell to the bourgeois, as they had done since Roman times. Before a 15th-century house decorated with a great wooden salmon, fishmongers displayed their offerings. Beyond were sellers of poultry, and of meat. A burly comedian hawked fresh-grown endive, one of the few vegetables of the winter season.

"Pretty little endives, endives of the countryside," he bellowed. "They are the most beautiful and the least costly. Formidable! Sensational! The king of endives!"

For centuries pilgrims have sought the sanctuary, famed for its Virgin's Veil, a cloth believed worn by Mary. The relic came to Chartres in 876 as a gift from Charles the Bald, grandson of Charlemagne, and survived a succession of fires that beset wood-and-stone cathedrals on the site. During early pilgrimages, townsmen held fairs to sell their fine textiles, leather goods, and wine. Church and congregation prospered together.

MONARCHIST © NATIONAL GEOGRAPHIC SOCIETY





"Palace of the Blessed Virgin, the special glory of the city, the showpiece of the entire region." That 12th-century description applies as well today to Notre Dame de Chartres.

Near the cathedral children play along a narrow lane (right) under the benevolent eyes of their elders and a wistful dog.

On June 10, 1194, fire devastated most of the town and the shrine that Fulbert, famed teacher and bishop, had begun in 1020, following an earlier conflagration. The west façade (above) survived and—miracle of miracles—so did the Virgin's Veil, secure in the crypt. To the medieval mind it seemed Mary permitted the holocaust because she desired that "a new and incomparable church be erected in which she could perform her miracles." Noble and peasant, bishop and burgher responded, creating most of today's cathedral in only 26 years.



Contented countryman, the author's friend Ephraim Grenadou farms the rich earth of La Beauce in sight of the cathedral.



Quaint, modest, warmly appealing, Chartres climbs the slopes from the river to the cathedral, providing a pedestal for a creation greater than itself.

"It is all one entity, town and church," said architect Guy Nicot as we lunched by the log fire in La Vieille Maison, an old house which is very much a part of that entity. "To me, the humble little homes below are part of one great genuflection culminating in the eloquent spires of the cathedral. The cathedral needs its town as a great gem needs its setting."

La Vieille Maison is not the only fine restaurant in Chartres, but it is the most intimate and the most comforting. I leaned back, savoring a snail, and let the fire draw the chill of La Beauce out of my bones as M. Nicot continued. A brilliant, dedicated young man, he had been assigned by the government to supervise the restoration of the old town, now under official protection as a national treasure.

"The ancient city is picturesque to look at and painful to live in," he told me. "Most houses have no toilets, some no running water. They were never grand, only charming; and they will be again. The national government will pay a third of the cost of restoring the medieval houses and making them comfortable and livable."

(Continued on page 868)

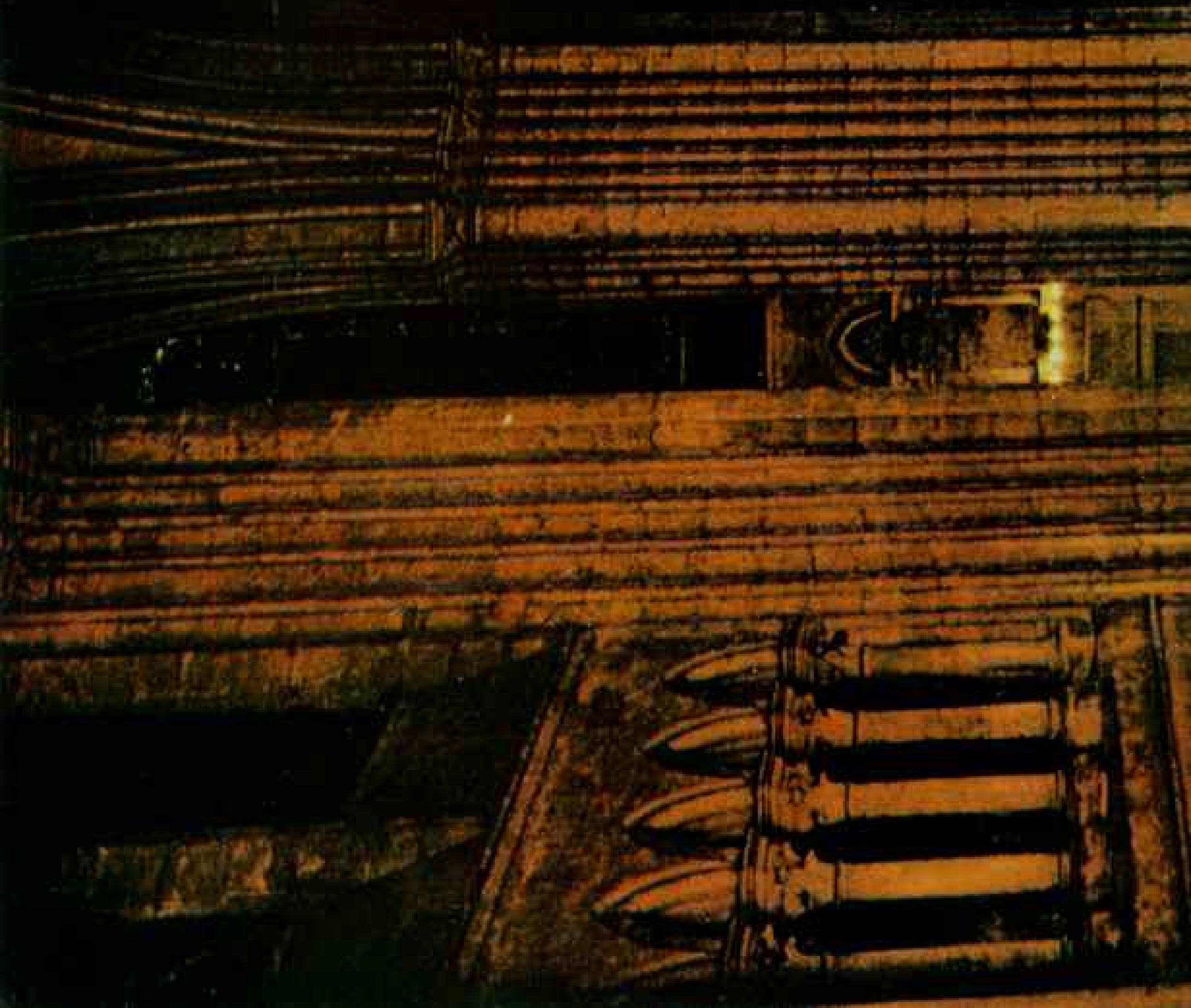
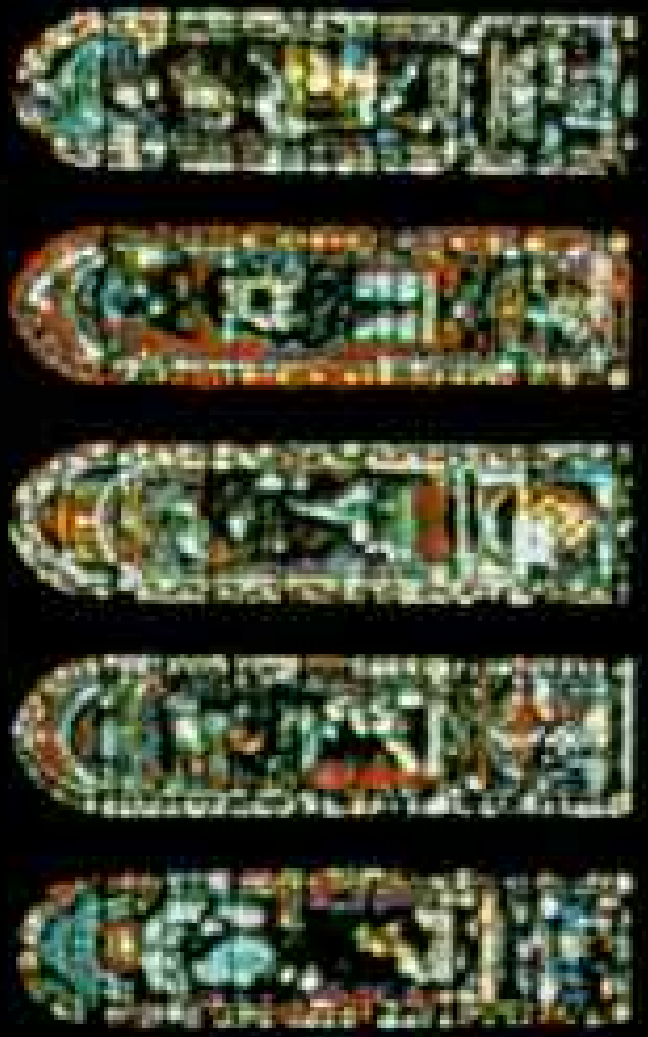
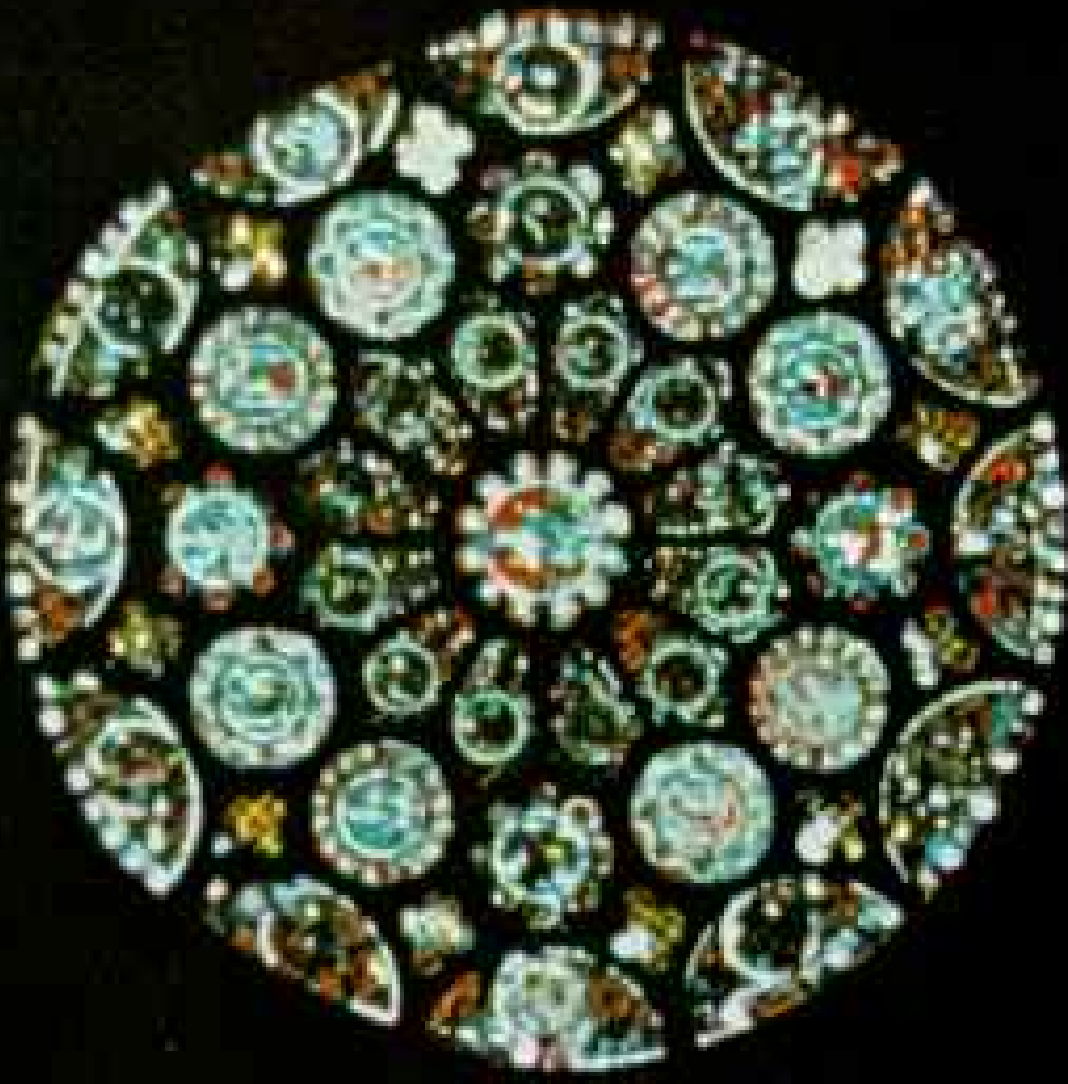
Six thousand souls pray as one (following pages) when the cathedral witnesses a Mass for the pilgrims (pages 858-9). More than a hundred priests, who accompanied the students, offer bread and wine in age-old ritual.

The setting of grandeur bespeaks the success of medieval builders. Great stone piers rise heavenward in simple unbroken lines. Dividing into ribs, the piers support a vault 11 stories high, loftiest of its time. The south rose window glows in the evening light with the image of Christ triumphant.

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RODACHORREZ (INCLUDING FOLLOWING PAGE) BY DEAN CONNER © R.E.S.







A mighty hymn in stone and glass

TO ENJOY CHARTRES FULLY, Henry Adams wrote, "You must, for the time, believe in Mary . . . and feel her presence as the architects did, in every stone they placed."

After the fire, a new choir (1), ambulatory (2), and nave (3) were raised above the round-arched crypt (4) of Bishop Fulbert's cathedral. Builders connected the new nave to the undamaged west façade with its three portals (5) balancing three tall, pointed windows called lancets (6) that bear scenes from the life and genealogy of Christ, including the Nativity (pages 856-7). Above the lancets, they added a rose window (7) and sculptures portraying kings of France (8). They prized the 12th-century south tower and spire (9) for the way square form shifts to octagonal behind a screen of turrets. Crossing the nave, a transept (10) creates a cruciform floor plan.

For each façade, artists carried out different Biblical themes. The life of Christ appears on the west, the glorification of the Virgin on the north (11), and the history of the Church, culminating in the Day of Judgment, on the south (12). Lesser figures represent the zodiac, the year's labors, and the liberal arts, recalling the city's role as a center of study under Fulbert, a "venerable Socrates."

Vivid expression of Gothic architecture, the cathedral harmoniously incorporates additions such as the 13th-century vestry (13), 14th-century St. Piat's chapel (14), 16th-century north spire (15), clock pavilion (16), choir screen (17), and wooden organ case (18), and modern altar and bishop's red throne (19). In the 19th century a copper roof and iron rafters replaced lead roof and wooden underpinnings.

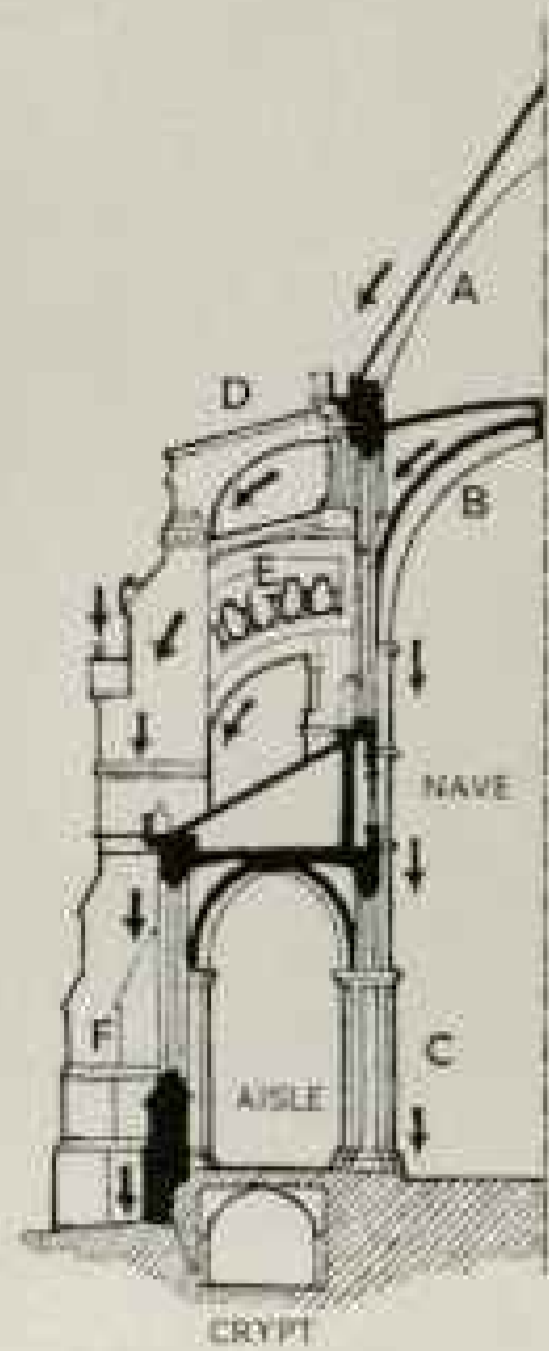
To preserve the purity of Mary's shrine, Chartres, unlike many cathedrals, has no tombs.

In 1954, using royalties from the publication of Henry Adams's classic *Mont-Saint-Michel and Chartres*, the American Institute of Architects donated a window picturing Fulbert (20), fashioned by local artist François Lorin (page 879). In medieval style, he included the donor's signature—a group of modern skyscrapers.

"Resplendent as the brightness of the summer morning's sun," sings an early hymn to the Virgin. On the north façade, the blue-hued Rose of France, gift of Queen Blanche of Castile and her son Louis IX, epitomizes medieval faith and artistry (opposite page). In the center circle sits a crowned Mary holding the Christ Child. Around her, panels show doves, angels, and thrones; 12 kings of Judah, her ancestors; and 12 minor prophets.

Like a morality picture book for the medieval believer, five lancets represent the triumph of divine law. The priest-king Melchizedek, left, towers over idolatrous Nebuchadnezzar. Beneath King David, Saul kills himself with a sword. St. Anne holds her daughter, the Virgin, above the arms of France. Solomon stands above Jeroboam, who worships calves, and Aaron over the pharaoh whose armies drowned in the Red Sea.

REPRODUCED BY DEAN JENSEN © W.G.L.

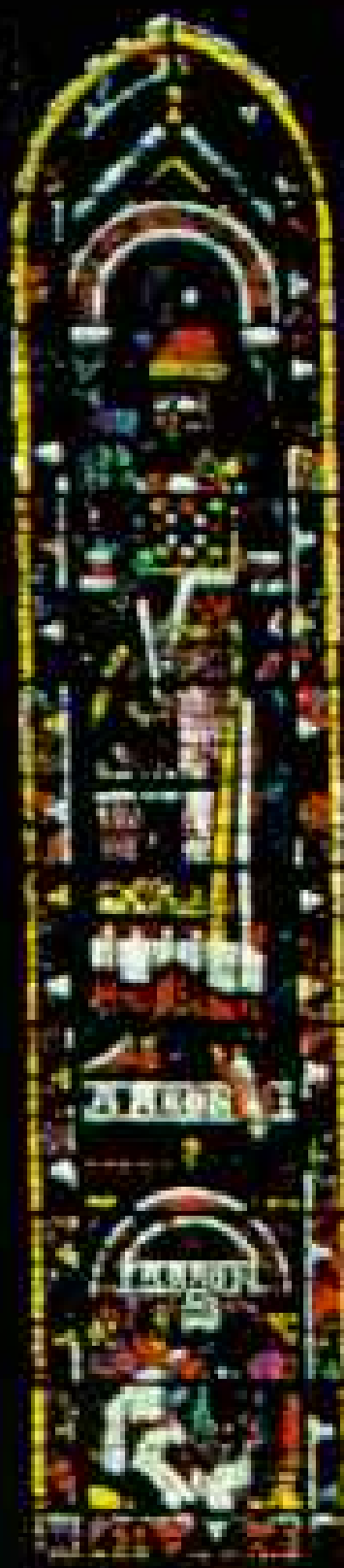
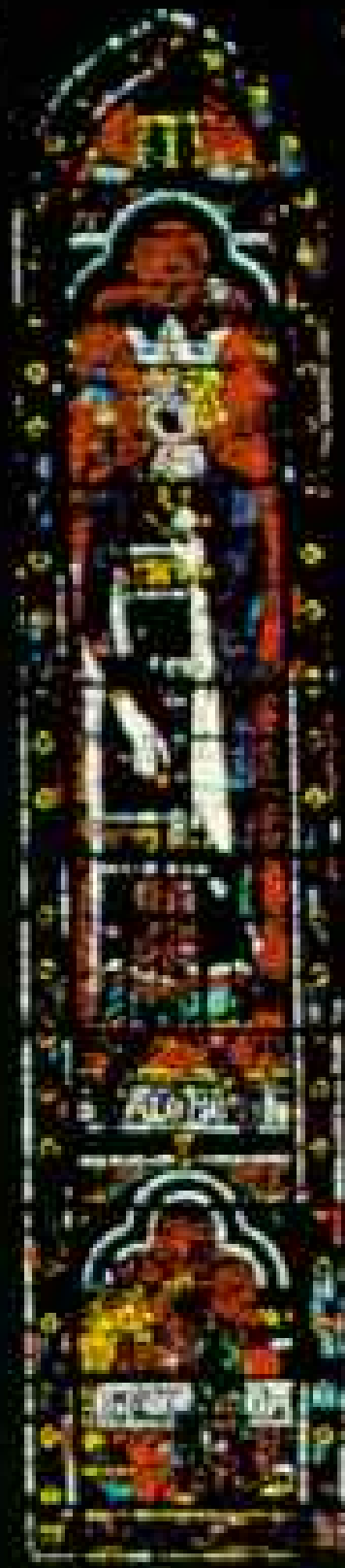
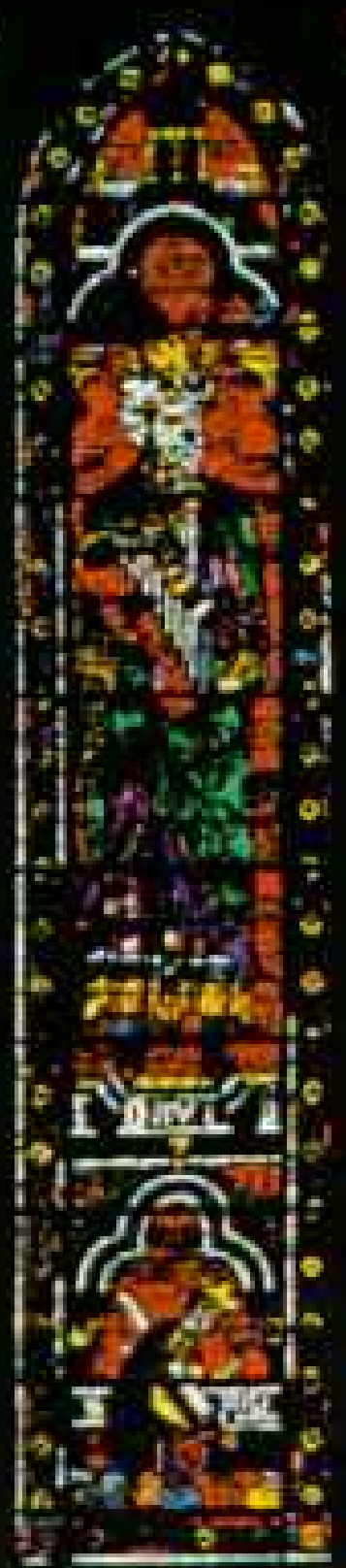
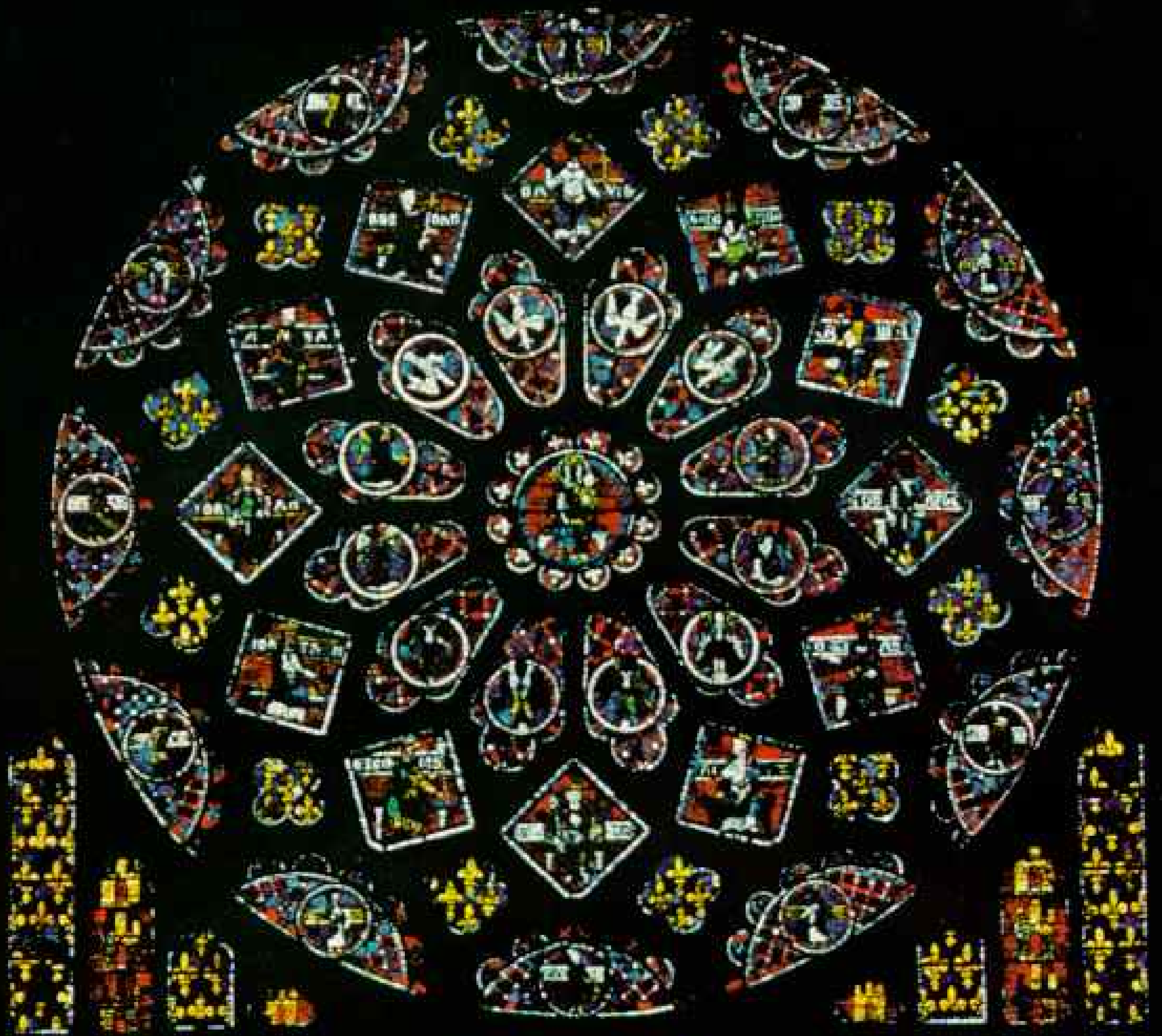


STRENGTH WEDS GRACE in flying buttresses (pages 876-7). They were first used in France at Notre Dame de Paris in the 1170's.

The downward push of the roof (A) and vault (B) concentrates in massive nave piers (C). The outward thrust of the roof springs across an upper arch (D), while the thrust of the vault crosses twin arches connected by columns (E). Onward the force travels through the center of a massive buttress (F), touching the ground. In the words of American historian Henry Adams, "as a bird would alight." Thus freed of pressure, the walls serve as frames for vast window panoramas, the most complete ensemble of stained glass to survive from the 13th century.



ILLUSTRATION AND DESIGN BY
STAFF ARTIST ROBERT W. WOODLICH
GEOGRAPHIC ART DIVISION
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I wandered among those antique dwellings for a while, searching out unfamiliar alleys. At almost every turn some small segment of the cathedral came into view above tilted walls and swaybacked roofs.

The Cathedral of Notre Dame de Chartres was never intended to be seen in its entirety except at great distances. In the old days the houses crept up to within a few yards of it. What the visitor lost in architectural understanding, he more than gained in straight-to-the-viscera impact, which is far more important. Standing in the street below the walls, he had to bend backward to look up. He sensed the cathedral's immensity, just as he was supposed to do.

The little houses that once stood under the church's west front have been removed. You can stand back a bit and see the whole of that magnificent 12th-century façade—the only wall to survive the disastrous fire of 1194—and compare the serene 12th-century south tower with the fantastically ornate 16th-century north tower (drawing, pages 865-6). They are worth comparing, for they mark the beginning and end of the great Gothic period, in which the burgeoning Age of Faith inspired many of the finest structures man has ever made. But the cathedral they adorn is special in being a perfect and almost complete expression of the hopes and beliefs and even the everyday life of a single glowing period: the first third of the 13th century.

THERE IS AT CHARTRES so great a wealth of architectural and artistic wonders that the sculptor Rodin called the cathedral the Acropolis of France. More than two thousand carved figures adorn its superb portals. Among them are many masterpieces (opposite). But it would take a catalogue to list them; and that is not the purpose of this story, which aims only at introducing an incomparable creation that can be sensed and loved—as it has been for more than seven hundred years—without being wholly understood.

Still, a little understanding helps. I walked to the church to await the arrival of M. Jean Villette—artist, author, and scholar—who

had accepted the task of adding to mine. He would arrive shortly; in the meantime I needed a few moments in which to follow Henry Adams's sound admonition: "If you want to know what churches were made for, come [to Chartres] . . . but come alone!"

I passed through the west portal, whose sculptures tell in stone the story of Christ's birth, His life, Ascension into Heaven, and His return on the last day to judge how well men have followed the Word He brought them. Christ and Mary preside in gentle majesty above their forebears of the Old Testament. Despite the implicit theme of judgment, there is no sense of menace here, no attempt to frighten in the style of later Christianity.

The doors closed behind me, and I stood in a different world. Not that of Jesus and Mary, nor that into which I was born; but a world between them, whose faith was more certainty than belief, a world which aspired simply and tremendously, which hungered for Heaven, and which stated its soaring thoughts in immutable glass and stone for all the centuries to savor. The very vastness of the church reflects the daring of its day; rich statuary presents its art and intellect; and stained glass windows, the greatest miracle in this house of miracles, open not upon the contemporary scene beyond its walls but upon the life and longings of the 12th and 13th century.

The interior of any cathedral is moving, but, to me, none is more moving than that of Chartres. The dim blue light, the interplay of somber stone and glass glowing like embers in an evening, the overwhelming upward thrust of pillars to the pointed vaults high overhead—these things would stir any human with the sensibility of a gnat. They apparently stirred Napoleon, for after a visit in 1811, he said, "Chartres is no place for an atheist."

Another famous man, this one named Albert Einstein, had subtler words to say: "The most beautiful experience we can appreciate is the sensation of the mystical. . . . He to whom the emotion is a stranger, who can no longer wonder and stand in awe, is as good as dead."

By Professor Einstein's reckoning, I was very much alive when M. Villette arrived.

Old Testament prophets and patriarchs, eight feet tall, remind worshipers at the north portal of the coming Saviour. Melchizedek, left, carries bread and wine, representing the body and blood of Christ; Abraham prepares to sacrifice his son Isaac, presaging Christ's sacrifice on the Cross; Moses suggests Christ as giver of the new law; and a figure thought to be Aaron, His priestly aspects. As 19th-century architect Viollet-le-Duc wrote, "Each statue . . . remains graven on the memory like the recollection of a living being whom one has known."



A shrine existed at Chartres, as I noted earlier, before the birth of Mary herself. The cathedral rests upon the site of a well which legend claims was venerated by the Druids before Caesar's conquest of Gaul. M. Vilette now took me down to the crypt in which that well, long blocked and concealed, may once again be seen.

"You will notice," said M. Vilette, dropping a pebble into it, "that our famous well is extremely deep." In roughly 2½ seconds the sound of the pebble's splash returned to us.

"About one hundred feet deep, in fact," he added. "Legend holds that a first-century Roman prefect threw local Christians into its depths to die. The bodies of these martyrs gave Christian miraculousness to the already magical pagan waters, which thereafter cured many ills.

"So says the legend. But probably most of those who were thrown into the well were victims of the invading Norsemen of the ninth century. In any case, the later clergy decided, on theological or hygienic grounds, to conceal the shaft. It was hidden for centuries. Now we have it back, restored in our own century; and a good thing, too, because it is the oldest of the ancient appurtenances that made Chartres an international pilgrim's shrine. But our greatest relic is the Virgin's Veil. Let us go up to the choir and see how close we can get to it."

M. Vilette located the sacristan, who led us to a gilt reliquary. Within the reliquary was a crystal container, and within the container a roll of silk.

"What you see is only the wrapping," said the sacristan. "But if you look closely, there, at the end, you will see just the edge of the real veil. It was given to Charlemagne by Constantine of Byzantium. Charlemagne's grandson gave it to Chartres in 876. Its very presence here has made Chartres one of the high places of Christendom for more than a thousand years."

"It is quite possible," added M. Vilette, "that the veil is responsible for the actual existence of the cathedral in which we now stand. Certainly it is responsible for the devotion that brought the building almost to completion in only 26 years. Come, let me show you something."

He led us to a trap door in the choir.

"This hides a stairway that leads to a chamber below the sanctuary. When the fire of 1194 broke out, clerics took the veil in its reliquary and carried it there for safekeeping, closing the trap after them. They stayed underground until the ruins cooled.

"Two or three days passed. The people thought the veil had been destroyed, that Mary was angry with Chartres. Then the clerics came out of the wreckage, bearing the reliquary. The people were overjoyed, and set to work at once to build Mary a new and finer home on earth.

"And this," he said, with a glance at the beauties about us, "this is what they built."

ONE of the delightful things about visiting Chartres in winter is that you have the cathedral largely to yourself. The two million pilgrims and tourists who pass through the church every year (about the same number that visit the White House in Washington, D. C.) prefer the warmer seasons, and they have a point. The cathedral is not heated on winter weekdays. And though the blaze of the windows always warms the spirit, it does little for the feet.

Despite the cold, that celestial light stopped us once again as we hurried down the nave toward the western portal. Above it, the three



EXTROCHROME (ABOVE) AND RODALCHROME © N.C.S.





KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Like forefathers, like sons. When medieval guilds donated windows depicting religious themes, they included pictorial signatures, leaving a lively record of daily life in old Chartres. Many Chartres merchants still practice the skills seen in the cathedral's glass.

This sidewalk *boucherie* (above) offers fresh meats to housewives. In stained glass (right) a 13th-century butcher raises his ax over a calf, while his little dog awaits his share.

Beside his forge (left), Albert Rousseau hammers metal at an anvil, a scene that duplicates the blacksmiths' window (below).

To create the pictures, glaziers cut hand-blown colored glass according to a pattern. Details were painted and baked on. Then the artists fitted grooved strips of soft lead between all the pieces to bind the mosaic together. They wired each panel to an iron frame that shows as a dark grid. Thus later generations could "untie" and remove the panels for repairs and for storage during the two World Wars.





Friend of Frenchmen, wine mellow: a Saturday morning for two Chartrains. During the Middle Ages, viticulture flourished in La Beauce, and prosperous wine merchants donated a lancet to the church. While 16 of the major panels record the rise of Lubin, a sixth-century shepherd boy, to the bishopric of Chartres, 23 medallions represent the donors' trade. A vintner (right) hauls a keg to market. Another circle (not shown) illustrates the sacred use of wine as the sacrament of the Eucharist.

tall 12th-century western windows which—like the veil—survived the holocaust, shone with the last fire of the setting sun beneath the great 13th-century rose window. There are no more beautiful windows than these in Christendom, and sunset is their moment.

The 12th-century lancets glorify the Messiah, presenting His lineage at right in a luminous blue; His Passion at left, against a radiant golden background; and His Nativity and youth in the central window which echoes the golds and blues to make a unit of the three masterpieces. Here is the essential statement of Christmas; the coming and spreading of the Light of the World (pages 856-7).

It is a subject treated elsewhere in the cathedral, notably in the high windows of the apse, which catch the first glow of morning. But here it is played against the theme of the last coming, which is described in the rose window above. The end of time is symbolized by the end of day, which belongs to the west; and so it is this western window that presents the apocalypse.

THE SUN DROPPED behind the edge of La Beauce. The lancets lost their light, then the rose faded. The symbolic apocalypse occurred, but only as a gentle reminder. Tomorrow would be another day, after all. I bade goodnight to M. Villette outside the doors and walked away into the crowded, twisted little streets full of evening shoppers and cheerful sounds.

In Chartres, as in all French towns, housewives buy their food (except on market day) in small specialized shops, many



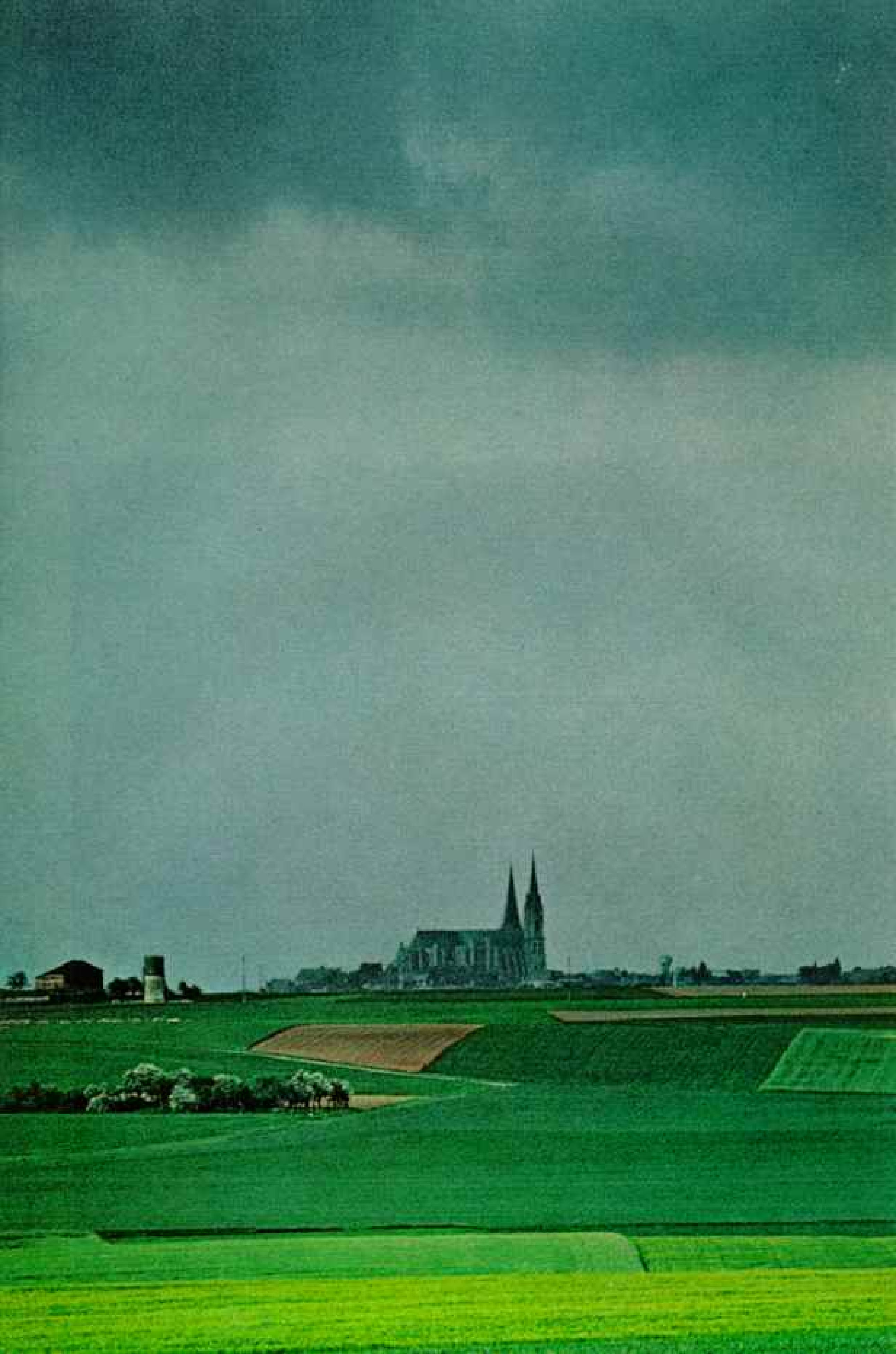
of them brilliantly clean and beautifully done up, in which proud professionals carry on their ancient trades with skill and flourish. Within these stores the women stand patiently in line, trading the gossip of the day. In a *baucherie* bright with tile and marble and polished glass, where suspended cuts of beef attract the eye as no garish advertisement could, a genial butcher operates with surgical precision (page 871). Nearby a *pâtisserie* displays a window full of elegant cakes and pastries, filled and frosted with succulent confections. The *charcuterie* offers a dozen kinds of pâtés, golden-cruste d meat pies, pork products of all sorts, and a choice of prepared delicacies, all reflected in a cut-glass mirror. Its window piece is a huge pig, portrayed in a mosaic of ready-to-cook snails.

Such stores enchanted me in my Paris childhood, and my own children during our recent residence there. The shopping takes time, and some of the ladies of Chartres are

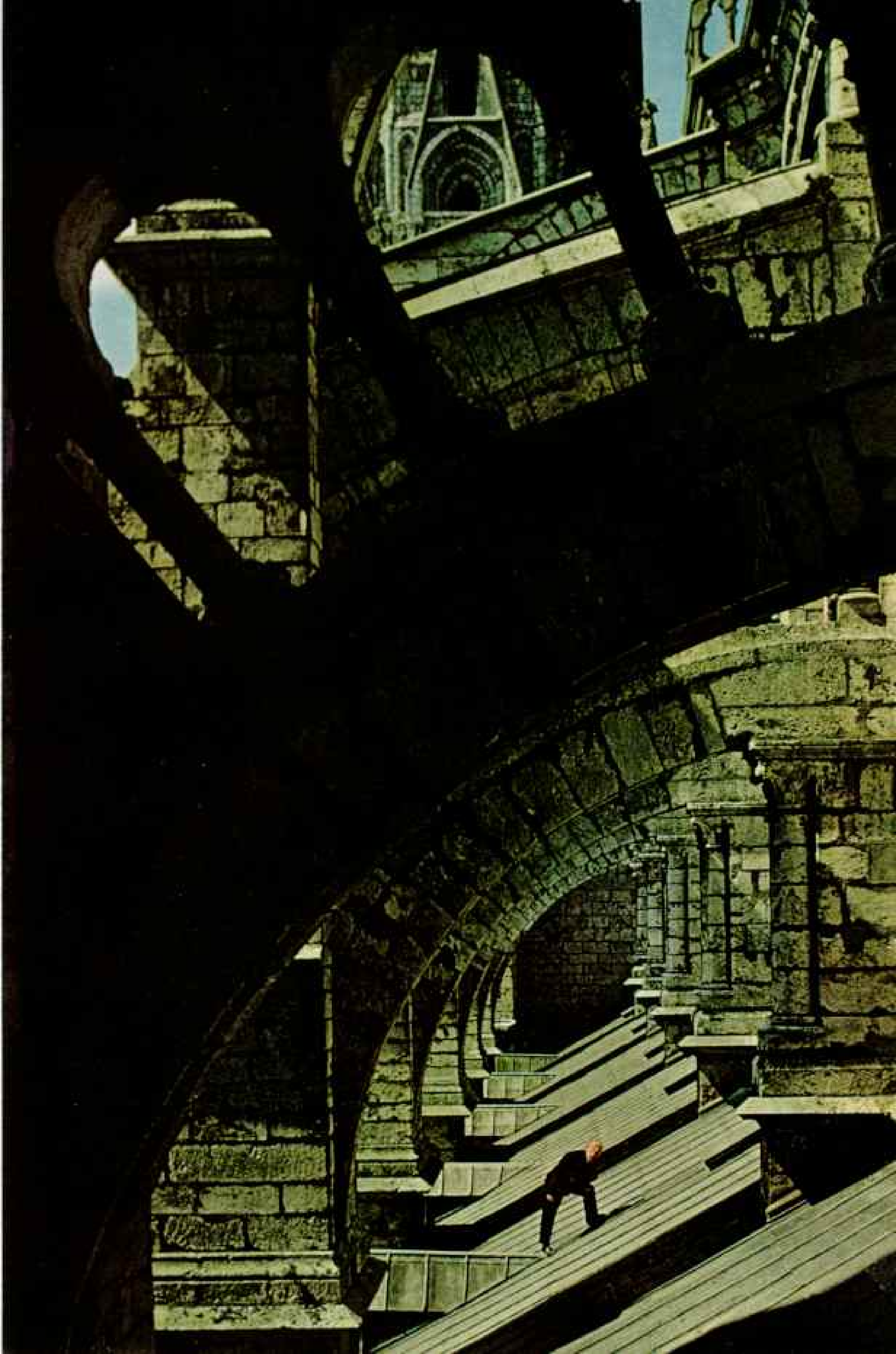
“Hanging quite alone between fields and clouds, between Heaven and Earth, the cathedral imposes its presence upon a whole district,” writes present-day historian Jean Villette.

In this view from the northeast (following pages), the town lies almost hidden on the banks of the Eure. Across such fields men and oxen pulled the great limestone blocks, quarried in nearby Berchères-les-Pierres, destined for the Virgin’s shrine.











beginning to admire the convenience of supermarkets in the modern suburbs. But I hope the specialty shops survive in the face of efficiency, for it is in them that the French respect for good food is first expressed.

As I wandered around the business district, a region of antique houses made over to serve 20th-century needs, it occurred to me that most of the trades still flourishing today are pictured in the cathedral's glass. Not only had the food sellers given windows in which their members appeared at their work, but so had drapers, furriers, apothecaries, shoemakers, vintners, money-changers, stonecutters, and workers in wood and iron (pages 870-73). Even the street names recalled the antique commerce: The Street of Milk, of Poultry, of the Coin Exchange, of the Harness Makers, of the Butchers.

It is just such continuity that joins ancient and modern into a single vital scene. In Chartres old things and ways are as much a part of day-to-day existence as new ones. And this is certainly one of the reasons why the cathedral itself is never solemn and pedantic, but a joyous place. It does not demand knowledge, nor dutiful study, nor even reverence (though it rewards generously those who come to it seriously): it exists for the Virgin's pleasure, and for ours.

BEFORE RETURNING for a closer examination of the cathedral's resplendent world of stained glass, I wanted to learn something about how such windows were made. Happily—and appropriately—there are still master glaziers in Chartres. One of these, M. François Lorin, is not only a creator of original works in glass but is the man in charge of maintaining the church's windows. It was he who supervised their removal and storage during World War II.

I found him in his studio by the river, a lean white-haired man, blue eyed like most of the Chartrains I met (page 879). We talked about the cathedral windows on which so much of his life had centered.

"We had prepared a place to put them when it appeared that war might come," he said. "So we were ready to move when word came to take them down. We got them down in 11 days. It took 8 years to put them back. Maintenance goes on. The glass is almost all original, but it can be cracked by hailstones or other flying objects. Henry IV put a cannon ball through one of the windows when his Huguenots attacked the town in 1591, and earlier the clergy had to post notices about not shooting arrows at pigeons on the premises."

M. Lorin escorted me into a large room where several men cut out bits of glass with diamond-wheeled tools, shaping them to paper patterns and picking colors according to the patterns' numbered code.

"Here we execute the work that has already been completely planned, sketched, and painted," he told me. "This is a simple window, an abstraction. I made the design, knowing as I did

Secret of stability for soaring heights, flying buttresses resemble spoked quarter wheels. Creating a science of engineering as they went, daring medieval builders gambled on such innovations to achieve higher walls with larger windows. Here Chief Guardian Henri Debarge guides the photographer toward the south tower.



ILLUSTRATION © NATIONAL GEOGRAPHIC SOCIETY

Image of inspiration, Notre Dame de la Belle Verrière—Our Lady of the Beautiful Window—survived the fire of 1194 along with the west façade and now reigns in the south ambulatory. Impurities in the original glass and weathering of its exterior give rich color and texture.

Master of an antique art, François Lorin tends the cathedral's 176 windows. He uses medieval surgery, adding lead strips to strengthen and repair panels, as his predecessors did in the Child's face on page 856. In his studio glows Saint Clare of Assisi, his own design.

so what one can and cannot do with colored glass. The technique is very different from painting."

Farther along a craftsman assembled the cut pieces in a wooden tray, putting them together with strips of soft lead. Where the strips joined, he applied a dab of solder to secure them.

Before I left M. Lorin, he showed me a high-ceilinged room with a window so big that whole stained-glass compositions could be hung before it for final judgment.

"My father's studio," he said. "And my grandfather's too. My grandfather was the son of a farmer. In the court of his father's house, as in the courts of all the farmhouses, there was always a great pile of manure. One day my grandfather came out the door and looked at the pile of manure and said, '*Tiens, I think I will become a maker of stained-glass windows.*' And he did."

I REJOINED M. VILLETTE in the cathedral to read for the first time the picture-story windows which I had seen before only as jewelled ornaments. I settled myself in a chair, borrowed his binoculars, and focused them on smoldering glass. Immediately

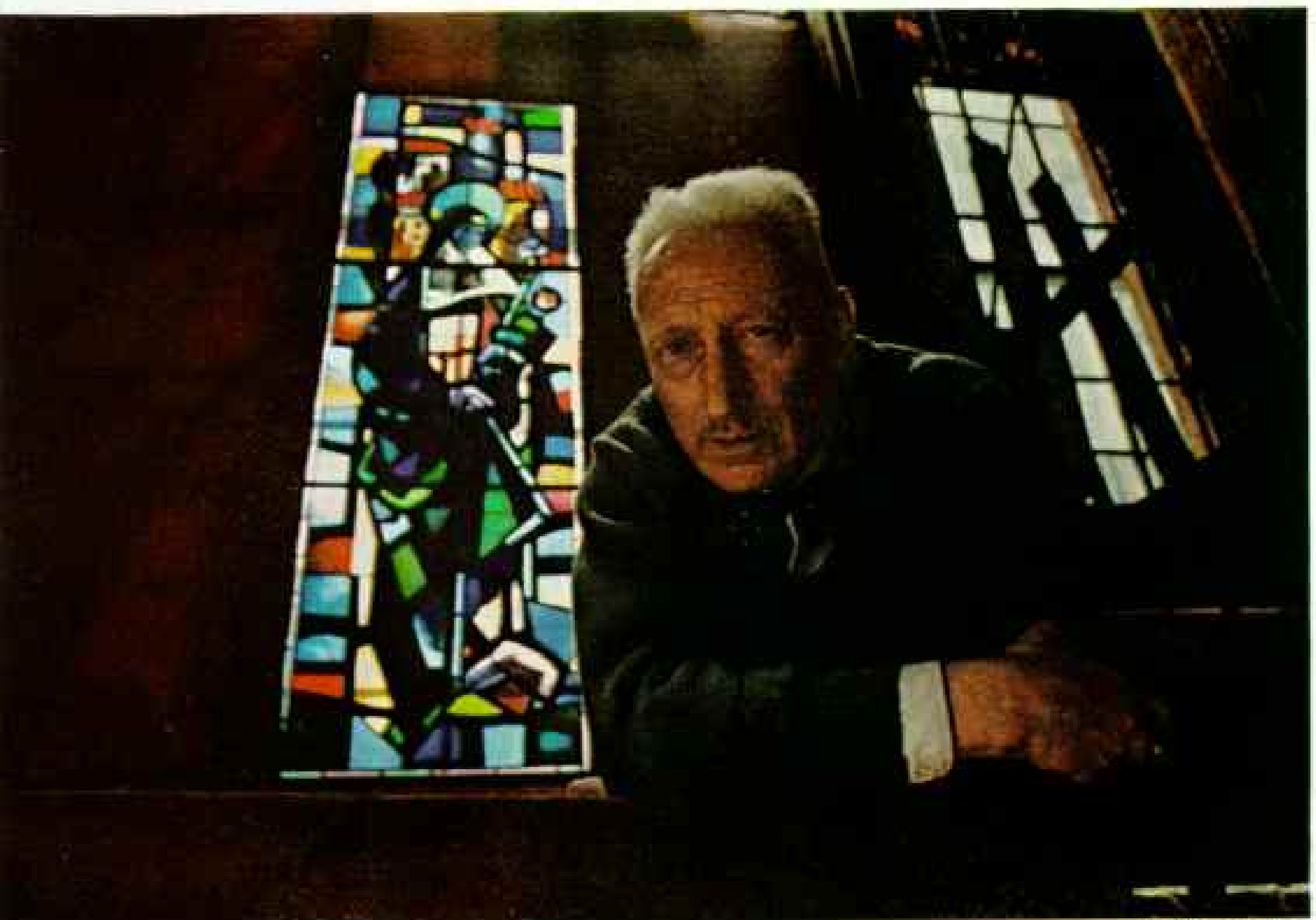
the almost ethereal abstraction became a series of strongly drawn scenes in which caricature served the story line far better than realism could have done. Here, in essence, was a 13th-century picture book.

"You may smile at it," said M. Villette, as I did. "The artist probably did too. But the work is graphic."

As we rose to move on, a stooped old lady, all in black, scuttled past us and fell to her knees before a nearby statue. Out of respect for her apparently deep emotion, I remained standing, hazarding a whispered question as to the object of her devotion.

"She is not really worshiping," whispered M. Villette in return. "The statue represents St. Anthony of Padua, and somehow people have come to believe that he can help find lost things. Perhaps the lady has misplaced her door key."

"Now I must go and work on some pictures of my own. I will leave you alone with the eight thousand people who populate our world of glass. You have seen in the legendary windows how the 13th century saw still earlier times. The signatures of the windows—themes showing their donors at their daily work—will tell you how the 13th century saw itself."



His footsteps died away, and the cathedral was silent. With a list of the windows in hand (you need a list: there are 176 of them, totaling more than 2,500 square yards of glass), I sought out some of the 42 given by the trades. In most of these the lower panels presented tradesmen at their accustomed task, while the upper portion told a religious story.

Here was a butcher, with inverted ax upraised to kill a calf as a little dog sat expectantly awaiting his bit of fresh meat (page 871). Elsewhere was a weaver at his loom. A carpenter operated a foot-powered lathe. Tanners scraped hides, soaked them, softened them; cobblers made shoes of them, leather workers made purses.

Water carriers poured out clear water; vintners tended vines and hauled great tuns of wine in two-wheeled carts (pages 872-3); apothecaries mixed syrups and potions. Fishmongers transported their perishable merchandise in parasol-shaded wagons as wheelwrights made wheels for these and other vehicles and blacksmiths shod horses to pull them (page 870).

Furriers and drapers, shown in their shops, displayed their wares to gesticulating customers who seemed unhappy about the prices. One lady had removed her glove, the better to feel a squirrel coat held out before her by a furrier. A certain Geoffrey, a stocking manufacturer by trade, appeared in a window labeled with his own name and offering red socks in the only personal advertisement to intrude upon this sacred place. That it has stood unscathed throughout centuries proves that the Virgin possesses not only grace but a sense of humor.

OF THE MANY OCCUPATIONS pictured in the windows or represented by them, those which seem to me most characteristic of the cathedral and its countryside are concerned with glass, stone, and grain. The church is, after all, a vast prayer in glass and stone. The country round about, on which the economy of Chartres has always depended, is a country of grain.

Practitioners of these occupations still ply their trades in Chartres. I had met and talked with them, and they came to mind as I studied their pictured predecessors.

There are no signatures of the glaziers in Our Lady's glass almanac of medieval life, but the windows themselves are their memorial. They recalled to me the cathedral's own master glazier of today, M. Lorin, and another great glass man of Chartres, M. Gabriel Loire, who has earned international fame with his modernizations of the ancient techniques.

Signatures of stoneworkers, with their plumb lines and mallets and chisels, reminded me of labors now being performed in the establishment of Messieurs Martin, father and son, who still quarry and cut the curiously dense, hard limestone from which most of the cathedral was built.

"It is a labor of love," the elder Martin had told me. "We get this wonderful material near the village of Berchères-les-Pierres, five miles away. We bring it here in 11-ton chunks and cut it into blocks and sheets to be used in housebuilding. Hear how the cutting machines labor as they attack it? There is no profit in the work, but if we did not do it, no one else would."

"Flinging its passion against the sky," the cathedral bears out the words of Henry Adams, who believed that "Chartres expressed . . . an emotion, the deepest man ever felt—the struggle of his own littleness to grasp the infinite."





Plowmen of the grain fields had given a window high in the nave; I knew a 20th-century successor to the peasant immortalized in that glimmering panel, Ephraim Grenadou (page 860), himself a peasant of La Beauce, had welcomed me to his simple farmhouse, where his wife Alice had fed us magnificently. Ephraim spoke with love of his land, the 170 hectares (420 acres) which he works with six tractors. "We were born here, and have been poor and then less poor here, but always happy. We will be buried here."

Until recently, Ephraim's grain, like that of the plowman in the nave, went to millers along the river or to windmills of the plain. Of these last, only one remains in operation, grinding a little barley now and then for the edification of tourists.

"Windmills cannot compete with modern machinery," the miller had told me, as his turning vanes threw strange shadows across the evening fields. "They're finished, there will be no more. But they do liven up a countryside, do they not?"

However milled, the flour ends up in a bakery. There are many now, and there were many in medieval Chartres, for the bakers donated several windows to the cathedral. In one, a man kneaded a mass of dough. He might have been modeled on a baker I had watched in the shop of M. Gauthier on the Rue Noël Ballay.

"We make about six hundred loaves a day in a modern oil-fired oven," M. Gauthier had explained. "When I was a boy, we made just as many, but we made them down in the cellar in an old wood-fired oven that my father used before me. That oven is still there, and it is like the ones used in ancient times. It made good bread. Awful work, down there underground all day, and with ashes to carry away. But good bread."

There were other arts and crafts in the cathedral's vivid roster of medieval occupations, reflecting other aspects of contemporary life. But what I had seen expressed the continuity of human experience quite clearly enough. I moved away from the windows, losing sight of their earthy, active detail and regaining the broad view which shows them in their brilliant, soul-stirring entirety.

I made the whole circuit of the nave, not studying but sensing. Then, because the impact of all that magnificence is too much to take for very long when one's eye and heart are attuned to it, I climbed 324 steps into the

north tower, escaping from medieval dream into 20th-century reality.

All around were empty fields, quiet in their winter sleep. The old town, from here a cluster of steep gables and twisting alleys, crowded affectionately around the cathedral. Some eighty feet away the south tower thrust its clean lines toward the big Beauce sky in contrast to the lovely and richly adorned spire in which I stood (preceding page).

SEEN FROM HERE, the tarnished copper roofs of the cathedral formed a gigantic cross. Beside me, a bell sounded, saying softly to the town that it was half past the hour. I felt its bronze voice in my bones, though it did not insult my ears.

I spiraled down again to the transept to walk around the stone screen which encloses the choir and presents in 40 exquisitely detailed scenes the best-known incidents of Christ's and the Virgin's lives. A late addition to the cathedral, begun in the 16th century and finished two hundred years later, it served as a sculptured Bible to those who could not read, and remains to inspire those who can.

As I reached the end of this visual narrative, an organ sounded in the sanctuary and a bridal party emerged through a door in the screen. All filed quietly from the church except the bride and groom, and two minuscule attendants, barely out of infancy but dressed, doll-like, in the manner of miniature adults. These four walked alone to the chapel of Notre Dame du Pilier, the best-loved Madonna of the church. She sat upon a stone pillar near the north transept, her Son in her lap, her dark pearwood body dressed this day in the finest of her five rich robes. Around her, candles guttered in the incensed gloom.

The young couple and the babies knelt before this touching figure of the Queen of Queens, the special chatelaine of Chartres. As they rose to go, the bride turned quickly and placed her bouquet upon a stand for Our Lady's enjoyment. She understood, as women do better than men, that visitors here are guests in the Virgin's house.

When they left, I left too, reflecting on the wisdom of some forgotten sage who had once said, "Chartres is the cathedral for those who do not believe." I walked slowly toward the windows of the west where pictures painted in gold, ruby, and sapphire light told the story of the first Christmas, and went out into the winter dusk.

NATIONAL
GEOGRAPHIC
DECEMBER 1959 PAGE 751A

SOUNDS
OF THE
SPACE AGE

FROM SPUTNIK
TO LUNAR LANDING

NARRATED BY
COL. FRANK BORMAN, USAF
ASTRONAUT

SIDE 1
33 1/3 RPM
MONOURAL

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OF THE
SPACE AGE

FROM SPUTNIK
TO LUNAR LANDING

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COVER: Wearing a bulky space suit, lunanaut Edwin Aldrin walks on the moon. His visor reflects Neil Armstrong and *Eagle* at Tranquillity Base (pages 736-7).

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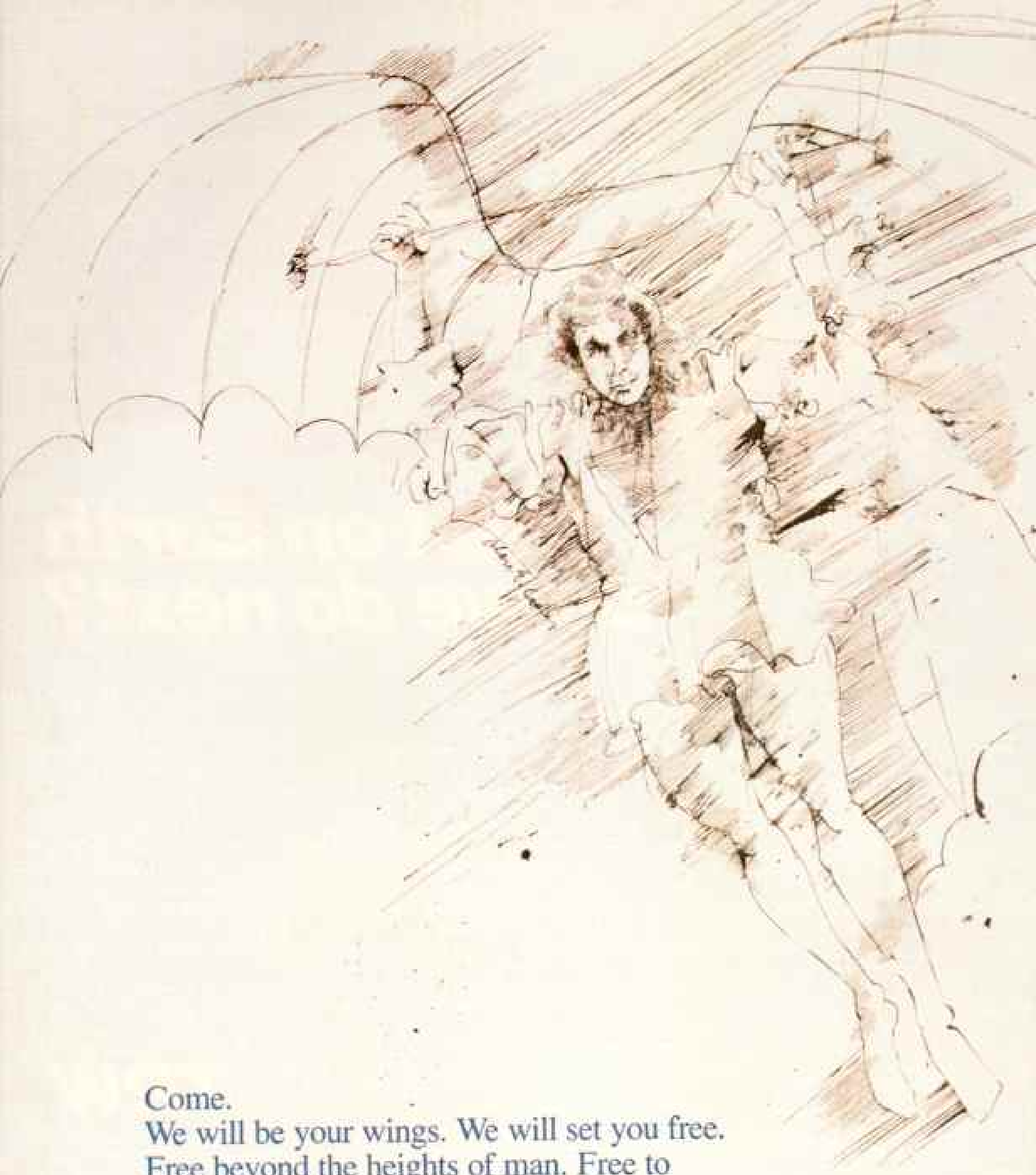
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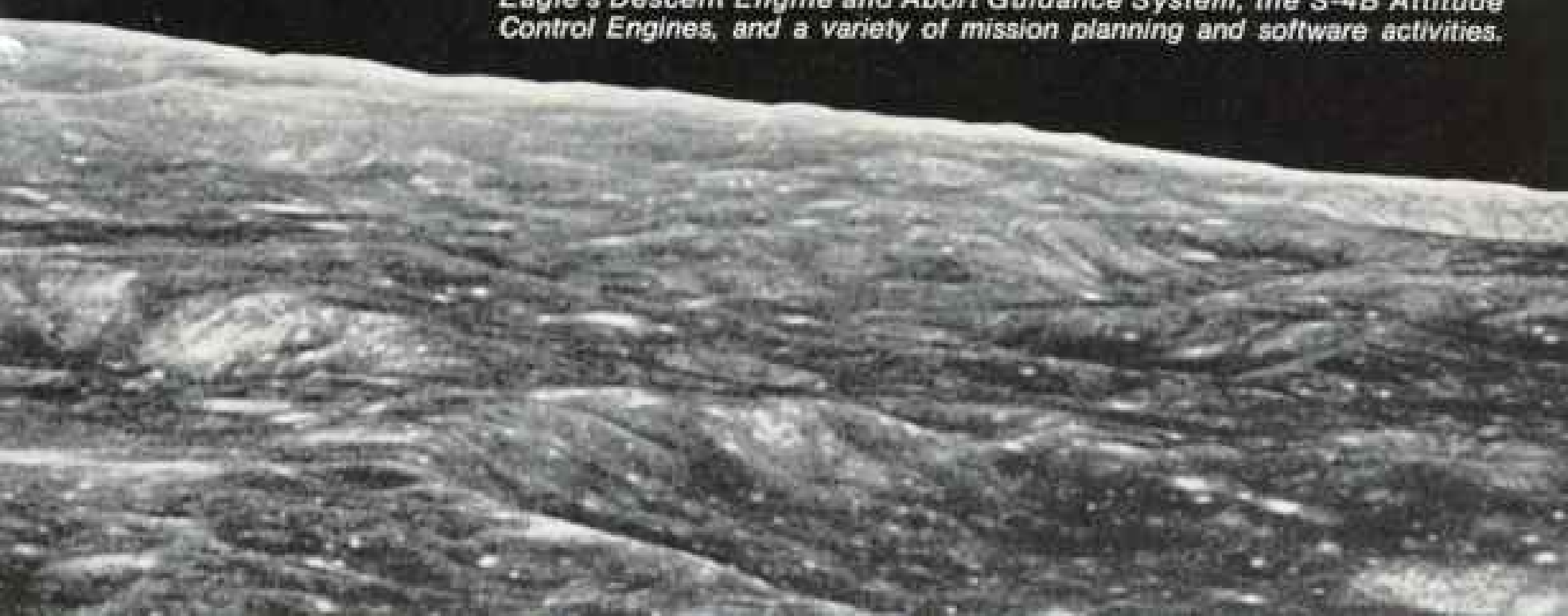
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NASA needed to bring back high-resolution photographs. (Don't you?) The Hasselblad 500 EL offered the superb optics of Carl Zeiss lenses, plus the large 2 1/4" square format.

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NASA needed simplicity of operation. (Aren't there times when you, too, want to concentrate on your subject, not your equipment?) The 500 EL offered electrically-driven automatic film advance and cocking of shutter.

Most of all NASA needed fail-safe reliability. (After all, if you were going on a long trip and didn't know when you'd get there again, you'd want insurance, too.) Since Hassel-

blad had been the space camera since 1962, there was no doubt it would perform reliably on the moon.

There are, of course, some differences between the moon and earth Hasselblads.

For one thing, the moon Hasselblad has wings on the diaphragm and shutter speed rings so they can be operated with bulky gloves on.

It has an oversized shutter release button for the same reason.

It has a longer handle on the film magazine slide for the same reason again.

And it has a hinge to keep the film back from floating off into space during weightlessness.

The earth Hasselblad doesn't have any of these things because it doesn't need them.

On the other hand the earth Hasselblad has things the moon Hasselblad doesn't have. Or need. Like interchangeable film transport mechanisms and interchangeable viewfinders.

In its own way, the earth Hasselblad, with its reflex viewing system, is just as sophisticated as the moon Hasselblad. So rather than stand in awe of the astronauts' Hasselblad,

it would be equally appropriate for the astronauts to stand in awe of your Hasselblad.

If you don't require an electrically-driven film advance, there are other Hasselblad bodies. All part of the Hasselblad system which includes three basic cameras, eight interchangeable Carl Zeiss lenses ranging from 40 to 500mm, five interchangeable magazines from 12 to 70 exposures, interchangeable viewfinders plus a large number of specialized accessories.

We didn't have to push technology to fantastic new limits to create the moon camera. We had been making such a product all along.

Which only goes to show that when you constantly shoot for the moon, you stand a good chance of making it.

For more information, see your Hasselblad dealer. For your free 48-page catalog on The Hasselblad System, write Paillard Inc., 1900 Lower Road, Linden, N.J. 07036. Outside U.S. / Victor Hasselblad AB Goteborg, Sweden.

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Space-age kids. Horse and buggy-age schools.

All over America, kids look up to our astronauts. Some 240,000 miles up, to be exact.

But back on earth, many of these space-age kids are going to horse and buggy-age schools.

Thus, today, an American youngster has something less than a 60% chance of completing his education through high school.

The odds would seem somewhat better that an astronaut will complete his mission.

A paradox? Yes. But with a simple answer.

We've been unselfish with our resources in putting a man on the moon. And if we'll be just as unselfish where our kids are concerned, we can put every American child in a school that can give him the education he'll need.

We've created a space program that every American youngster can be proud of.

Now let's build an educational system that every American astronaut can be proud of.





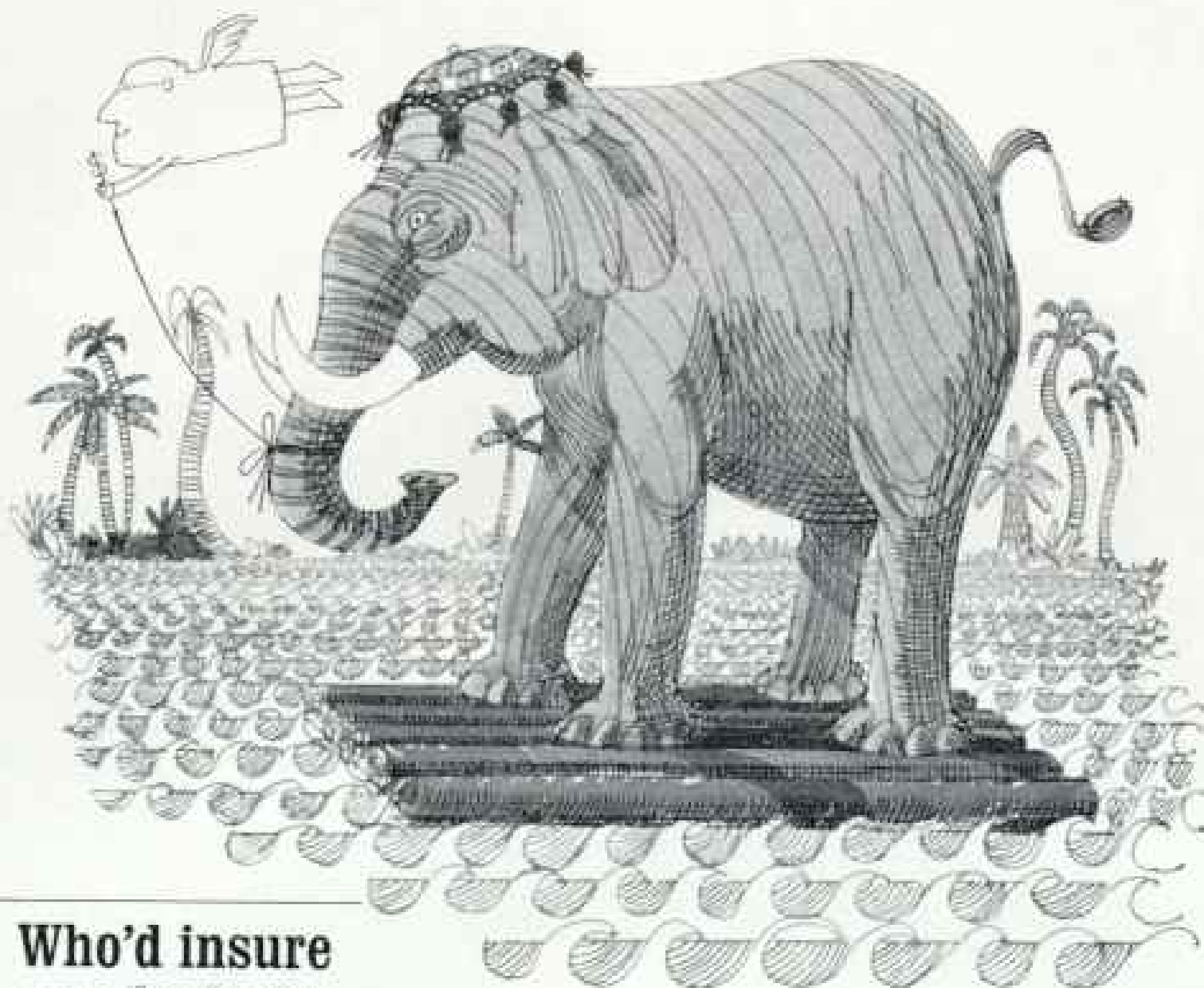
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Second, because we believe America's future—and ours—is no better than the future of American education.

If you'd like more information on how educators are using our products to improve their schools, or if you'd like reprints of this message, write Addressograph Multigraph Corporation, 1200 Babbitt Road, Cleveland, Ohio 44117. (Information sources on request.)



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Q. Why did the elephant people come to us anyway?

A. Well because The St. Paul is quietly notable for insuring things never insured before. (Electronic data processing equipment, farm crops against

hail, fur coats against theft, to name some.)

Q. Haven't you got an elephant?

A. Don't fret. We also write good Non-Elephant insurance. (What do you want insured: your house, your business, your car, your health, your life, your reputation?)

Q. Is the elephant important?

A. No. Our broad-minded kind of underwriting is. (You get a lot more service out of an insurance company with imagination.)

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So the low price of our new compact stereo may leave you feeling a bit queasy. What'd we cut out?

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Feel good about the visual

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"Tranquility Base here. The Eagle has landed."

The "X" on the moon above marks the spot where, at 10:56 p.m. EDT, July 20, man first set foot on another celestial body.

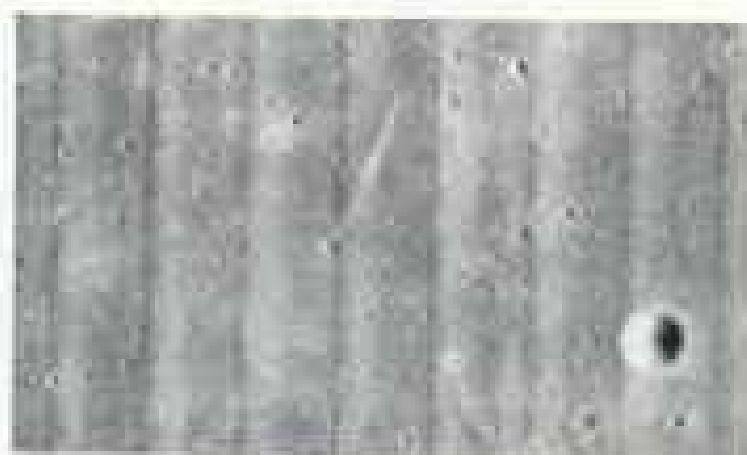
The historic Apollo 11 voyage of more than half a million miles began with the firing of the Boeing-built first-stage booster.

The Boeing booster, the most powerful in the world, produces 7.5 million pounds of thrust. It lifted the 30-story-high moon rocket on its way to the moon.

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In all, some 10,000 Boeing people participated in the Apollo 11 moon-landing mission.

Boeing scientists, technicians and engineers integrate the entire Saturn 5 launch vehicle with the Apollo



Close-up view of the Apollo 11 landing zone, as photographed by NASA's Boeing-built lunar Orbiter on August 12, 1967. Five Lunar Orbiters photographed all potential Apollo landing sites and 99% of the moon's surface.

command, service and lunar modules. They also support NASA during the actual launch operations, and provide technical integration and evaluation assistance on Apollo.

The historic accomplishments of the Apollo missions measure the dedication and skill of the NASA and industry people involved. Boeing is proud to be a member of this distinguished team.

NASA's space program has already contributed significantly to the nation's progress in virtually every field of technology and science.

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Delta 88. Like a radio antenna cleverly concealed in the windshield glass—nothing to mar those sleek lines. And body sideguard beams—extra protection built right into the doors. You can even order a washer/wiper control conveniently built into the gear selector lever. Try an Olds Escape Machine today.

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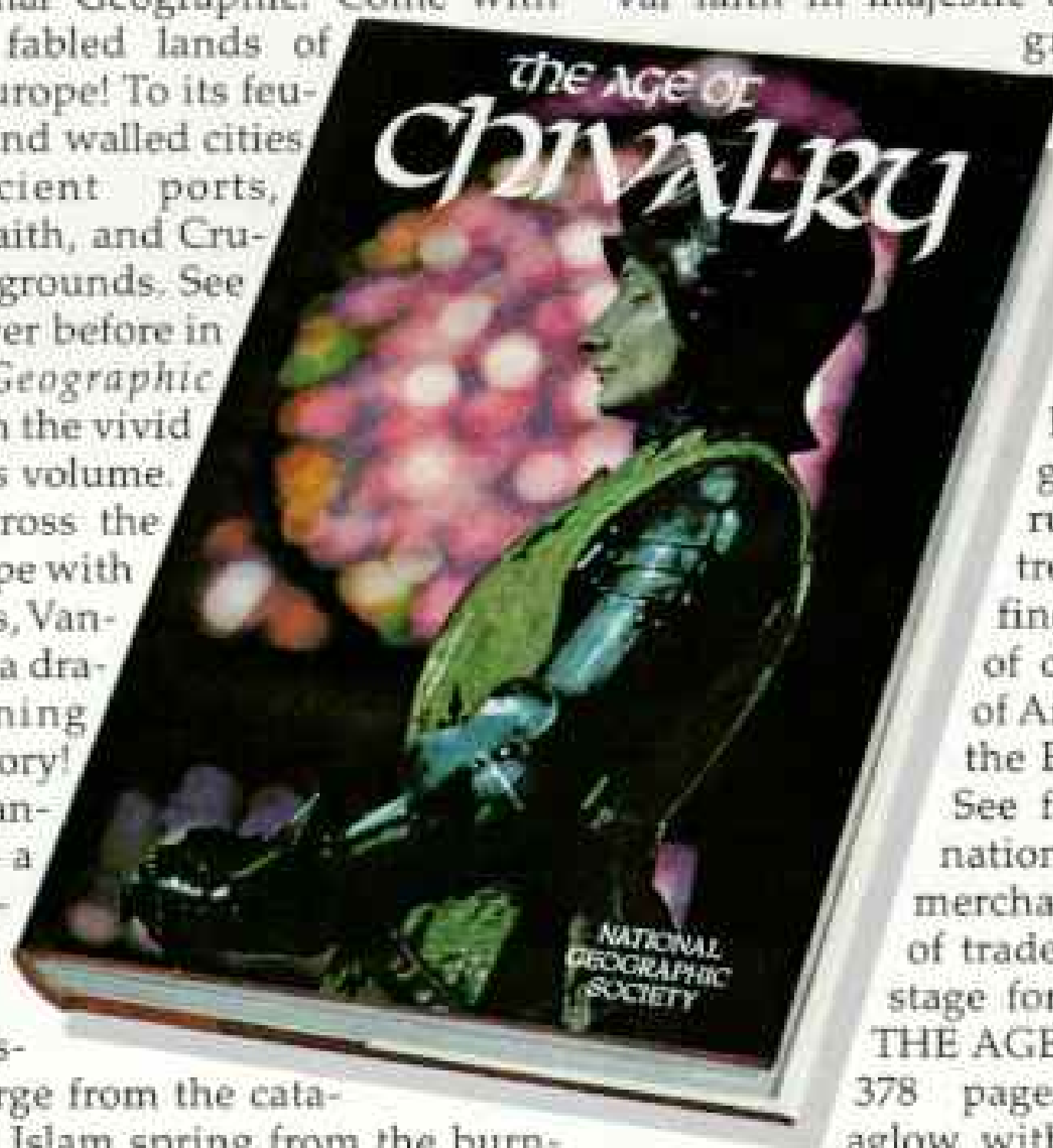
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“You’d hardly know

Thus spake the mayor of Benicia.

His words are echoed by almost everybody else we spoke to in this breezy little city off the Carquinez Strait, near San Francisco.

Such words are music to the ears of Jersey’s affiliate, Humble Oil & Refining Company. For Humble has spent an extra \$10 million just to make their new Benicia refinery as unheard, unsmelled and unobtrusive as possible.

Conserve the air, the water, the beauty and the peace. These were Humble’s main concerns as a newcomer to town. And, before a single bulldozer growled into action, they made stud-

ies of air currents, water, vegetation and sound levels to give themselves a benchmark against which to measure change.

Water. One way to keep it clean is to use as little as you can. There is less to get dirty and less to clean up. For each gallon of gasoline produced, many refineries use up to ten gallons of cooling water. Thanks to air-cooling and water recirculation, Benicia uses only one.

“How’s the fishing off the refinery?” we asked. “Fine” said the mayor. “We hook sturgeon, bass and flounder. And sometimes we get a salmon.”



the refinery was there”

Beauty. Nobody can hide a refinery. But, with subtle landscaping, you can stop it looking like a monstrous set of drums and clarinets.

At Benicia, embankments are covered with flowering iceplant. Tanks and towers are painted corn gold and moss green, the dominant colors of this Cézanne countryside. And it works.

Harold Gilliam, former consultant to the President's Council on Recreation and Natural Beauty, writes—“The refinery's impact on the landscape seems muted and moderate.”

As for the air and the peace, our headline and picture surely say enough. But there's one

effect of the refinery that every Benician notices. It has quintupled the city's tax base.

Local tax rates have been cut. Yet Benicia has a new source of water and a new youth center. The high school has a new gymnasium, new classrooms and more teachers making more money. And the band is getting new uniforms at last.

**Standard Oil Company
(New Jersey)**



It may tell you when



to take your vacation.

Won't it be great when you can know weeks ahead what the weather is going to be? You can plan your vacation so you won't be rained out. If we could predict the weather just five days ahead, it would save American industry billions of dollars a year.

One important element that has been missing in our forecasting is exact knowledge of what the great "weather-breeder" is doing. The oceans cover two-thirds of the earth's surface and what's happening out there is what largely affects our weather back here. The ocean data stations will tell us.

Built by General Dynamics for the Office of Naval Research, these oceanographic "weather bureaus" will transmit reports on winds, dew point, air-sea temperature differences, solar radiation, barometric pressure and rainfall.

Each forty-foot structure and its four-mile-deep tether line contains more than 200 advanced electronic devices that measure and transmit weather data up to 2,500 miles—and can continue transmitting, untended, for as long as two years. It can remain on station and transmit in winds up to 160 miles per hour and in seas 60 feet high.

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The ocean data station is just one example of what technology can accomplish when it's handed a problem. At General Dynamics we put technology to work solving problems from the bottom of the sea to outer space...and a good bit in between.

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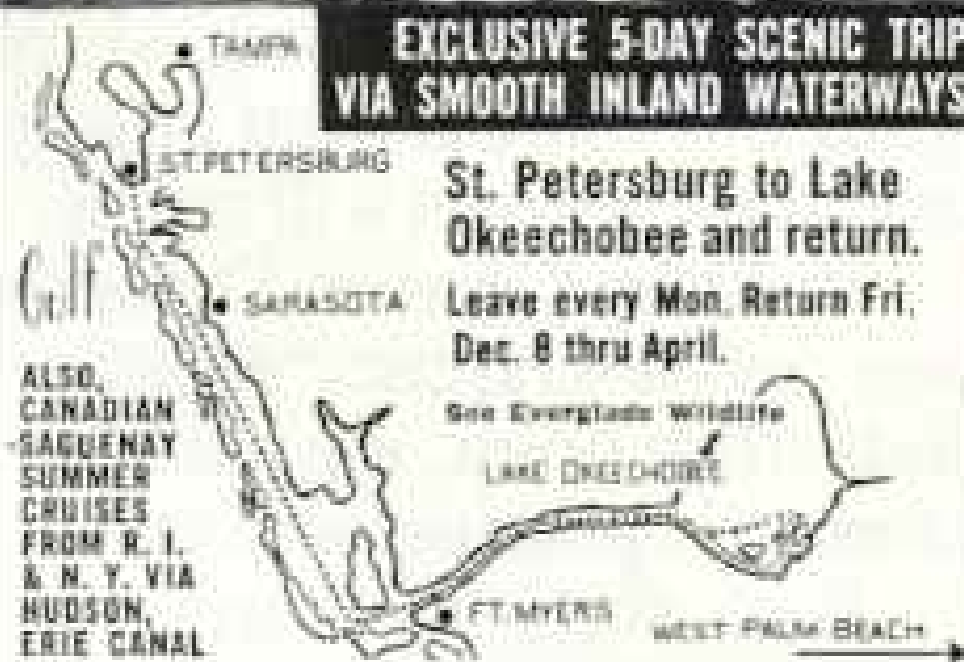
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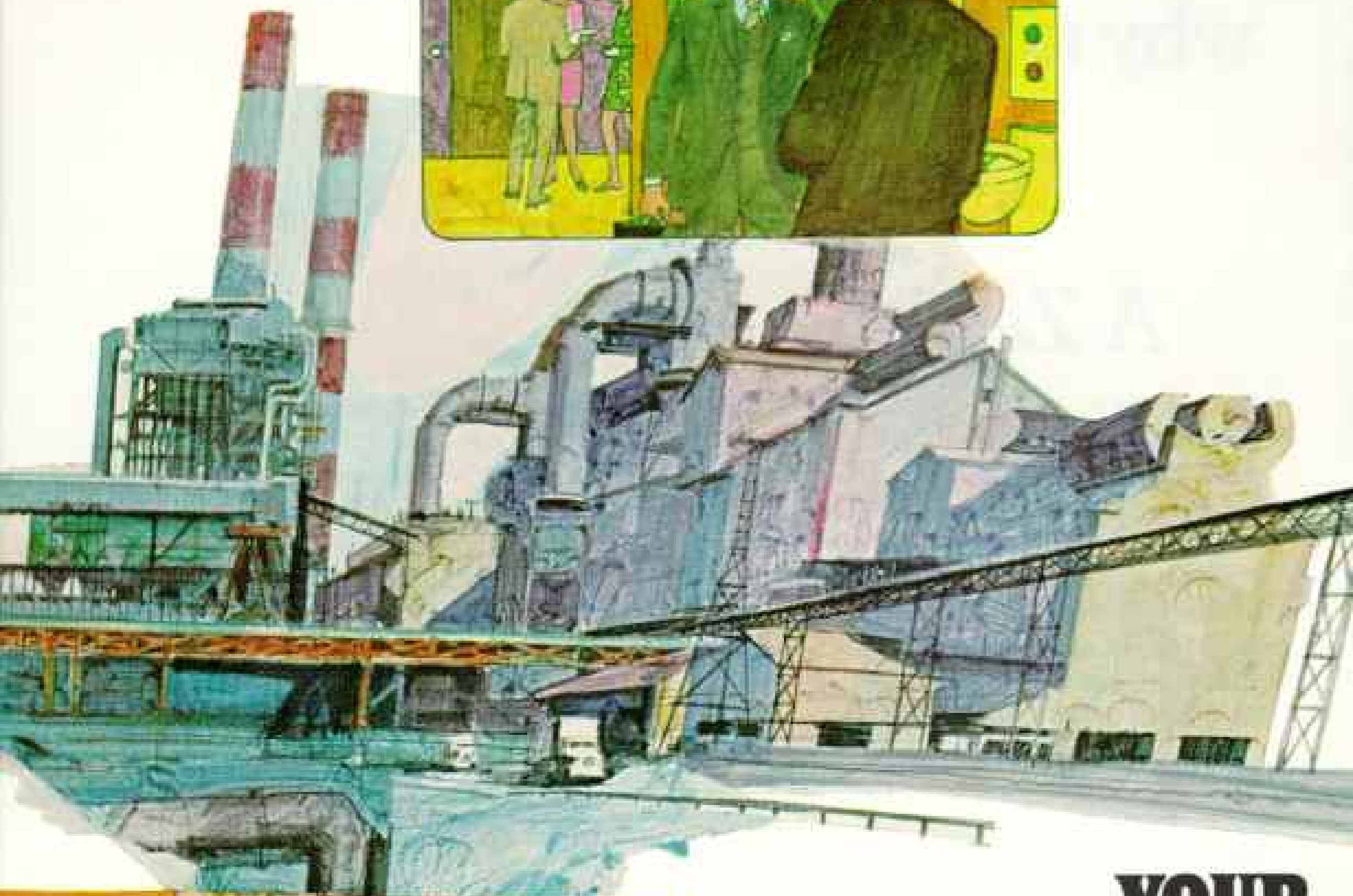


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Revolutionary new Admiral speaker/enclosure combination gives the finest sound in console stereo!

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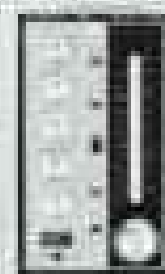
Admiral has; in fact we've applied for patents on the "Bull Horn" system.



Admiral designed "long throw" speakers. They move far more air than restricted short throw speakers. When you move more air, you get better bass.

But the speakers are only half the story. Admiral built $\frac{1}{4}$ wavelength tuned chambers and scientifically matched them with the new speakers.

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Bull Horn stereo comes in 11 models, in 6- and 8-speaker consoles, plus a new line of stereo portables and a table-top FM stereo radio.

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We know there's more to life than that. Living is caring. And at INA, our MEND rehabilitation program and our INA MEND Institute are important parts of the way we care.

MEND is a rehabilitation program that steps in immediately after a disabling accident. It offers physical treatment, psychological counseling, vocational training and personal guidance to get a man back on his feet. So far we've helped more than 8000 people this way.

But there's more to rehabilitation care than helping a person back to normal life. Applied research to help prevent accidents is important, too. And there are always new basic techniques to be discovered to help disabled people find themselves through work.

That's what the INA MEND Institute is all about. We've created it at the Human Resources Center on Long Island. And the research being done there should have value far beyond preventing accidents and helping the disabled.

In fact, part of the idea is to develop information that may one day be helpful even to the aged, the infirm, the culturally and educationally deprived.

Insurance is care—care for people, care for life. And through imagination we try to help people live their full lives usefully, no matter what the obstacles.

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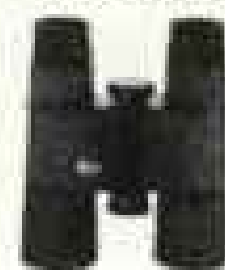
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