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JANUARY, 1952

Color Supplement "Adoration of the Magi"

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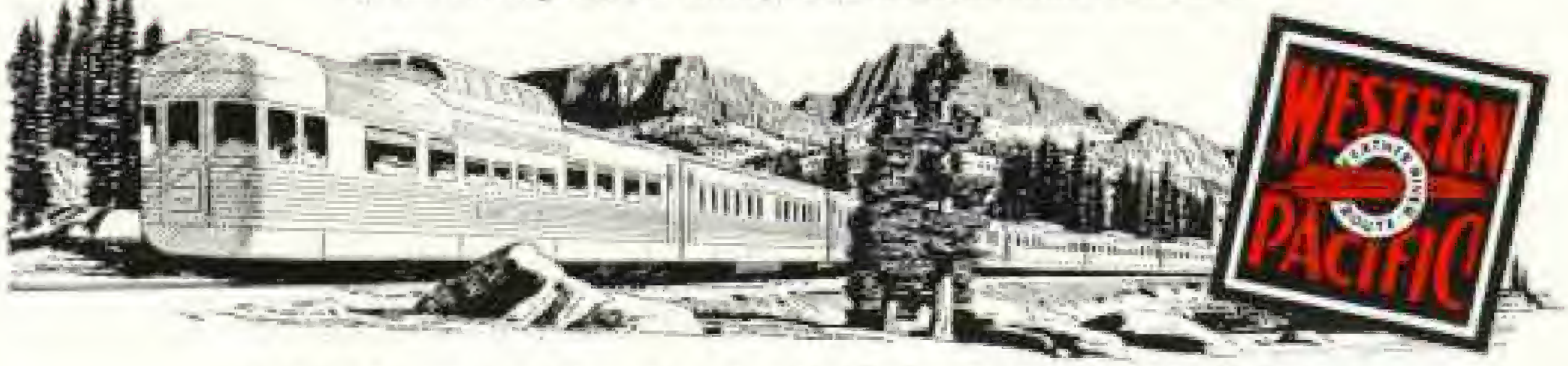

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One of the major achievements of medical science is the progress that it has made against pneumonia. A recent study shows, for example, that for every person who now succumbs to pneumonia, three or four were claimed by it as recently as 15 years ago. This gain has been made possible by improved methods of treatment—including increasingly effective medicines.

Yet, pneumonia is still an important disease—especially among infants and elderly people. It takes an annual toll of about 50,000 lives. Doctors say that this toll could be reduced if the skills of medical science were used *promptly*—at the first signs of pneumonia. This is because the new antibiotic drugs work best when given in the early stages of this disease. So, during the winter everyone should be alert to these warning symptoms of pneumonia:

1. **A severe, shaking chill followed by fever.**
2. **Coughing accompanied by sharp pains in the chest.**
3. **The appearance of rust-colored sputum.**
4. **Difficult or labored breathing.**

Certain types of pneumonia may occur without these symptoms. However, if they do appear, call a doctor promptly, go to bed, and remain quiet.

Remember, too, that a neglected cold—particularly if accompanied by fever only a degree or so above normal—may be a forerunner of pneumonia. Even if fever does not occur, it is always wise to take care of a cold, especially one that "hangs on." Stay home and rest if you can, eat lightly, and drink plenty of fruit juices and other liquids.

While medical science can assure recovery from respiratory infections in a vast majority of cases, *prevention* is still largely up to *you*. To guard against pneumonia—as well as colds, influenza, and other respiratory conditions—the following precautions are advisable:

Try to build up your resistance: get plenty of sleep, avoid excessive fatigue, and eat a well-balanced diet.

Dress warmly when going out, especially during cold, damp weather.

Keep away from people who cough or sneeze carelessly.

The wisest precaution of all, however, is to keep in the best possible physical condition—for those with the most resistance and vigor have a definite advantage in avoiding pneumonia and other winter ailments.

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VOL. CI, No. 1 WASHINGTON JANUARY, 1952

THE NATIONAL GEOGRAPHIC MAGAZINE

Solving the Riddle of Chubb Crater

By V. Ben Meen

Director, Royal Ontario Museum of Geology and Mineralogy

With Illustrations by National Geographic Photographer Richard H. Stewart

IN ALL the vast and lonely reaches of the Far North I doubt that there was a more disappointed man that Friday evening. My calendar said August 17.

Time had all but run out for the expedition dispatched by the National Geographic Society and the Royal Ontario Museum of Toronto to the subarctic tip of Quebec Province to solve the mystery of Chubb Crater.

Was this gigantic hole the throat of some long-extinct volcano? Was it formed as a sinkhole after the retreat of a prehistoric glacier? Or, as I thought most likely, was it blasted in the rock by the impact of a giant meteor?

For a month now, seeking the answer, the six of us had been working our hearts out against time, laboring in rain, cold, snow, and the everlasting wind that sweeps this desolate land of eerie stillness.

Three Days Left and Still No Proof

But Chubb Crater stubbornly held on to its secret. We still lacked positive evidence as to the origin of this enormous scar gouged out of the granite-covered barrens.

The amphibian plane that would fly the expedition back to civilization was due at camp in less than three days. Were we fated to return and report the riddle still unsolved, leaving the world still to wonder how the great crater came into being?

As leader of the expedition I felt an especially keen sense of frustration. True, we would not be going back empty-handed. The days of driving effort had produced a goodly store of scientific data on the crater-land area, as well as material for further laboratory study. But the big prize would be lacking.

Unpleasant as this prospect was, my responsibilities gave me no choice but to face up to it, and for good reasons.

The weather was our implacable foe. We had seen the last snows of the Arctic's 1950-51 winter when we arrived at the crater. Now, only four weeks later, the first snows of the 1951-52 season were already upon us, and General Winter strikes swiftly here. A few degrees' drop in temperature would put ice in the lake that offered the only landing place for our amphibian.

Safety of the expedition's members was paramount. Once ice began forming on the lake, our amphibian would be prevented from landing. On foot it would be a rough 60-mile trek to Wakeham Bay in the teeth of increasingly severe weather, and I doubted we could pack enough supplies to cover that distance. I felt we had to get out by air in a few days or hole up to await rescue.

Saturday's program thus seemed clean-cut: pack equipment and specimens; get ready to strike camp. Up on the crater rim the men still working against time for a key to Chubb's riddle could continue the search until midday, but then it must end. They would need most of the afternoon to negotiate the tortuous way back to camp, burdened with their heavy gear.

Then on Monday the amphibian would come to lift us out of the cold and wet and speed us back to civilization. After all, it was summer there, and one could luxuriate in a bath, wear light clothes, and forget the lashing winds.

Of course, I would still cling to my theory on the origin of this Gargantuan punch bowl in the wastelands, but theories are not facts. Science demands conclusive proof. I believed

Royal Canadian Air Force

Chubb Crater Lake Fills a Significant Circle; Its Neighbors Lack Geometric Pattern

Dreams of a fortune glittered for prospector F. W. Chubb (text, below) when he studied this panorama, made in 1948 by a Royal Canadian Air Force plane from 20,000 feet. If of volcanic origin, the crater area might yield diamonds, he believed. Mr. Chubb consulted geologist V. Ben Meen, to whom the picture suggested the work of the mightiest meteor to hit the earth. After an exploratory visit, Dr. Meen enlisted the help of the National Geographic Society and the Royal Ontario Museum to solve the mystery of the crater.

I knew what had *not* caused the crater, yet lacked acceptable evidence as to what had.

Birth of an Adventure

The story of Chubb Crater begins with World War II. On June 20, 1943, a U. S. Army Air Forces plane, on a weather flight over the Ungava region of Quebec Province, took a photograph showing a wide crater rim thrust up above the snow-mantled landscape.

Five years later the Royal Canadian Air Force covered the same little-known area in its program of photomapping all Canada. Not until 1950, however, were these photographs and resulting map corrections made available to the public.

Here that sturdy prospector and frontiersman Frederick W. Chubb becomes an important figure. His interest was fired by the photographs of the strange configuration of terrain far north of the limit of wooded country. He sought me out at the museum for my opinion as a geologist.

Mr. Chubb was hopeful I would tell him what he wished to hear—that the crater appeared to be that of an extinct volcano. If so, the area might hold diamond deposits similar to those found in South Africa.

My interest was stirred, but for a different reason. My knowledge of Canadian geology tentatively ruled out the possibility that the crater was of volcanic origin, or a huge sinkhole left behind by retreating ice.

The only other likely explanation was that this immense pockmark on northern Quebec Province was the handiwork of a mighty me-

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Canoes Came in Sections to Fit the Expedition Plane's Cargo Spaces

Nigel Martin and Fred Chubb load the amphibian at Roberval, Quebec, jumping-off place for the northern wilderness. Canoes bear names of the expedition's sponsors. Once reassembled, the three bulkheaded sections of each craft accommodated two men and a 500-pound load. Bright yellow paint facilitated spotting the canoe on Chubb lake (pages 29 and 30).

tear that crashed into the land at terrific speed untold centuries ago.

Eager to inspect the crater firsthand, I flew there with Fred Chubb in 1950. The visit was brief, hardly more than a reconnaissance, without time or equipment for a thorough study. I was awed then—as I have been ever since—by the stark, brooding grandeur one beholds from the crater rim.

Crater Named for Arctic Prospector

On this trip, incidentally, I named the crater Chubb, as a tribute to my good friend who deserves so much credit for its exploration.

I came back to Toronto fired with a determination to return to Chubb Crater with an expedition that would unlock its secret. More than ever I was persuaded my theory was right—that a mighty meteor had blasted out the crater with an explosion that left the surrounding barren plain a chaos of boulders.

The fine cooperation of the National Geographic Society and the Royal Ontario Museum, so typical of the neighborly spirit linking the United States and Canada, made possible my return to craterland with all I needed. Now it was up to me and my team.

Our take-off point was Roberval, a quiet lumber town, one of the last stops on the rail line that reaches north from Quebec City.

With me was a hand-picked team of which I was already proud, and later even prouder, Doughty Fred Chubb, who started all this in the first place, dropped everything to join us.

To help me in geological and survey work were John Keefe and Leonard Cowan. John, a geophysicist, had originally intended to start work that summer in western Canada's new

Drawn by Harry S. Ofiot and Irvin E. Alleman

No Man Saw Chubb Meteor Gouge Its Brand on Quebec's Northern Tip

Eskimos called the peninsula Ungava, their word for "far away." The name fits a seeming eccentricity of major meteors, which have left their biggest craters in desert or wilderness. "Far away" will soon cease to describe southern Ungava, for a new railway is advancing into the wilds from the St. Lawrence to exploit Burnt Creek's vast deposits of iron ore. The expedition which explored Chubb Crater made a refueling stop at Burnt Creek on its 1,000-mile flight from Roberval to Museum Lake (opposite page).

oil fields, but scrapped his plans. Leonard, who was not due back on my staff at the Museum until September 1, had done likewise with his leave program.

As our biologist we had Nigel Martin, on generous loan from the Ontario Department of Lands and Forests. And last, but by no means least, there was the versatile Richard H. Stewart, of the National Geographic Society's photographic staff, a veteran of many far-flung scientific expeditions.

Delayed equipment and bad weather held us up five days at Roberval. We made good use of the wait, however, to remove supplies from crates and cartons in order to pack the maximum load into our amphibian (page 3). Incidentally, it was the only commercial plane in the area that had the capacity to fly us to Chubb with all our equipment, supplies, food, and fuel for a month's stay.

Known in World War II as a PBY patrol plane, or as the Catalina, this work horse of the air is called in Canada a Canso. Modified for peacetime use, it is capable of lifting big loads great distances; hence its value in the north country.

Capacious as the Canso was, we needed every bit of space for the 5,000 pounds of cargo we stowed aboard her. Our biggest problem was the gasoline we had to carry. Craterland is barren of fuel. We needed the gas for cooking food, heating and lighting our tents, running the generator for our radio, and powering the outboard motor for our canoes.

Weather gave us the green light on July 25.

Thirsty Amphibian Gulps $1.75-a-gallon Gasoline for the Final Hop North

At Burnt Creek, main base for tapping a huge new-found field of iron ore, all gas must be flown in; hence the high price. This 300-gallon drink cost $525.

The burdened Canso moved down the apron at Roberval's shore and slid into the waters of Lake St. John. Motors revved up as we taxied for take-off. Capt. Wilf Allard, our able pilot, lifted his big ship from the lake's surface at 9 a. m.

Less than 10 hours and one refueling stop later, the captain eased our Canso down on Museum Lake, about two miles north of the crater. A few smooth stretches on its otherwise rugged shore line offered the only practical campsites in the area.

I had given this lake its name on our previous trip, with the thought of reminding the public that museums, far from being dusty, sleepy places, are actively engaged in research for advancing the frontiers of knowledge.

Coming in for our landing, the Canso gave us an excellent opportunity to view the crater from aloft. It resembled a gigantic teacup,

An Optical Illusion Tricks Rock Tossers on the Crater Rim

So deceptive are distances on Chubb's slope that fantastic misjudgments occur. Here the water's edge seems an easy, downhill throw. Actually, the stretch is 300 feet, a greater distance than from a centerfielder's position to home plate. These hurlers never came close to hitting water. Lack of landmarks gave them no scale to gauge space, and clear air made the distance appear short.

Scientists theorize that the Chubb meteor might have been traveling 32,000 to 150,000 miles an hour when impact stopped it in a fraction of a second. Instantly, a tremendous compression occurred, heating and partially vaporizing the missile. The resulting explosion hurled countless tons of rock at the northern sky and left a hole like a World War II bomb crater enormously magnified.

Searing hot air waves destroyed any life near by. Earth shudders spread in violent ripples, convulsing rocks.

Scientists believe the collision did not affect the speed of earth's rotation. "It would have been like a mosquito crashing into a bus," one said.

Astronomers and geologists can only speculate. No man has ever reported one of these cataclysms. History records not a single authenticated instance in which a meteor killed a human being, though small ones have fallen in populated areas.

Arctic Visitors Drop from the Air

Callers are rare in the Far North; so greetings were warm for these guests who flew 290 miles from Fort Chimo to see the crater. They were welcomed as companions, bearers of mail and news, and couriers to carry back word. Until their arrival, the camp's bulky radio had failed to make itself heard by other stations (page 21).

Dr. Meen (center), expedition leader, chats with Dr. Jacques Rousseau, Montreal naturalist en route home from field work near Chimo. N. V. Martin, expedition biologist, and René Richard, artist-prospector, listen in at left. At right are Dr. J. W. Jones, Quebec Province geologist, and Dr. Rousseau's son François.

Summer's extreme brevity in upper Ungava allows scientists about seven weeks of open weather for field work. In the folksy speech of frontiersmen, "Summer is the day they change the ice in the lakes."

Ice is a constant bugaboo to expeditions, which depend on amphibians to airlift them out. Any landing on an ice-strewn lake verges on suicide.

Vast stretches of upper Ungava remain unknown save to a few nomadic Eskimos. The region may possess considerable mineral wealth.

slightly tilted (page 2). The rim rears up hundreds of feet above the surrounding wasteland, and the lake deep in its bowl has an unbelievable color of purple-blue.

I was pleased to see the water was ice-free. This would facilitate lake research. On my three-day visit to the crater in 1950 I had found most of the surface covered with drifting cakes of ice, some of them three feet thick, although near-by lakes had none.

On Museum Lake shore that night there was no haste in pitching camp. Even at midnight, when we decided things were adequately squared away, we still had bright daylight. A beautiful sunset, which had appeared to the northwest two hours earlier, was now straight to our north, its glory undiminished.

Camp under Four Flags

Because of this virtually continuous daylight, all but one of our tents were dark green to make sleeping possible. Only the cook tent was white, for visibility inside. It also aided in spotting our site from the air (opposite page).

Throughout the stay our little encampment operated under four flags—the Union Jack for Canada, Old Glory of the United States, and the banners of the expedition's two sponsors, the National Geographic Society and the Royal Ontario Museum.

Our first morning witnessed the debut of Dick Stewart as the expedition's *chef de cuisine*. He volunteered to assume all mess-tent responsibilities, but served this ultimatum:

"The first man who complains about the food replaces me as cook immediately!"

Dick held his job until we struck camp to go home. The lack of any complaints may be interpreted as a tribute to his culinary genius. I often marveled that the meals were so appetizing, considering that much of the food was in dehydrated form (page 32).

If Dick and Fred Chubb, his mess tent aide, lavished any special care on that first breakfast, their pains went for naught. Everyone just bolted it down; all in our party had a single thought—to see Chubb Crater close up. It was the same with the four crewmen of the Canso, who had remained overnight.

Only two miles separated our camp and the crater, yet it took as much time to cover the distance as five miles or more of normal cross-country hiking. The boulder-littered plain made progress tormentingly slow. We scraped, scrambled, and slithered through the jumbled rocks that always seemed an invitation to a very bad sprain at least, if not a broken ankle (page 11).

At intervals we scaled granite ridges apparently concentric to the crater. These rear up from 20 to 30 feet above the rest of the plain.

Finally we clambered up the 25° slope to the rim's summit, which rounds off gently to a broad, almost flat surface (pages 26-27). When Fred Chubb and I had climbed to this same point the year before, our first view had left us speechless. It was the same this time with the others, rooted solemn and silent where they stood by the harsh majesty of the scene. The strange, almost unearthly silence heightened the effect.

To my mind, the most stirring view of Chubb is from the rubble down at the very edge of the cold lake. An aerial view is striking (pages 12-13), but it leaves one without a full appreciation of this natural wonder. Seen from the crater rim, which averages 400 feet above the water, the lake seems dwarfed—far smaller than its true diameter of more than a mile and a half. It is only down along the wave-wet rocks, I think, that the senses can begin to comprehend the splendor of the crystal-clear lake and the bare magnificence of the crater panorama.

While most appreciative of such unmatched scenery, I found my thoughts concentrating on other matters. I again marked the amazing points of similarity which Chubb shared with Arizona's Meteor Crater, long officially recognized as the largest proven scar of a meteor's collision with the earth.*

Both are much alike in circular shape, in general appearance, and in their settings amid fractured rocks. Meteor Crater cradles no beautiful lake like Chubb. On the other hand, during my 1950 inspection the Chubb area had yielded no meteorite fragments or droplets such as bestrewed the vicinity of the Arizona scar, and I would have been happier if some such meteoritic evidence were already in hand. Of course, I hoped we would secure it.

Chubb Far Larger than Arizona Crater

The striking difference between the two craters is in size. Arizona's crater has a diameter of about 4,000 feet. I estimated that our survey would show Chubb's rim-to-rim breadth almost three times that. In depth the Arizona scar is approximately 600 feet. Even without measuring, my eye told me Chubb was deeper, even if its lake proved deceptively shallow, which I doubted.

Thus Chubb bid fair to become the world's newest and largest natural wonder of meteoritic origin. The catch was that we had to prove that Chubb was a meteor's handiwork.

My thoughts were interrupted by Captain Allard, the Canso's pilot.

"Time to get back to the plane and start

* See "Mysterious Tomb of a Giant Meteorite," by William H. Boutwell, National Geographic Magazine, June, 1928.

First Mess Call Sounds in Crateriand

Cook's white tent got top priority when the National Geographic Society-Royal Ontario Museum Expedition pitched camp at Museum Lake. Sleeping tents, dark green to shut out midnight sun, blended into the landscape, so pilots relied on the white tent as a marker.

Chubb's Grim, Wind-whipped Rim Is Measured by Surveyors

Seven rock cairns, each topped by a brilliant fluorescent flag, were set up so that crews could start plotting dimensions of Chubb Crater, Ungava's huge scar born of an exploding meteor. Its diameter: 11,500 feet. This party takes a sighting on another cairn (page 16).

Kodachrome by Richard H. Stewart

A Snowball Fight Brings out the Small-boy Urge in Scientists. Ammunition Is Handy on Chubb Crater's Flank

Permanent snow fields dot the area; any prolonged drop in temperatures would bring back the Ice Age. White patches on the distant hills sometimes get 24 hours of sunshine a day but seldom if ever thaw. Deep-blue Museum Lake lies two miles away. The rocky incline (left) leads to Chubb Crater's rim.

Five Billion Tons of Shattered Granite, Debris from a Meteor's Mighty Crash, Guard Approaches to Chubb Crater

Acres of giant boulders explain why it took the time equivalent of a five-mile hike to cover the two miles between Museum Lake (right) and the crater. Falls and fractures were a constant hazard, but no expedition member was injured.

Kodachrome by Richard H. Stewart

Chubb Crater in the Gloaming: the World's Newest Natural Wonder

Until evidence of Chubb's meteoritic origin was found, Arizona's Meteor Crater was the largest known. Chubb is more than two miles across; Meteor measures less than half that diameter. Other major craters in Australia, Saudi Arabia, and Texas do not compare. Although watches said night had begun, the Arctic's sleepless summer was made possible this picture, taken from the expedition's amphibian.

13 Kodachrome by Richard H. Pough

Only the Howling of Winds and Lapping of Waves Break the Unearthly Silence

On June 10, 1943, eve of the Arctic spring, a United States Army Air Forces pilot on a routine weather flight made the first photograph of the crater without realizing its significance. A 1948 photographic survey by the Royal Canadian Air Force produced the aerial view that sparked the 1951 National Geographic Society-Royal Ontario Museum Expedition. Dr. V. Ben Meen recognized the crater's challenge to science and set out to solve its mystery.

Kodachromes by Richard H. Stewart

Dr. Meen Drags a 13-pound Magnet to Pick up Ore Particles and (Left) Examines Them under a Magnifying Glass

Exploding meteors, born in outer space, sometimes spatter earthly targets with shrapnel-like fragments. Such a shower fell around Meteor Crater, Arizona. Chubb Crater's explorers searched in vain for similar specimens. However, they did obtain magnetite particles of earthly origin. Flakes of this iron oxide were common in the rocks. A striking feature of the region was the virtual absence of soil.

Chubb's Fish Seem out of Shape; Heads Are Big, Bodies Slender

▼ These Arctic char were taken from the crater and its satellite lakes. They resemble lake trout but are soft and flabby. Large heads and thin bodies indicate malnutrition. One fish was so hungry it snapped at a paddle.

How the first trout entered the lake and how they survived on short rations remains a riddle.

◄ Fish caught by casting in Museum Lake were healthy and normal; they weighed up to 13½ pounds, four to six times as much as Chubb's. Filleted, they made fine eating. Other fish were taken by net for scientific study.

Transitman John Keefe Signals to His Rodman

This instrument was set up in the flat between camp and Chubb to survey a base line. Triangulation was used to pinpoint cairns on the rim and thus determine the size of the crater.

An interesting feature of the surrounding wastelands is a concentric series of granite ridges which hump up at intervals. Seen from the air, they suggest ripples spreading away from the splashlike shape of Chubb's rim. In Dr. Meen's theory, they are compression ridges forced up in the granite by the impact of a meteorite.

Whether or not the interstellar missile formed these ridges, the rim itself gives evidence that the meteor struck with many times the force of an atom bomb.

Last Rocks Are Added to Cairn No. 1

All survey stations tied in to this rock pile as a central point. In addition to aiding survey and magnetometer teams, the cairns helped crater lake canoe teams take bearings as they made depth soundings. Any cairn station offers breathtaking vistas. Beyond the rim stretch the Arctic barrens, endless, monotonous, bleak, unfriendly.

heading for home," he explained. Then he added something about landing the amphibian in the crater lake.

I took this parting remark in jest. The crater's precipitous walls and the unknown air currents within them seemed to me a risky combination that any pilot would shun.

Imagine my amazement an hour or so later when the big flying boat buzzed the entire circumference of the crater, then dipped abruptly to the purple-blue lake waters. It was a superb exhibition of a pilot's skill.

For a moment we almost lost the Canso's outline against the mouse-gray crater walls. Even when it got down and skimmed along the water, throwing up great plumes of spray, the ship seemed no bigger than a mosquito.

Our "mosquito" rapidly resumed normal size. Captain Allard gunned the amphibian off the lake, climbing fast. He cleared the west rim with engines roaring, dipped his wings in salute, then was gone.

Now we were completely on our own!

Scientific Detective Work Begins

Jack Keefe (soon dubbed "Long John") was eager to get started on the land survey to which he could tie in future readings taken from his magnetometer, the delicate and valuable instrument used to determine whether any buried meteorite mass lay beneath the crater rim (opposite and page 31). Len Cowan teamed up with him—a good partner, for Len had had considerable surveying experience in the Canadian Rockies.

"Nick" Martin's job was to make the soundings that would establish the crater lake's depth (page 30). He also was to study any life in its waters or those of adjacent lakes, and to gather all information possible on bird, animal, and plant life in the area.

Fred Chubb worked with Nick on the lake, where his frontiersman's skill with a canoe was invaluable, and also assisted me.

Strictly speaking, Dick Stewart's only job was to compile a photographic record of our activities, yet somehow he found time for the cook-tent chores and always was ready to assist anyone in need of help.

In my primary capacity as expedition geologist, I devoted my attention at the outset to three studies: the region's rock formation; the effects of the terrific explosion believed to have produced the crater; and what had taken place since that blast. I also assumed the task of searching for fragments or other traces of the meteorite (page 14).

This search was a major preoccupation with me. Over and over I kept asking myself, "Where are the fragments of the meteorite?" Surely there must be some evidence that would tie the crater to a meteoritic origin.

We got on with our work in what seemed an abandoned, inhospitable world. The landscape might have been that of some deserted planet. There was no escaping the universal loneliness of our surroundings, the oppressive silence, the feeling of utter isolation.

The sparsity of vegetation heightened the monotony of all vistas. Nothing higher than nine inches could be found. Plant life seemed limited to a species of heather, various lichens and mosses, Arctic cotton-grass, Iceland poppy, and dwarf willows. The insect population also was negligible, although occasionally we encountered voracious mosquitoes.

Rainy weather we had in unwelcome abundance. Usually the storms were not driving downpours, but the rain always was sufficient to soak the lichens on boulders and make them dangerously slippery. Work had to be stopped until the lichens dried.

On colder days the rains gave way to sleet and snow. Toward the end of our stay we had snow squalls daily. These aroused considerable worry. If, at any time, there had been two or three hours of steady snow, the expedition's work might have been ended for the season. A prolonged snowstorm would have blanketed boulders and the gaps between them so completely that any attempt to pass through the rock fields would have been foolhardy.

Fortunately the snow we had did not remain long enough to cause serious inconvenience.

Though it was August, the average temperature ranged between 37° and 49° Fahrenheit. The lowest temperature we recorded was 26°. Twice the mercury climbed as high as 65°, but only for a few minutes. On most days it never reached the 50° mark.

We all found it cold, despite heavy Arctic clothing. It was especially hard on Dick Stewart, who came to Chubb almost direct from tropical Panama jungles. There he had spent five months with a National Geographic Society-Smithsonian Institution Expedition.

Land of Seven-week Summer

And, mind you, the weather conditions we encountered represented crateriand's summer at its best. Winter's ice does not leave this region until mid-July. Even before the end of August increasingly heavy fogs were rolling in on us from Hudson Strait, sealing off the barrens from air transport for days at a time. Such weather explains why we had to confine our work to this so-called "open period." Even then, one can expect to face the vanguard of winter snow before leaving.

In this cold emptiness birds were the only form of animal life we saw in any variety. Among those identified were snow buntings,

American pipits, northern horned larks, Lapland longspurs, sandpipers, semipalmated plovers, golden plovers, herring gulls, Arctic terns, common loons, red-throated loons, duck hawks, and a lone eagle. But even bird life seemed very scarce.

Four-footed animals were an extreme rarity. We saw only three. One was a lemming, and Len Cowan pounced on it to provide the expedition with its lone specimen of the rodent family. We also spotted two Arctic foxes and shot both. Nothing else was taken. Scores of small traps were kept baited, but we always found them empty.

An explanation of the marked scarcity of animal life may be that many Arctic species are subject periodically to unexplained fluctuations in population. It happened, as I learned later, that 1951 was a year of sharp decline for these creatures of the Far North.

One day we found, near the crater, the remains of some Eskimo campsites. They probably were about a century old, a reminder of the long-vanished days when big caribou herds made good hunting in these parts (page 25).

Nightmare Descent to Lake

Canoeing on crater lake sounds as if it might have been the expedition's easiest assignment. It wasn't. First of all, the canoe and all research equipment had to be carried to the lake, not forgetting an outboard motor, gasoline, and other items (pages 28-29).

Nick and Fred did this punishing job. They set out early a few days after our arrival, one burdened with a 105-pound canoe, the other packing a large aluminum winch that weighed 75 pounds, including 1,500 feet of stainless-steel cable on its drum.

Their way led through the treacherous fields of shattered gray and white granite. The going was so laborious that every 10 or 15 minutes the men were forced to stop and rest. Then they'd swap loads and push on.

It took hours to reach the crater's rim. There they faced the most dangerous part of their trip—the descent. For the first 100 feet down from the top, the incline is relatively gentle, but the final 300 feet has a pitch of 40° to 45°.

This descent was a nightmare obstacle course, for the slope was of rocks ranging in size from a foot to 10 feet high, intermixed with small patches of loose fragments made to order for starting a boulder avalanche.

The man carrying the winch dropped his load and served as eyes for the teammate walking almost blind with the canoe over his head. With utmost care the pathfinder picked a reasonably safe path down the hazardous slope for his partner. After an extremely slow and cautious passage the canoe at last was set down upon the lake's waters.

This represented a whole day's work; by the time Fred and Nick got their aching muscles back to camp it was evening, however bright the sleepless sun might be above.

The next day the two iron men put on a repeat performance, packing the outboard motor, tins of gasoline, and equipment to the lake over the same wearisome trail.

Originally we had intended to use both expedition canoes in the crater. However, the difficulties involved in getting one canoe there safely were so great that I decided to assign the second craft to Museum Lake at once for the research work we had planned to do there later.

Ironically, after all the labor and luck it took to get a canoe to the crater, the sunken lake knew only two days during our entire stay when its surface was calm enough to permit sounding work and other research at any distance from the shore. Winds seemed to get on a merry-go-round down in the basinlike crater. As a result, the lake surface was invariably troubled or choppy.

Long John Keefe and Len Cowan, painstakingly occupied with their instruments on the crater rim, also found progress discouraging. Sometimes rain or snow made the rim's boulders too dangerously slippery for work. Even in fair weather magnetic storms plagued their operation by rendering magnetometer readings valueless. An added discouragement was the failure of the mine detectors to be of any value in finding meteoritic material. They "sang" almost continuously in the boulder field because virtually all the rocks contained traces of terrestrial metallic minerals.

The days were slipping by inexorably, and expedition results still remained on the slim side, even counting the two Arctic foxes and the lone lemming.

"Crater Calling!"

I know amateur radio operators are proud to refer to themselves as "hams." In my case the word has a special connotation.

By far the heaviest single item we had brought with us was a radio transceiver borrowed from Canadian Army Signals. No one else in the party professed knowledge of radio, so I volunteered as operator of this transmitting-receiving device, aided by some preliminary instruction from experts. I made copious notes on what each tutor told me and was able to work the instrument without trouble in a test run at Roberval.

After we had camp properly organized, I decided one night it was time for the expedition's radioman to demonstrate his talent. The antenna system already had been rigged

Cribbage Games Whiled Away Evening Hours in the Warm Cook Tent
Cards and books offered diversion. Nobody was tempted to play for money; all cash was left behind. Here Mr. Martin and Dr. Meen, lacking a table, face the cards on knees while Mr. Chubb looks on.

to the 25-foot collapsible aluminum poles, which also did duty as flagstaffs.

With some misgivings I pressed the switches and began tuning. The instructions I had taken down from my tutors were at my elbow. I quickly picked up a station on Baffin Island talking to Goose Bay, Labrador.

My expectations soared. Crater land was going on the air! I set the transmitter for our frequency, pressed the microphone switch, and sent out my call. It was in a surprisingly quavery voice.

I waited. No answer.

All evening at intervals I kept repeating the call. No answer.

Cut off from Outside World

With minor variations, the tragedy of Meen at the microphone was reenacted night after night. No matter how often I checked over my notes and four guide manuals, the result was always the same. My calls failed to bring any reply.

At first the radio was set up under an awning outside the cook tent. When the temperature began dropping lower in the second half of our stay, I moved it into the kitchen. The change of location made no difference.

The radio's failure (or was it mine?) filled me with an abiding uneasiness. What if an emergency should occur, serious illness, a bad accident? We had no way of reaching the outside world to summon speedy aid.

As our third week in the field lengthened and my radio calls still brought no results, my concern increased.

Quite apart from our radio problem, camp life had other ups and downs. Our first site, at the west end of Museum Lake, had been selected because of its convenience to the areas of our initial operations. It enjoyed no protection from the never-ending wind, but at first I thought it would be satisfactory.

Sometime later, however, two days of extremely powerful wind changed my mind for me. The gale lashed the camp hard and steadily, diminishing only slightly the first night.

On the second night its fury increased, and with it came snow. At 2 o'clock in the morning I heard Nick and Fred out checking the guy ropes of their tent and its neighbor.

An hour later the wind velocity was so great that the Meen-Stewart tent began to take off. I hurried out and got it moored more securely. I also lowered the antenna to ease

the strain on the aluminum masts, which flailed about like buggy whips. It was a shivering, worried expedition leader who crawled back into his sleeping robe.

The next morning, in casual understatement, Dick Stewart remarked he hadn't slept much. I inquired what he had been thinking about.

"I just lay here and prayed," he replied solemnly.

"What do you think I was doing?" I said. He didn't have to ask.

Canoe Blown Like Chip

When I went outside I found that the 105-pound canoe, which the night before had been parked snugly against our tent wall, had been blown some 50 feet away, turning over several times in the trip.

In a couple of days the winds subsided to something like erratic normal, and we shifted camp across to the east end of our lake. Everyone felt better after tents were pitched behind the shelter of a seven-foot sand dune.

Judged by Far North standards, our camp was reasonably comfortable throughout our time in the field, despite the exposed location of the first site.

Having some experience in the wilderness, I am inclined to scorn chairs as excess baggage. However, the Arctic is different. The ground is cold and damp, and the rocks bestrewing our camp areas were far from comfortably upholstered.

The four-pound aluminum folding chairs we took along probably would look more at home on the sands at Miami or Atlantic City than they did in the bleak wastelands. But they proved more worth while per ounce than anything else we brought with us.

We slept on collapsible cots with spring-steel frames. Some of us rested well on them, but others complained that, with the cots a bare three inches off the ground, dampness would seep up even through the warm thickness of heavy sleeping robes. Our few spare evening hours were spent in reading, playing cribbage for no stakes (page 19), or working over specimens collected during the day.

Crater More than Two Miles Wide

One satisfying development was that we finally logged the dimensions of our uncooperative subject. Chubb Crater, so surveys established, has a rim-to-rim diameter of 11,500 feet and a circumference of 6.8 miles.

The lake in the crater bowl averages 9,100 feet in diameter. The shore line measures 5.4 miles around, and soundings showed the greatest depth of water to be 825 feet.

Before we obtained final sounding data we already knew that the highest point on the lopsided rim was 500 feet above the lake surface. Now we double-checked figures and were jubilant that our crater had a maximum depth of 1,325 feet, unprecedented if we could establish that it was meteoritic in origin.

To get accurate measurements of the lake's depth, Fred and Nick outdid the most eager of beavers in the way they toiled on the only two calm days to come their way. Their task was laborious and exacting. The weighted sounding cable had to be lowered repeatedly until it hit bottom, and the various locations had to be precisely plotted (page 30).

The lake's waters are remarkably clear. Tests proved it was possible to see an object suspended 115 feet below the surface, even in less than ideal weather (page 29).

This crater lake also presented us with a fish puzzle, still unsolved. We took from its waters a number of misshapen Arctic char, a fish of the trout family. They had grotesque heads, far more developed than their soft, spongy bodies (page 15).

Melting snow and ice can explain why Chubb boasts a deep lake. But how did the char get into its waters?

Still more baffling is how the fish have survived, for study of lake water proved it deficient in the minute plankton organisms on which fish feed (page 31).

Magnetometer Probes in Vain

On the crater rim overlooking the lake, Long John Keefe and Len Cowan pressed their magnetometer survey with the zeal of the perfectionists they were (page 31). The search, however, was still no more productive than my nightly radio calls. If a meteorite mass existed somewhere under the crater lip, it, too, was giving no answer that could be detected by delicate instruments.

On August 14 a Norseman plane dropped unheralded from the sky and disrupted our routine (page 7). Aboard were Dr. Jacques Rousseau, director of Montreal's Botanical Garden, and Dr. J. W. Jones, chief geologist of the Department of Mines of Quebec, who had been doing field work in northern Ungava. Malcolm Ritchie, Dr. Jones's assistant, Dr. Rousseau's son François, René Richard, artist-prospector, and the plane's crew.

These unexpected visitors brought us news and a bundle of mail from home. Their welcome could not have been warmer.

Tramping along the crater rim with Dr. Jones, I poured out the story of the expedition's work to date (page 27). I told him of our disappointment over the failure to find evidence of a buried meteorite, how my search for meteoritic particles likewise had been fruitless, and how I regretted that only small portions of the vast plain could be covered in this hunt.

Throughout our survey tour Dr. Jones made his geological observations, which led him to favor a meteoritic origin as the explanation for the crater. His opinion gave me a lift, for I hold his scientific ability in high esteem.

In the course of our talks the subject of radio cropped up. Dr. Jones said the Fort McKenzie station, 350 miles to the southeast, had called us nightly and listened for our signals. I took this as confirming my suspicions that something was wrong with the set, not with Meen, perhaps because of some unnoticed damage to it in transit.

We bid our guests Godspeed the next day, and that night came the miracle which made their visit an omen of good luck in my mind.

I was at the radio and heard Fort McKenzie trying in vain to raise another station. I gave the operator plenty of time, then on some strange impulse tried to butt in.

Your stunned expedition leader almost fell from his chair when McKenzie promptly answered, saying he could get my transmitter's carrier wave, but *no voice!*

This temperamental transceiver—what was it doing? I was at a loss as to what I should try next. For no reason at all I pressed switches cutting in our two microphones at once and blurted out our call letters.

Happy Fugitive from the Razor: Photographer Dick Stewart

No one shaved; beards offered protection against cold, wind burn, and occasional mosquitoes. Month-old whiskers disappeared on return to Roberval, where a dollar still bought both shave and haircut.

Radio Contact at Last

"You wouldn't be the crater, would you?" McKenzie's operator inquired.

Would I be the crater? *Would I!*

The shout of "*Yes*" I hurled back across the ether must have set the other chap's ears ringing. I felt as if only 350 inches separated us instead of 350 miles, and wanted to run right over and shake hands.

I still don't know why the set operated with two "mikes" cut in, but went dumb when I used only one. However, it performed flawlessly for me during our remaining week. We were in daily contact with the outside.

Our luck with the radio failed to bring any corresponding change in our fortunes in the field. Days dwindled. Friday, August 17, arrived.

The camp awoke to foul weather, snow squalls, and rain. I had planned to send someone up to the crater early to give the magnetometer team the bad news: their futile search was to cease by noon the next day so that they could return to base and pack up for our departure Monday. The weather, however, made any trip to the rim foolhardy.

Conditions improved greatly by midday; so I had Stewart and Martin set out on the

12

A U. S. Army Mine Detector Hunts Meteorite Needles in Ungava's Rocky Haystack

This instrument, resembling a stove lid on an elongated litter, was expected to track down nonterrestrial particles, but earth-born metallic minerals, found in flaky abundance, kept amplifiers "singing" confusingly (page 18). On a nonmetallic terrain, only meteorite fragments would have "rung the bell."

errand. I insisted two go because the boulders still looked slippery, and I wanted immediate help at hand in case one man got hurt. Bad weather returned with a vengeance a short time after they left. As the day dragged on, my anxiety mounted. Not until 7:30 did they make it back to camp. Heavy snow squalls had forced them to seek shelter repeatedly under large boulders.

But they brought great news. "The boys said to tell you they think they are on the right trail at last," Dick reported.

Last Chance to Solve the Riddle

This terse report sent my hopes soaring. The section which the boys were then working would be a likely spot for discovering proof of a buried meteoritic mass, or a concentration of exploded fragments.

My elation soon began ebbing. What the boys thought might be wishful thinking, sired by last-minute desperation. Even if they were right, there was insufficient time left for the work necessary to establish adequate positive evidence. If only we had an extra 24 hours or so at our disposal. My disappointment returned, sharpened by the feeling of being cheated by clock, calendar, and weather.

Chubb Crater had never witnessed anything like the feverish efforts put forth on its east rim that Saturday and Sunday.

"Doc! Doc! I've got it!"

Exultant and almost beside himself with excitement, Keefe came striding up to me on Sunday.

"I've found the anomaly," he said. "But I need more time to study it. How much longer have I got?"

23

Fish Pop into Cellophane Kimonos as the Expedition Packs for Airlift Home

Any fish of special interest were preserved in formaldehyde for laboratory work in Toronto. Only scales and stomach contents were retained from other specimens. Mr. Martin packs this fish while Dr. Meen watches. The char on the box is one of Chubb lake's malformed inhabitants (page 15).

It was already evening. Our plane was due tomorrow.

John did have the information we had hunted so long. At least he had some of the information—that a magnetic anomaly existed. This scientific term means a difference in the earth's magnetic force at a given point or area, caused by a foreign subsurface mass. The presence of such an anomaly in the glacier-scoured, granitic crater region could mean the east rim held portions of a buried meteorite. A similar magnetic anomaly exists at Arizona's Meteor Crater, and is the next best thing to actual recovery of meteoritic material.

Ill Wind Blows Good

As yet we had no data on the size of the area the anomaly covered, as well as a number of other things it was important to know. It was hard to contemplate going back tomorrow without all we wanted.

Then bad weather intervened overnight to give us more time. For once we were grateful for a storm.

That next morning sleet squalls chased snow squalls down Museum Lake, sometimes blotting out all visibility. No amphibian could come in through that kind of weather! The squalls continued all day. Occasionally the sun intervened brightly and dried things up, but wind-lashed Museum Lake was much too rough for a landing.

The boys went scrambling back to the crater at an early hour, but I had to remain behind. The radio required constant monitoring in case the expected inquiry on weather conditions came in from our amphibian.

To borrow an expression from World War

If slung, I "sweated out" those hours at the transceiver, and for two good reasons. One was that I wanted news of the plane. The second was that the radio showed we were in the midst of a magnetic storm which would play havoc with magnetometer readings on that all-important portion of the east rim. Radio reception could not have been worse.

About 5 o'clock the magnetic storm passed and reception became crystal-clear. Soon Fort McKenzie came on the air to announce:

"The Canso is here!"

That was the first information I had of the whereabouts of the big flying boat, which had been delayed 24 hours in attempting to reach Museum Lake Monday, as previously scheduled. I chatted with Captain Allard across the 350 miles and promised to provide him with weather reports in the morning for the last leg of his flight to our camp.

Then came the climax of the day and the entire expedition.

At 9 o'clock Keefe and Cowan staggered into camp, almost spent with fatigue. Their happy faces told the story.

Last-minute Success

Between 5 o'clock and 7:30 they had run the magnetometer over the close grid of stations which they had prepared in the morning. The survey had defined the anomaly we had hoped would be there.

Positive evidence at last! The anomaly indicated an area elliptical in shape and elongated east-west between the two highest peaks on the crater's rim. From the shape of the underground mass and the character of the magnetometer readings, it is highly improbable that it can be any ordinary body of rock. The most likely explanation, I believe, is that here lies a concentration of fragments from the exploded meteorite which were hurled forward with tremendous force and buried deep in the granite of the rim.

Besides our positive evidence from the magnetometer survey, we had accumulated an impressive store of negative evidence, invaluable in eliminating other known natural causes as the agents responsible for the crater's origin. There is ironclad proof that volcanic action was not involved; the rim and corrugated barrens are definitely not explained by any rain of debris from a volcano.

Everything points to the fact that a terrific blast raised the whole region bodily. The action of advancing and retreating glaciers would not produce such an effect, nor leave such a symmetrical rim protruding in the wastelands. Subterranean erosion likewise fails to account for our geological phenomenon.

Even before we obtained our magnetometer evidence, the process of elimination systematically scrapped these alternate theories.

Someday eventually someone may find meteoritic fragments or droplets on the surface of Chubb's wide, encircling plain. Until then we must rely on the weight of the magnetometer evidence, the striking similarity of the crater to other proven meteorite scars, and the overwhelming absence of geological clues that Chubb could have had any other origin.

Meanwhile, I am quite satisfied that the expedition achieved what it set out to do.

Tuesday morning at 8, our incoming Canso reported by radio. Captain Allard's voice sounded crisply from the receiver.

"Doc, the crater's in sight. We'll be down in 15 minutes."

Craterland Hostile to the End

As good as home, we thought. Or almost as good.

But we reckoned without this hostile land. It evidently was determined to extort a last full measure of toil, sweat, and irritation before letting us go.

A high north wind was blowing as the amphibian came in. Off our campsite the lake was so rough that the pilot dared not venture too close inshore for fear of holing his hull on the rocks. He anchored some distance out. Our canoes would have been swamped if we had attempted to ferry all our gear out that far, battling extremely choppy water and the wind.

Captain Allard sought a more sheltered spot. Irony of ironies, he found one in a cove close to the original campsite we had quit 10 days before because it was so windy.

All day the six of us, reinforced by Captain Allard and one of his crew, portaged our equipment two miles over the boulders in trip after trip to the protected beach from which it was ferried out to the flying boat.

The weather record for the past week, fog, rain, snow, sleet, was so bad that the pilot and I agreed we must take off by evening and head south. To speed departure, some equipment was abandoned in a cache on the shore.

At 6 p.m. the last bag came aboard. Quickly the canoes were hauled in and disassembled. The engines roared, the Canso climbed up off Museum Lake, banked gracefully, and pointed its nose south.

Our thoughts were already on the comforts of civilization to which we were returning, but our eyes were held by the stark beauty of Chubb until it was lost in the retreating wastelands. Monarch of all the known meteorite craters in the world, it had given us a bad time until almost the end. All agreed, however, that its challenge was more than worthy of the expedition's best efforts.

An Eskimo Kilroy Camped Here a Century Ago

Good hunting or fishing, not spectacular scenery, was the Eskimos' goal. When caribou disappeared from this area, the hunters moved away too, leaving flint and bone implements examined here by crater explorers.

Rock Roof and Crumbled Walls Mark a Once-snug Shelter

Many Eskimo hunters made use of overhanging rocks as roofs for their lodges. One of these rude huts boasted the comfort of two fireplaces. Skin tents, anchored by stones, protected other nomads from wind and cold

Kodachrome by Richard H. Stewart and Nigel Marvin

Restless Breezes Ruffle Crater Lake; Its Blue Is Rarely at Rest

♣ Across the lake rises the crater's highest point, a 500-foot eminence. Between this peak and the snow patches lies the draw where the scientists at the 11th hour found their magnetometer evidence of the crater's meteoritic origin.

Boulders Tumbled by the Meteor's Explosion Make a Lumpy Picnic Ground

♀ Expedition members, lolling on granite, enjoy lunch. Their sandy garb was not chosen for style. Dark clothing melted so naturally into the camouflagelike background that men lacking Kodachrome shirts or hats were easily lost to view, even from a few hundred yards.

Kodachrome by Richard H. Stewart

Kodachromes by Richard H. Stewart

Not an Animal Is Visible: Chubb Lake Spends Its Beauty on a Wilderness

Dr. Mean (pointing) discusses progress with Dr. J. W. Jones, Quebec Province geologist. The site has been visited by only one other geologist, Malcolm Ritchie, an aide to Dr. Jones. Low clouds usually roof the Chubb area.

Crunch of Boots on Snow, Tang of Cool July Air Stimulate Crater Visitors

Soon after the expedition's arrival, keenly interested crewmen of the amphibian which flew the party to its camp-site came along with their passengers to inspect the big scar close up. The kneeling airman has snowballs on his mind. Museum Lake merges into the sky line.


NATIONAL GEOGRAPHIC
SOCIETY

Few Explorers of Pioneering Days Faced Rougher Going

It took brawn and endurance to move the National Geographic Society's canoe from the Museum Lake camp to the crater. Boots took a terrific beating.

↑ Most ticklish part of the trek was making a way down the precipitous inner rim of the crater. Its grades were as steep as 45°; rock slides were a constant hazard.

← Fred Chubb, packing a 75-pound winch to sound the lake bottom, leads the way through jagged rocks. Nigel Martin follows with the 105-pound canoe. Below: They halt every 15 minutes to rest and exchange loads.

→ Mr. Martin, a marine biologist, prepares a Secchi disc to test the clarity of the crater's water. The disc could be seen 115 feet down, proving the lake one of the clearest known.

↓ Canoe party appears to be at water's edge. Actually it is just below Chubb's rim, almost 400 feet above the lake.

  Reconstructions by Richard H. Stewart

Chubb's Secrets Are Hunted on Lake and Rim

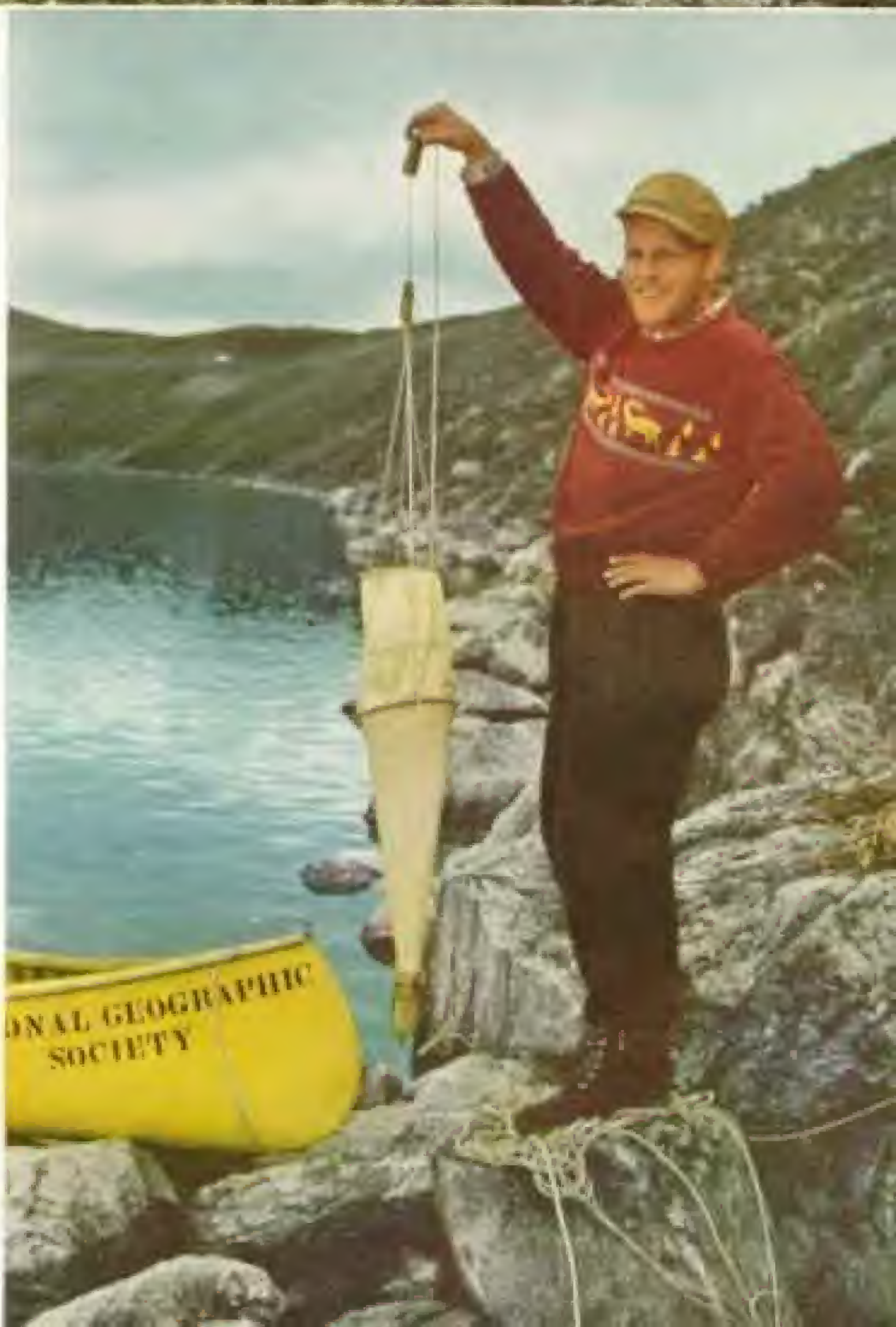
↑ Painstakingly the magnetometer survey team scours the blustery crater edge for readings that might hint at a buried meteorite.

← Down on the lake, green marker dye is released to trace any water which might be seeping to satellite lakes fringing the crater's slopes. No hidden outlet was discovered, however. Submerged rocks inshore are visible under 20 feet of crystal water. The temperature of the crater lake was 36.5° F.—much too chilly to encourage swimming. Soundings showed the lake's bottom to be 825 feet down at its deepest. The aluminum winch for sounding carried 1,300 feet of stainless-steel cable.

A churning paddle (seen in lower picture) spreads green dye over wide surface areas.

→ In another research field, tow nets were plied in lake waters for plankton, minute organisms which furnish fish with basic food. Mr. Martin's haul of these tiny forms indicated a plankton population inadequate to support healthy fish life. Some plankton are animal in nature, others vegetable.

Illustrations by Richard H. Stewart



Kodachrome by Richard H. Stewart

↑ What the Well-dressed Man Wears in the Frosty Arctic

Messrs. Chubb, Meen, and Martin model the stout parkas decreed by fashion for the Far North. Not shown: the heavy shirts, thick socks, and wool underwear that go with the trim ensemble.

↓ Dick Stewart, Photographer-Chef, Cooks With Gas

Because the wasteland was bare of fuel, all cooking had to be done with low-octane aviation gasoline. Mr. Stewart (right) served as cook throughout; Mr. Chubb often helped him. Dehydrated foods were a mainstay.

Kodachrome by Richard H. Stewart and V. Don Meen

America's "Meat on the Hoof"

Because Housewives Want Smaller Beef Roasts, Bigger and Leaner Pork Chops, Scientific Breeders Remodel the Steer and Hog

By William H. Nicholas

WHEN the American housewife steps into a meat market to buy a steak, rib roast, pork loin, or lamb chops, she is conducting the final transaction in an astonishing 10-billion-dollar-a-year business maze—meat.

To see a cross section of America's "meat on the hoof" eventually destined for the Nation's dinner tables, I visited ranches, farms, stockyards, and agricultural experiment stations in 26 States; talked to the aristocrats of the livestock-breeding world, the raisers of purebred cattle, sheep, and hogs; and looked in at the premier gathering place of the country's finest meat animals, the International Live Stock Exposition in Chicago.

Meat Leading National Industry

Over the last decade, I found, meat has never ranked lower than third, and frequently has stood first, among America's industries in dollar value of its products.

Increased prices for meat, shortages, and Federal controls make headlines in the Nation's newspapers. But the housewife goes on spending about the same proportion of her family budget for meat under nearly all circumstances.

The American Meat Institute in Chicago keeps charts, based on Government figures, showing factory payrolls in the United States over the last 50 years—in times of depression, in so-called normal times, and in times of inflation. With them are other charts showing how much has been spent for meat and meat products.

Each year, except in the war years when black-market operations could not be computed, figures show that the average household expenditure for meat has stood at about 5½ to 6 percent of total take-home pay whether the housewife has had an average of $20 or $100 available weekly for food.

Even more important to the men who raise the Nation's meat on the hoof is the fact that women's preference for certain cuts of meat determines basically just how this huge industry is to be operated.

For example, in recent years demand for smaller rib roasts set in action a chain of events involving extensive experimentation among breeders in "redesigning" the humble steer to meet the housewife's wishes.

As a first step, the retail butcher tries to buy from the Nation's 4,000 packers the cuts of meat women ask for. The packers buy livestock from some 5,000,000 farms and ranches, paying to them about 30 percent of the country's total farm income. The packers try to buy from the raisers animals which will yield the cuts the housewife wants.

Generally, cattle raisers now concentrate on producing medium-sized animals, rather than huge ones or small, "compact" types.

Texas First in Beef Cattle

Texas continues to outstrip every other State in raising beef cattle. Of America's 60 million head on farms and ranches last year, 8,000,000 grazed in the Lone Star State. Iowa ranked second, with about 4,000,000 head, but thousands of steers in its feed lots were calved in the range States and shipped in at weaning time or later to fatten on corn and grain.

The Pacific Coast States no longer ship meat to the East. Their population has grown so fast in recent years that instead they are importing more and more cattle from other States to help fill their own demand.

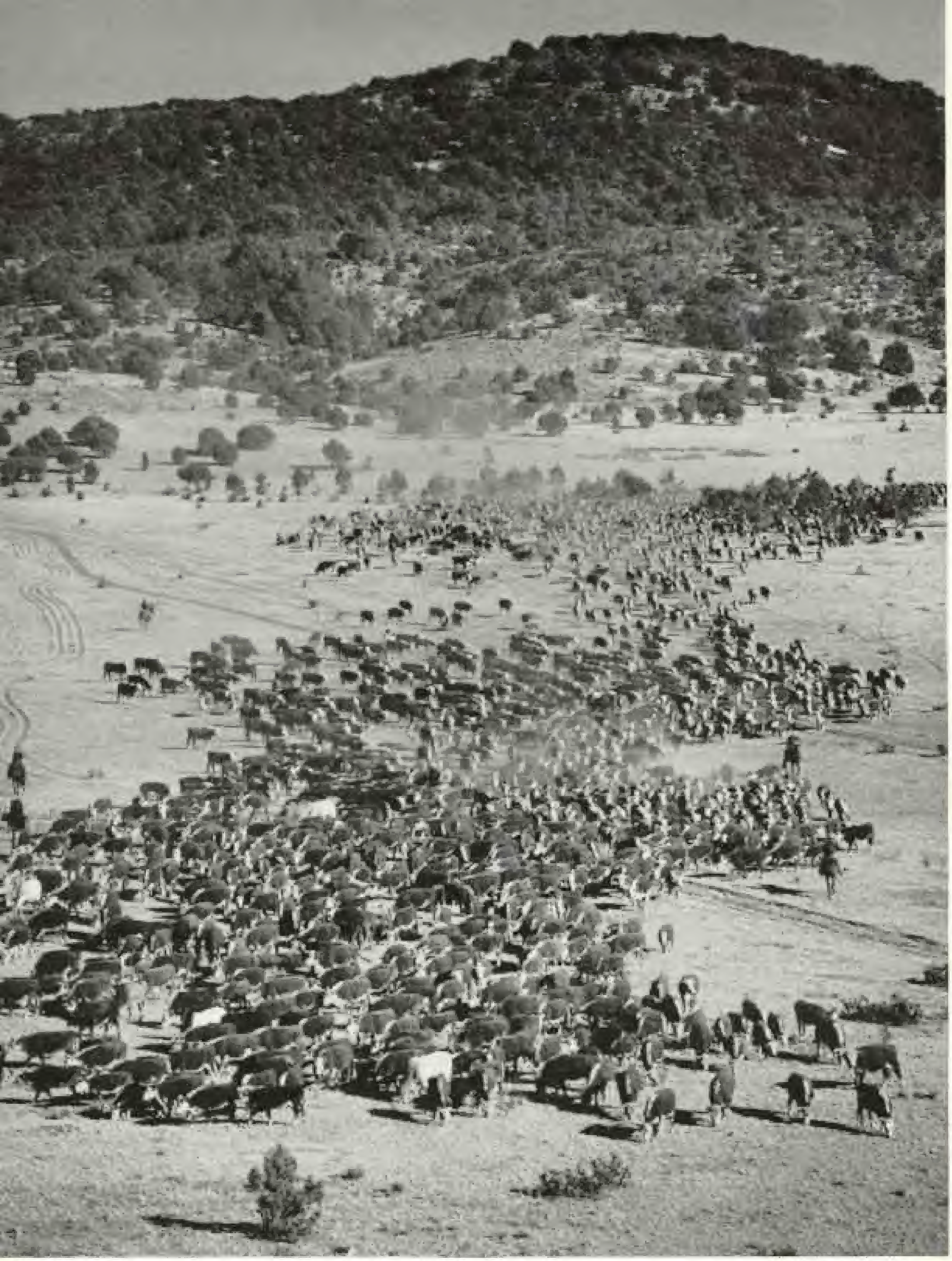
The South has become important in beef production. In 1951, southern States all showed gains in cattle population, ranging from 8 to 11 percent. As I drove through Florida and along the Gulf Coast, I had only to look about me to see how Brahman cattle from India had established themselves in those humid areas (page 51).

Interest in purebred cattle has reached fever proportions. In December, 1950, Dr. Armand Hammer, owner of Shadow Isle Farm, at Red Bank, New Jersey, paid $100,000 for an 8-year-old Aberdeen-Angus bull, Prince Eric of Sunbeam (page 53). A. H. Karpe, of Bakersfield, California, paid $87,500 for a Hereford herd sire, Baca Prince Domino XX, in September, 1951. Fabulous new figures make price records short-lived.

"How can a bull be worth so much money?" many a rancher asks.

Purebred cattle raisers have a ready answer. In November, 1949, Mr. Karpe paid $65,000 for Baca Duke 2d, a Hereford bull. Fourteen months later one of his calves, just a week old, sold for $7,500. Forty-seven heifers bred to Baca Duke 2d were sold in a one-day auction for $113,223, averaging $2,409 a head. Thus, at one sale, Mr. Karpe more than paid for his high-priced bull!

Sheep, which had declined in numbers from



Roundup in Arizona! More than 2,500 Steers Start the Long Trek to Market

These Brahmans, Herefords, and crossbreds were raised by the Diamond-A Ranch near Seligman on the high plateau bordering the Grand Canyon. Like 60 percent of the continental United States, the region is covered with grass. Basis of America's meat industry is conversion of this grass into beef and mutton. Two-thirds of our grasslands are privately owned. The remainder, in dry and mountainous parts of the West, belongs to the Nation.

50 million head in 1944 to only 30½ million in 1950, finally increased slightly last year. But with ranchers holding many head off the market for breeding stock, the shortage of lamb and mutton remained acute. Good mutton chops, as a result, are almost a rarity today.

At the time of the Civil War there were more sheep than people in the United States. Today there are five people for every sheep.

In recent years lard became a drug on the market. Many housewives used vegetable shortening instead. So hog raisers and agricultural experiment stations collaborated in producing lean swine. But since the Korean war, with prices rising, lard has suddenly become valuable again, to the wonderment of raisers.

Desirable market weight for a hog still is low—about 225 pounds. Large hogs do not bring as much money per pound. The largest ever sold in the Chicago stockyards was a 1,402-pound Poland China in 1928.

Last year the Nation's hog population was the third largest in our history.

Meat from the Milk Belt

With a group of eastern writers, economists, and businessmen I made a flying trip at the invitation of Armour and Company, the Chicago packers, to see typical livestock raising, marketing, and experimentation at close range in eight western States.

At St. Paul, Minnesota, we soon saw an example of the huge contribution that dairy breeds make to the meat industry.

The St. Paul stockyards, sometimes inundated when the upper Mississippi goes on a rampage, is America's largest calf market. Nearly all the calves crowding the pens were Holsteins or Guernseys or other dairy animals, surplus stock of the farmers in that vast "milk and butter" region. Usually it is uneconomical to slaughter beef-breed calves, since they are much more valuable when fattened later; hence the bulk of the country's veal comes from dairy calves.

In other pens stood milch cows which had out lived their usefulness as producers. Destined to be graded as "canners and cutters," they would end up as canned and ground meats. Old dairy bulls awaited the same fate.

Other enclosures held a better grade of meat animal—younger dairy cows, also in good health but useless to the farmer because they did not produce sufficient milk, or did not calve, or were otherwise uneconomical in his herd.

In many localities as much as 20 percent of the income of the dairy farmer comes from sale of his animals as meat.

At the University of Minnesota, in the Twin Cities of St. Paul and Minneapolis, we talked with men who have contributed two new breeds of hog to the Nation—Minnesota No. 1 and Minnesota No. 2. Methods used in their development, principally of intensive inbreeding, were patterned after those of the hybrid seed corn breeder!

Minnesota's Two New Hogs

The basic cross in arriving at Minnesota No. 1 was made in 1936 by breeding Danish Landrace hogs, famed for meat superiority, with British Tamworths, noted for ability to bear and rear large litters. After a few litters from this cross the purebred Landraces and Tamworths were discarded, and from then on the remaining stock was inbred.

By continuous careful selection the breed was established in 10 years. Now it is thriving throughout the Midwest, producing large, healthy litters which gain weight rapidly and economically and develop a longer carcass and lean bacon and ham, the primary objectives sought.

Minnesota No. 2 was developed along the same scientific lines from an original Poland China-Yorkshire crossbred foundation in seven years. This is in striking contrast to the 50 to 100 years which were required to develop, by selection for type and quality, the older breeds of hogs in general use in the country today.

The Minnesota experiments are part of the Regional Swine Breeding program sponsored by the U. S. Department of Agriculture and participated in by a dozen Midwest agricultural colleges. Hog raisers all over the country are interested in them. How to produce lean bacon and less lard is one vital question.

But the problems of farrowing, saving, and raising the little pigs bulk even larger—one-third of all pigs born in the United States die before they are weaned! Lowering that mortality rate would mean millions of dollars more for our hog farmers.

Hog Aristocrats of Exotic Ancestry

Our three most widely distributed breeds of hog were developed in America: Poland Chinas along the Miami and Little Miami Rivers in Ohio, red Durocs in New York and New Jersey, and Chester Whites in Pennsylvania and Ohio. They come from crosses of the best imported blood available, not only from English swine but from hogs brought in from the Guinea coast of Africa by slave traders, and from China by Salem and Boston sea captains. Also popular today is the Hampshire, a black hog belted white.

Minnesota has under way an inbreeding project with Shropshire sheep, but this pro-

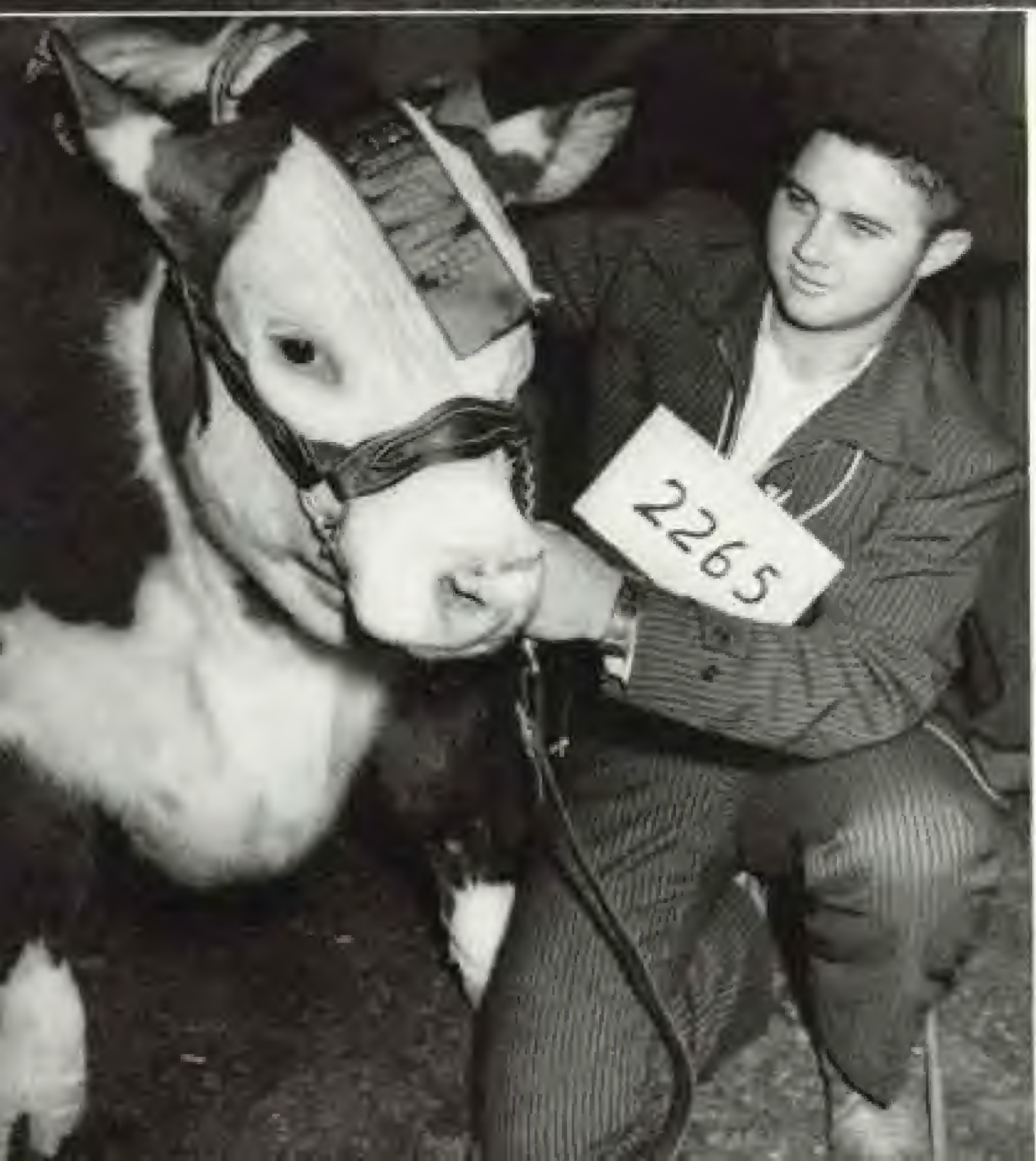
12,000 Head of Cattle Fatten in Warren Montfort Feed Lots near Greeley, Colorado

Grain-fattened steers produce the finest steaks, identified by the marbling effect of streaks of white fat. Thousands of feed lots dot the country, but few are larger than the Warren Montfort operation.

37 Tyne C. Wilson

Four Months on Corn and Alfalfa Change Spare, Grass-fed Cattle to Juicy Beef

Irrigated fields surrounding these pens in South Platte River Valley yield beets, potatoes, barley, and alfalfa. The alfalfa moves directly to the lots' mixing rooms; other crops are sold. Corn is trucked in from Nebraska.



★ Star Picture VI: Top Hereford Bull in America for 1950

Dr. Jess C. Andrew (left), president of Chicago's International Live Stock Exposition, presents the Grand Champion Hereford bull trophy to Robert Lazear, of the Wyoming Hereford Ranch (page 51).

First-generation bulls from that ranch have sired animals which produced 14,000,000 pounds of beef in one year, according to the owners' estimate.

★ Big Spring Special Sold for $12 a Pound

Lloyd Robinson, 19-year-old ranch boy from Big Spring, Texas, won the coveted Grand Champion Steer prize at the 1950 International Live Stock Exposition with this 1,025-pound Hereford. A hotel chain paid $12,300 for the blue-ribbon winner at auction, then served the beef to patrons of its dining rooms.

National Geographic Photographer B. Anthony Stewart

Catering to the Housewife's Taste: Prime Aim of a 10-Billion-Dollar Industry

The American housewife sets livestock fashions, for cattlemen breed animals to yield the cuts that appeal to her (page 53). At 7:30 a. m. meat cutters in this supermarket began to trim, package, and price meats for the refrigerated display counters. By 9 a. m. opening, customers could help themselves without standing in line. This purchaser, who wanted an extra-thick steak, rang a bell to get special service.

ceeds more slowly. Sheep produce only one or two young at a time instead of litters, reach sexual maturity later, and breed once a year compared to twice for swine.

This last factor has been the subject of experimentation sponsored by Armour and Company. Hormone injections have been given to ewes in an effort to force them to breed twice a year. Results thus far, the experimenters report, have been extremely promising.

With Fargo, North Dakota, as headquarters, we set out on a tour of farms in the rich Red River Valley to study trends toward balanced farming in that area. North Dakota farmers are not large livestock operators (grain still is the foremost crop), but on the great majority of farms animals are raised.*

Small herds are not unusual. In Iowa, largest feeder cattle State, few farmers fatten more than 70 head of cattle, but there are 200,000 thus engaged.

Each year some 300,000 feeder cattle go from North Dakota to markets where they are bought by Corn Belt cattlemen for further fattening in their feed lots.

Roland and Charles Brandt operate a typical Red River Valley farm of 1,040 acres near Fargo. They escorted us about the broad

* See "North Dakota Comes into Its Own," by Leo A. Borah, National Geographic Magazine, September, 1951.

fields and gave us a summary of their annual crop production—potatoes, onions, wheat, barley, flax, sugar beets, and alfalfa. They balance these operations by raising a Minnesota-pattern crossbred pig and by winter-feeding lambs.

"We have been producing an average of 280 spring pigs in the last few years," they told us. "Our father was one of the first farmers in the Red River Valley to fatten western feeding lambs, and we sort of inherited this business from him. It always shows a nice profit. It utilizes farm hay and feed and gives us a substantial amount of manure to be returned to the soil."

Usually the lambs, up to 2,500 head, are bought in the State of Washington in late fall, fed all winter, and sold off in the spring.

Incidentally, every year at least 10 percent of the net income of the Brandt farm is set aside for church and charity.

On the 1,700-acre farm of Albin and Walter Olson we saw a purebred herd of 250 Herefords. The Olsons decided to balance their grain operations with livestock in 1936, when they bought 14 purebred cows and a purebred bull. From that nucleus they built up their herd. They also feed commercial cattle as one of their regular farming operations.

Only once during this tour of Red River Valley farms were we distracted from cattle, sheep, and swine. This was upon our arrival in the village of Casselton, where our thoughts turned to poultry. There the women of the American Lutheran Church served us a bountiful dinner of fried chicken, true country style.

Experimenters Replace Indian-fighters

Our plane carried us next to Miles City, Montana, where the Range Livestock Experiment Station of the U. S. Department of Agriculture is located, in the heart of the State's range area. The station sprawls over 56,300 acres in an area about 10 miles square, formerly the site of the Fort Keogh Military Reservation of Indian warfare days. Most of the terrain is rough, broken badlands, typical of eastern Montana range country.

Work here centers chiefly on grazing investigations, cattle-feeding tests, beef-cattle breeding, and swine breeding.

The three principal breeds of beef cattle in the United States are Herefords, with their characteristic white faces and red bodies; black Aberdeen-Angus; and Shorthorns, which may be solid red, red with white markings, white, or roan.*

The Hereford, which outnumbers all other beef cattle in the United States and thrives particularly on the western ranges, originated in the valleys of the Severn and the Wye, in the west of England. The breed takes its name from the County of Herefordshire, drained largely by the Wye. The Shorthorn, once well known in the United States as the Durham, came from England's Counties of Yorkshire and Durham. The Aberdeen-Angus, extremely popular today in the East and Middle West, developed in eastern Scotland where Aberdeen, Kincardine, and Angus (Forfar) Counties face the North Sea. In Angus they were familiary called "doddies," and that name often is applied to them by their admirers in the United States.

Meat Production Speeded Up

Research at the Miles City station has demonstrated that selective breeding can establish lines of beef animals that will gain weight rapidly in the feed lot. It can now be safely predicted that a steer sired by a rapidly gaining bull will inherit his weight-gaining characteristics. This basic principle has been used in developing a cooperative beef cattle research project among 35 States and the U. S. Bureau of Animal Industry. The program will make possible quicker production of beef from a given amount of feed and facilities.

Systematic crossbreeding also produces results. Of this year's crop of coming yearling steers at the Bar B Ranch near Ogden, Utah, for example, 389 head of Shorthorn-Hereford crosses averaged 526 pounds, compared with a 492-pound average for 760 head of coming yearlings of one breed.

Our flight from Miles City to Twin Falls, Idaho, gave us an insight into the desperate need of the western range country for water. From the air the irrigated areas stood out boldly in their lush vegetation, giving dramatic evidence of the possibilities inherent in millions of acres of land now barren most of the year or densely covered with sagebrush.

From Twin Falls we drove north to Ketchum, Idaho, in the heart of sheep country. On the way we paused to watch a flock of 1,100 yearlings grazing on alfalfa and to talk with their herder. His dog was by his side, and his canvas-covered wagon stood a short distance away.

The meeting was unusual in the extreme for him. The man just happened to be close to civilization temporarily. Usually a shepherd's life is lonely—his home is his wagon, his only companion his dog, his surroundings the high hills, far from the main highways.

Sheepherding requires special characteristics in a man. Best in the West, say the sheepmen, are the Basques from the Pyrenees.

* See "Taurine World: Cattle and Their Place in the Human Scheme—Wild Types and Modern Breeds in Many Lands," by Alvin Howard Sanders, National Geographic Magazine, December, 1933.

King Ranch, 900,000 Texas Acres, Developed the Famous Santa Gertrudis Breed (Below)

▲ Mrs. Richard Kleberg, Jr., a member of the family which owns the Nation's largest ranch, enjoys the November sun at Norias, a division headquarters of the Gulf Coast estate. Rhode Island could be fitted into King Ranch with room to spare.

▼ Mahogany-colored Santa Gertrudis steers wear the ranch's running-W brand. This man-tailored breed is the established outgrowth of an original cross between meat-producing Shorthorns and fever-resisting Brahmans.

Kodachrome by Justin Locke

Kodachrome by Bonzo Waller

Across a Texas Range Vaqueros Drive a Herd of Silver-gray Brahmans, Descendants of India's Sacred Kine

Brahmans show resistance to ticks, cancer eye, and Texas fever. Unlike the English breeds, they do not run temperatures from exposure to hot sun. This herd was selected for experimental crossings with other breeds to produce calves suited to all-year grass feeding on the blazing Gulf Coast.

Santa Gertrudis, King Ranch's Main Headquarters, Stands Where Richard King in 1853 Began Converting Wilderness into Ranchland

Holding Tight to His Hat, a Cowboy Picks Up a Bootful of Dust as His Pony Leans in a Turn to Cut Off a Steer

The fat yearling tries to rejoin the herd, but the quarter horse heads him off to another "cut" bound for market. In cutting out cattle, a trained pony seldom falls, even in lightning turns. Showing high intelligence, he watches every move of the steer and swiftly charges to head him in the desired direction.

After Eating Spareribs Hot off the Grill (Lower Left), Two Foremen Talk Beef with Their *Patrón*, Robert Kleberg, Jr. (Right)

When it comes to feeding a cowboy, give him plenty of Dutch-oven bread to go with sizzling grilled beef. Here is a stack hot from the pans, while still more bakes on the charcoal fire (upper left). The recipe is simple: mix flour, water, and salt, toss the dough into a grease-varnished pan, and cover with a lid loaded with glowing coals so bread browns evenly. Don't bother to serve; that pile will be gone before you can say "Come and get it." Cook handles the hot lid with a pitchfork.

Kodachromes by Hassell Walker

Reclamation by Howell Walker

Prevailing Winds off the Gulf of Mexico Drive These Sands Inland, Smothering Rich Texas Pastures

King Ranch lays brush fences and fish nets, spreads tons of clay, plants Georgia cane, hardy grasses, and even trees, but the sands still march on.

Rhodes Grass Once Blanketed 30,000 Acres on King Ranch; Then Most of the Stand Fell Victim to a Scale

Robert Kleberg, Sr., introduced this African forage crop on King Ranch 40 years ago. Members of a harvest crew here examine the plant for grass-destroying scale. *Anagyrus antoninae*, a wasp imported from Hawaii, now combats the pest.

Kodachrome by Louis Latta

When School Is Out, King Ranch Youngsters Follow in Their Fathers' Stirrups

Two teachers instruct 46 Mexican-American children in this one-room school, which also serves as a church.

As soon as a boy is able to ride he is taught to knot and handle a rope (right), brand, doctor, and do the many things a full-fledged cowhand must know. Falling heir to the long and rich tradition of the cattle country, he grows up in the business.

After a hard morning in the saddle rounding up cattle on the Laureles division, Juan (left) is happy because he smells beef broiling on the charcoal grill.

For some three-quarters of a century they have herded America's sheep. When immigration laws prohibited their entry into the United States after World War II, a decided shortage of herders developed. Many sheepmen insisted this was the principal reason for the decline in our sheep population. Now that the laws are relaxed for the Basques, ranchers are hopeful of acquiring new herders.

Lambing on the range in midwinter is mostly a thing of the past in the West. Today the flocks are brought in to huge lambing sheds, about the end of February in the Twin Falls region. At the Clyde Bacon ranch between Ketchum and Twin Falls the ewes are driven into a big corral. When the lambs start to arrive, feverish activity marks every hour of day and night. Men attend the ewes, and, when a lamb is born, they immediately place it on a wheelbarrow and start for one of a series of tiny sheltered pens. The mother sheep instinctively follows.

Prime duty of the attendant, once he has reached the pen with his charge, is to see that the lamb begins to suckle. Then, with a belly full of warm milk, and curled up at its mother's side in the shelter of the pen, it is ready to withstand below-zero temperatures, blizzards, sleet, or anything else climatic.

Within 24 hours mother and offspring are moved to a larger enclosure to make room for another ewe and its newborn. By the first of April the flock is ready to return to the range.

Shipping Time Is Hectic

Lamb shipping time is another hectic experience. At Ketchum huge shipping pens have been built alongside a Union Pacific Railroad spur. A flock of ewes and lambs is driven into the main corral. Then, one by one, ewes followed by their lambs go down a narrow passageway with a fork at the end which leads to two enclosures. At the fork is a swinging gate.

As ewes and lambs approach, a keen-eyed, fast-moving sheepman swings the gate back and forth, sending the lambs into one enclosure, the ewes into the other. Then the lambs are led up chutes into double-decker stockcars to go to market; the ewes go back to pasture.

Nine British breeds of sheep (Shropshire, Hampshire, Oxford, Lincoln, Cotswold, Southdown, Cheviot, Dorset, and Suffolk), the French Rambouillet, which is related to the Spanish Merino, and the New Zealand Corriedale are recognized at the International Live Stock Exposition.

This annual classic of the livestock world brings together the Nation's best purebred cattle, sheep, and swine. Under its president, Dr. J. C. Andrew, La Fayette, Indiana breeder of Aberdeen-Angus cattle and Shropshire sheep, it sets purebred livestock standards.

But none of the purebred sheep are entirely suited to the western ranges, so sheepmen constantly seek crosses which will have the meat properties of the British breeds, the wool qualities of the Rambouillet, and the hardiness which range foraging requires.

The U. S. Sheep Experimental Station at Dubois, Idaho, has developed a breed known as the Columbia which has become popular on the ranges. Foundation stock was a cross between the Lincoln and the Rambouillet.

Experiments with Multinippled Sheep

Near the close of the 19th century Alexander Graham Bell, the inventor, turned his versatile mind to sheep breeding and initiated an unusual experiment. He wanted to breed ewes that would bear twins and triplets consistently. He knew that, among many animals, those with a larger number of mammae produced more offspring at a single time.

At his summer home in Beinn Breagh, Nova Scotia, he began to build a flock of multinippled native sheep, including rare 6-nippled specimens. At the time of Dr. Bell's death in 1922 the ewe flock was producing multiple lambs in more than 50 percent of the births.

After Mrs. Bell's death a year later the flock was turned over to the New Hampshire Experiment Station. Since Dr. Bell had not yet been able to concentrate on improvement of mutton or fleece quality, this step was taken next, and the Beinn Breagh sheep were mated with a Rambouillet-Southdown cross. The high twinning capacity was retained, and by 1939 nearly 80 percent of the ewes had multiple births. But later the experiments came to an end with the transfer of the flock to another station.

Last January the first Merino sheep exported from Australia to any country other than New Zealand for the last 25 years arrived at the University of California College of Agriculture. Three rams and nine ewes from the best strain of Australian Merinos, finest wool-bearing animals in the world, were added to the University's breeding project and shipped to its field station high in the mountains. The object of the program is to put better wool on the backs of American sheep. The Merinos were sent under an exclusive grant by the Commonwealth of Australia.

Elko, Nevada, lies in the heart of the West's range country. The cattle population of Elko County is almost as large as the human population of the entire State. Here survives the spirit of the Old West. Cowboys with their high-heeled boots go to movies on Saturday nights, chiefly to see Western films.

Charles J. Belden

All-wool Coats Keep Montana Sheep Warm on Snow-covered Grazing Land

American sheep ranchers agree that Basques from the Pyrenees make the best herders. Former restrictions against admitting them, sheepmen say, contributed to the numerical decline of United States sheep (page 40). This flock's herder lives a lonely existence in his canvas-covered wagon throughout most of the year.

"They love to criticize the riding," an Elko cattleman told me. "And they love to criticize most anything else in the film which does not square up with ranch life as they know it. They would rather see a Western than any other type."

Steers Inspect Easterners

On Chester Brennen's ranch we saw 200 steers, grass-fattened and ready for market. We stood along a little fringe of trees while his cowboys rounded up the herd and drove them toward us. Within 100 feet they came to a halt, and, with the curiosity of the whiteface, they stood in a solid line and surveyed us just as intently as we surveyed them.

About 50 miles north of Elko lies Spring Creek Ranch, owned by Bing Crosby. The ranch runs about 3,200 head of cattle and ships the yearlings every autumn to California markets. The four Crosby sons spend considerable time there, working as ranch hands.

The Coffee Hereford Ranch near Fallon, Nevada, received more than ordinary notice last spring when one of its cows gave birth to quadruplets. All of them, two bulls and two heifers, were in good health. Quadruplets have occurred in the cattle world before, but the approximate odds on their birth is three in a million.

In Salt Lake City we heard much about reclamation, irrigation, reseeding, and erosion. Reed W. Bailey, director of the U. S. Department of Agriculture's Intermountain Forest and Range Experiment Station at Ogden, Utah, told us about some of the problems of the area.

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Are Brahmans Wild? Not to 3-year-old Lonnie Fulford, Aboard Albacruta, Jr.

Albacruta, herd sire of Sugarland Ranch, Clewiston, Florida, is mated with cows of British breeds. Their progeny is adapted to the subtropical climate of the Lake Okeechobee area. Blackstrap molasses produced by the ranch's parent corporation, United States Sugar, helps feed the herd (page 65).

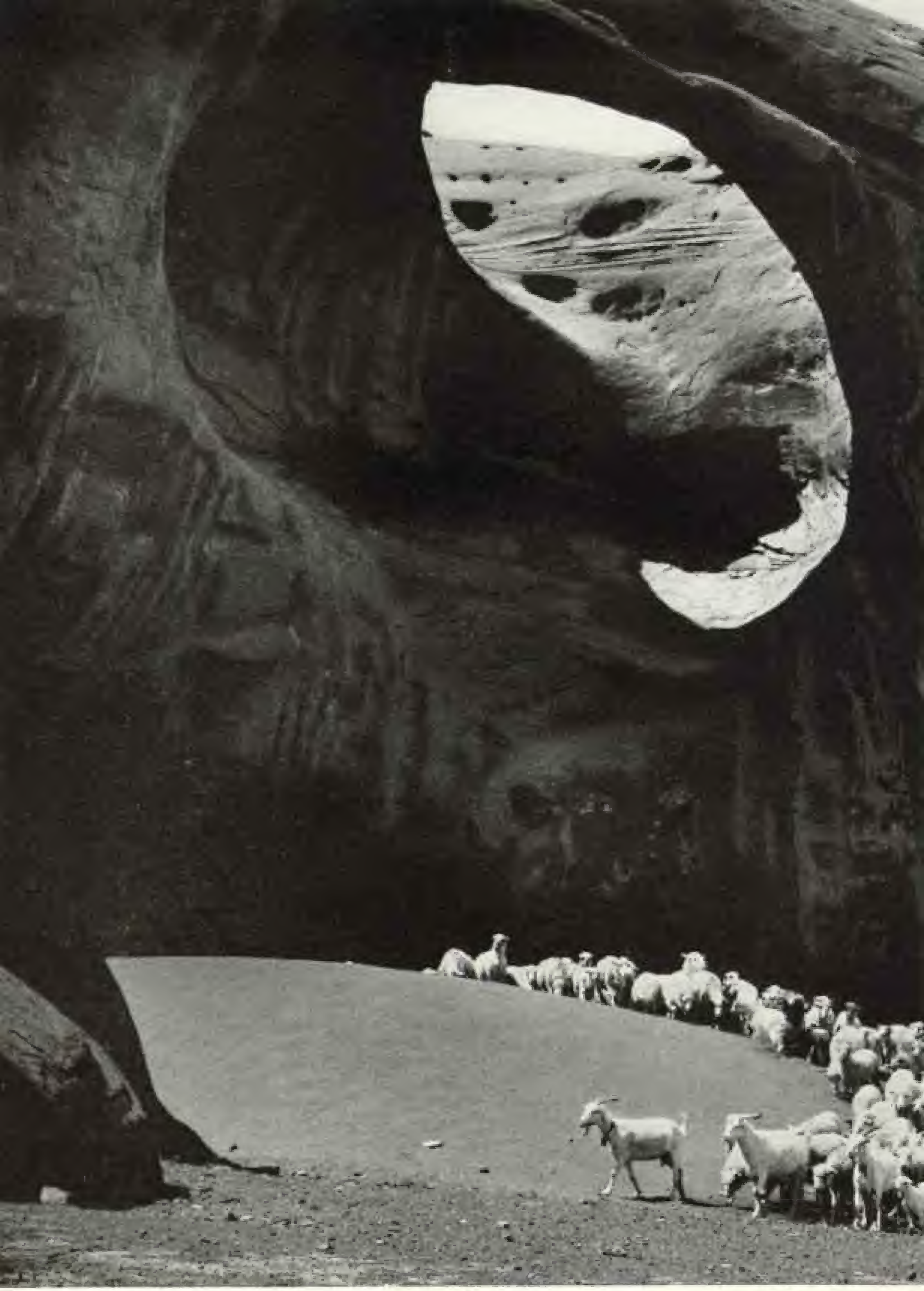
"The most universal land use in the intermountain region during most of the 100 years since settlement has been grazing," he said. "Much of the area has been overgrazed in the past, and as a result there is a twofold problem in range management—the adjustment of livestock numbers to grazing capacity and the rehabilitation of depleted vegetation. The need for rehabilitation applies to vast areas—desert lands, sagebrush plains and foothills, mountain brush types, forest types of various kinds, and mountain grasslands."

Airplane Seeding Presents Difficulties

Reseeding, together with good range management practices, has great promise as an ultimate solution to the problem. Increases in forage of from two to ten times are possible, and research-tested techniques can now be applied on a large scale. Even the airplane has been enlisted in attempts to sow more acres faster. Thus far, success from airplane seeding has been limited largely to mountain aspen areas at elevations of from 7,500 to 9,000 feet. Flying is hazardous over such terrain and seed distribution sometimes unreliable, but results generally have been good.

I saw thousands of dollars of meat on the hoof concentrated in a half-dozen animals at the famous Wyoming Hereford Ranch outside Cheyenne. Here purebred Herefords have been raised for some 70 years, but in the last quarter-century, under the management of Robert Lazear, known to cattlemen from coast to coast, the ranch has acquired an international reputation.

When Lazear won the blue ribbon for cham-



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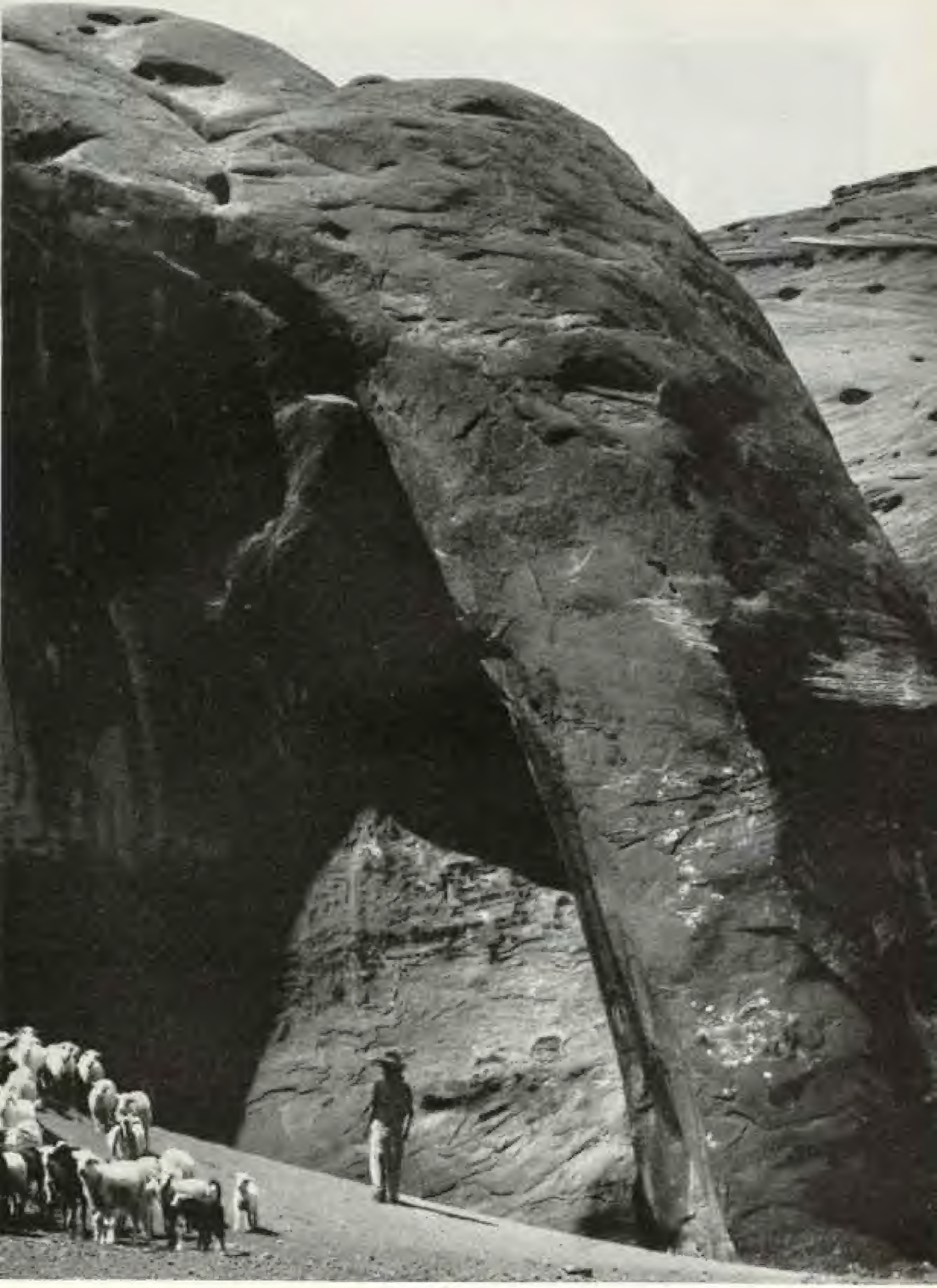
Led by a Belled Goat, Navajos' Sheep Meander Through Fantastic Monument Valley, Arizona



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Remote Ancestors of This Flock Came to America with the Spaniards 350 Years Ago

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Men Who Know Meat Best Gather in Chicago's Saddle and Sirloin Club

Portraits of breeders, traders, and other livestock leaders look down from the walls of the Baronial Banquet Hall. The club burned in the disastrous stockyards fire of 1934. Within 18 months it had been rebuilt and 164 portraits in its famed collection had been repainted and hung.

pion bull at the International Live Stock Exposition in 1950, it was not a new experience for him (page 38). He has been winning blue ribbons for a long time at the country's leading shows. Nineteen times in 25 years, for example, Wyoming Hereford Ranch exhibited the championship carload of bulls at the National Western Stock Show at Denver, Colorado.

The Wyoming Hereford Ranch is one of the cattle showplaces of America. We had lunch there in a show barn completely outfitted as a restaurant. This layout is extremely useful when the ranch holds its annual sale, which draws buyers from all parts of the country. For six consecutive years its average sale price per head was the highest in the Nation. In 1951 it was $5,306.

Going from this huge ranch to the farming area around St. Joseph, Missouri, meant moving into a totally different atmosphere, but both scenes are part of the general picture of livestock raising in the United States. For Buchanan County, in which St. Joseph is lo-

National Geographic Photographer Willard R. Culver

Chalk Marks Tell Where the Choice Cuts Come from

Prince Sunbeam 400th, a registered Aberdeen-Angus bull on the Sunbeam Farm of Miami, Oklahoma, plainly displays the diagram. Area number 1 covers the rump; 2, rib and loin; 3, chuck; 4, round; 5, short ribs or plate.

Berg's Photo Shop

Prince Eric of Sunbeam, Sire of Four International Champions, Cost $100,000

Visitors to Shadow Isle Farm at Red Bank, New Jersey, admire the marcelled Aberdeen-Angus beauty. Prince Eric was purchased from Lakewood Farms, Mukwonago, Wisconsin (page 33).

cated, is a region of small Midwest farms. It has served as a national model for farm improvement because of the Balanced Farming Plan, sponsored by the St. Joseph Chamber of Commerce, in effect since July 1, 1944.

The underlying idea has been to help farmers get the most out of their land, and a plan of private bank financing for soil improvement has been worked out successfully.

We visited the Duncan Ray ridge farm of about 230 acres to see his improved pastures which enable him to maintain a purebred Hereford cow herd and to raise and fatten some 250 hogs a year. A modern water system distributes water to all feed lots and fields from five good ponds. Main crops are corn, oats, red clover, alfalfa, and tobacco.

Beef Cattle in the Old Dominion

Interest in purebred beef cattle in Virginia has never been stronger. Driving through the Old Dominion on another trip, to the South and Southwest, I noticed scores of signs along the roadside identifying breeding farms, principally Hereford and Aberdeen-Angus.

Typical of one of the newer installations is Birdwood Farms, across from Charlottesville's Farmington Country Club. Here Cornelius W. Middleton and his son Richard established their herd in 1940 and have seen it grow to 400 head of purebred Herefords.*

At North Carolina State College of Agriculture and Engineering, in Raleigh, I discovered just how rapidly the beef-breeding business is growing in the Tarheel State. Reports from Robeson County, where tobacco, cotton, and sweet potatoes have long held sway, tell of farmers purchasing 232 heifers and feeder steers in the fall of 1950 and adding another hundred early last year. Rockingham County farmers bought 65 choice beef heifers in a few weeks.

These examples reflect the results of the North Carolina long-time farm program drawn up several years ago by farm leaders to diversify the State's agriculture.

At North Carolina State, Dr. H. A. Stewart, professor of animal husbandry, is trying to develop crossbred cattle which will thrive in the swampy coastal plain section of the State. Dr. Stewart studied beef cattle in Colombia, South America, and became interested in the Romo-Sinuano breed developed by the Colombian Government in a hot, humid, insect-ridden area.

Colombia forbids exportation of this breed, but by artificial insemination Dr. Stewart produced a Romo-Sinuano cross with about 40 Herefords at Raleigh (page 68). Now he is studying the performance of the young heifers in a swamp environment where British breeds of beef cattle do not thrive.

In the meantime, the Riegel Paper Corporation maintains a herd of Brahman and Brahman-crossed cattle in the swampland areas of the southeastern part of the State, on a vast piny grazing range which is still the haunt of bears and alligators.

My first experience with the enthusiastic raisers of Brahman cattle came, fittingly enough, in Charleston, South Carolina, where Brahmans first were imported into the United States. That first shipment of a cow and a bull, in 1849, for a South Carolina planter, is merely an interesting historical fact. The animals were used as beasts of burden, and they and their progeny, if any, finally disappeared.

Much more important is the Brahman ranch of Mr. and Mrs. G. Philip Higdon, on Route 4 near Charleston, on the way to the famed Magnolia Gardens. About 25 years ago Higdon came to Charleston from Texas and became a superintendent at Magnolia Gardens. He was there for 17 years, but during that time he always had cattle in the back of his mind as his Texas heritage.

Eventually he and Mrs. Higdon went into the nursery business themselves and finally branched out into the purebred Brahman business—pioneers in South Carolina. Theoretically, Mrs. Higdon is in charge of the nursery and Mr. Higdon looks after the cattle. Actually, their interests and enthusiasms are intermingled, so that when I arrived in Higdon's absence I found a stalwart representative of the Brahman cause in his wife.

"We call our interests the 'bush-and-bull business,'" Mrs. Higdon announced. Then she drove me over the 1,300-acre ranch to see the cattle. We stopped at a fence and saw a herd of cows in the distance. She called to them, and obediently they trotted up to the fence and gave me a close inspection.

"Some people say Brahmans are wild," Mrs. Higdon remarked. "Go on up and stroke one, and see what happens."

Nothing did, except that the animal showed disappointment when I stopped.

Camel-like Hump Identifies Brahmans

Then, for the next few hours, I was indoctrinated in Brahmans.

These Indian cattle, also known as zebus, are characterized by a fleshy hump above the shoulders, an extreme development of loose skin along the entire underside of the neck, and a similar pendent condition of skin about the navel. They have also a short, steep rump and comparatively long legs.

The head is long and narrow, the ears are very long, and the horns differ widely accord-

* See "Mr Jefferson's Charlottesville," by Anne Revis, National Geographic Magazine, May, 1950.

Four Thoroughbred Mares Look to Their Offspring for Future Triumphs on the Track

▲ Originally King Ranch used blue-blooded stock to improve its cow ponies. Interest in raising racers naturally developed. Third mare from the left foaled Assault, voted the Horse of the Year in 1946. Right: Grooms at the ranch's racing stables walk colts and fillies around a paddock after the morning workout.

▼ Once a champion in his own right, Bold Venture now basks in the reflected glory of a famous son. Bold Venture won the Kentucky Derby in 1936. Ten years later his offspring, Assault, captured that classic, the Preakness, and Belmont Stakes—racing's triple crown. Middleground, a King Ranch horse, won the 1950 Derby.

Astride a Lively Cow Pony, the Head of King Ranch Cuts Out a Hereford-Brahman Bull During a Roundup

Robert Kleberg, Jr., schooled in ranching from childhood through agricultural college, can do anything expected of his cowhands. This bull represents another experiment in the ranch's cross-breeding for beef. In addition, King Ranch has developed the quarter horse, a superior pony of stamina and "cow sense" (pages 62, 64)

From the Time They Are Three Weeks Old, Colts and Fillies Are Handled Regularly to Make Them Friends of Man

Left: Twice a week cowboys round up the young ones, then walk them around and around until they quiet down. Vaqueros stroke their heads, backs, and flanks; pick up first one front leg and bend it at the knee, then the other, and the back legs, too. When the foals grow up after such handling, they are gentle, easy to train, and have confidence in man. A well-behaved colt (below) takes his running-W brand standing up. Irons are heated in a wood fire.

Right: Richard Kleberg, Jr., assistant ranch manager, and Mrs. Kleberg watch the handling of quarter horse colts. King Ranch pioneered in gentling ranch horses early, superseding the old method of roping and breaking wild horses.

Kodachromes by Howell Walker

Robert Kleberg, Jr., Looks Over Some of His Grass-fattened Steers

Mr. Kleberg's lasso is of nylon; his running-W saddle blanket of wool grown, spun, and woven on the ranch. Each of the steers weighs a marketable 1,400 pounds. If gorged on grain, they might gain another thousand pounds

Kodachrome by Justin Locke

King Ranch's Santa Gertrudis Cattle Trace Their Descent to Monkey!

That was the name of the famous bull which King Ranch geneticists produced after hundreds of crosses to establish the new breed. Now some 65,000 head on King Ranch carry the blood of Monkey.

King Ranch Quarter Horses at Roundup Time Take the Coastal Country's Sand and Scrub in Stride

The ranch pioneered in breeding quality ponies for the western range. Now 5,000 fine-bred horses help the cowboys work 85,000 head of cattle. King Ranch extends into eight counties; it covers black loam and clay as well as sand.

Even in the Machine Age the Cowboy Holds Sway on a Cattle Ranch. Only He Can Round Up, Cut Out, Rope, and Brand

King Ranch's vaqueros descend from Mexican families employed by the King-Kleberg family for generations. They sleep in the open, eat from the traveling kitchen or chuck wagon, and tend the Santa Gertrudis cattle.

Kodachrome by Russell Walker

^ Observe the Fine Conformation of Quarter Horse Brood Mares

Cow-pony stock of the King Ranch developed with the West. American colonials raced the horses over quarter-mile courses; hence the name. Not until 1940 were they officially recognized as a breed.

v Strap Replaces Car Door to Permit Quick Exit When Game Is Sighted

It's unlawful to shoot from an automobile in Texas. Mrs. Richard Kleberg, Jr., however, obligingly poses for the photographer. Wild hogs, turkeys, and deer abound on King Ranch.

ing to sex and breed, but usually are very long in the males. The color of the short, fine hair ranges from white to varied shades of gray.

Contrary to popular belief, the Brahman is gentle by nature, becoming dangerous only when excited or fearful. This is not strange when it is remembered that these animals have been sacred in India for centuries and roam unharmed through the streets of its largest cities, and even through public buildings such as railway stations.

The first important shipment into the United States took place in 1906 when A. P. Borden brought 51 head from India to the Pierce Estate in Wharton County, Texas. In recent years they have increased materially and have been crossed with the British breeds very successfully, particularly along the Gulf Coast, in southern Florida, and in Texas. Freedom from pinkeye, ticks, and cancer eye, plus ability to withstand heat and drought, are among the strong points claimed for them.

Bulls from the Higdon herd have been sold to farmers in South Carolina to be used with British beef and dairy-breed cows.

To see one of these operations, I went with Mrs. Higdon to the farm of Gunther Wallen, a transplanted Connecticut Yankee who has bought considerable acreage on Wadmalaw Island and stocked it with 100 local cows of dubious origin, but bearing traces of Jersey, Guernsey, Hereford, and Shorthorn. The Higdon prize bull also was pastured there.

We found Mr. Wallen on crutches.

"Met with a Brahman?" I asked.

"Sorry," he said cheerfully. "I fell off a horse."

Prize Brahman Tame as a Pony

Mrs. Wallen and her 5-year-old daughter accompanied Mrs. Higdon and me to a feed lot where the Higdon bull and two young bulls were standing. Into the lot we paraded, accompanied by two Negro helpers. All three of the bulls permitted us to pat and stroke them. Then, without further ado, the 5-year-old clambered up on the back of the prize Brahman and happily rode him about the lot.

We walked over to the pasture where the cows, some with calves and some about to drop them, were grazing.

"We bought these cows wherever we could find them," Mrs. Wallen explained. "Each has been bred to a Brahman. See the size of those calves."

"They get plenty of milk," Mrs. Higdon pointed out, "because their mothers have some milk-cow blood. Before weaning time they will be so big they will have to kneel down to nurse."

Enthusiastic and zealous Brahman breeders have decided differences of opinion among themselves as to just what the future of their cattle in the United States is to be. One group insists on maintaining the integrity of the Brahman breed—the long legs, steep rump, and huge hump. Another insists that to further the development of Brahmans as a beef breed they must be bred with more of the American standard beef conformation.

What sort of cross between the Brahmans and the English breeds is best? Should it be half-Brahman, one-quarter Brahman, one-eighth Brahman? Here again is a difference of opinion. On one point all seem to be agreed—there is nothing static in the Brahman-raising situation, and the difference of opinion is a healthy sign.

Florida Now 12th in Beef Production

More than one cattleman I met expressed the belief that the future expansion of the cattle industry lay in the South and Southeast. Certainly increased beef production in Florida lends support to that theory. Today Florida is selling "stocker" cattle to ranches in Idaho, New Mexico, Texas, Kansas, and Colorado. Once comparatively inconsequential as a beef cattle State, Florida now ranks twelfth in the Nation and first in the South.

Here the Brahman is thoroughly established. A pioneer breeder in the State is Henry O. Partin, who, with his sons, operates the Heart-Bar Ranch at Kissimmee.

Another big grower is the Norris Cattle Company, with headquarters at Ocala. The company's holdings, divided into six ranches, spread out over 110,000 acres. Of this, only about 20,000 acres remain to be cleared for pasture. R. G. Herrmann, ranch manager, has built up a herd of 1,000 purebred Brahmans. The ultimate aim of the company is to produce each year 25,000 head of 500-pound crossbred calves at six months of age.

The ranch recently acquired five Charolais bulls, of which there are only a few in the United States. This breed of heavy beef cattle is native to southern France.

In the Everglades, the United States Sugar Corporation became interested in 1940 in feeding blackstrap molasses to cattle (page 51). To the duties of Sidney Crochet, director of purchases and sales, were added those of cattle director; so he started a ranch.

Now this is known as Sugarland Ranch, sprawls over 5,000 acres of improved pasture near Clewiston, and supports a large commercial herd as well as 400 registered Brahmans. Brahman bulls are crossed with Herefords, Shorthorns, Aberdeen-Angus, and French Charolais. Resulting crosses are known as Braford, Brahorn, Brangus, and Charbray.

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Bob Taylor

Who Wouldn't Repay Such a Lovely Kiss with Calf-like Adoration!

Hereford mother and baby lare in lush pastureland of southeastern Oklahoma. White-faced Herefords outnumber all other beef breeds in the Western range States.

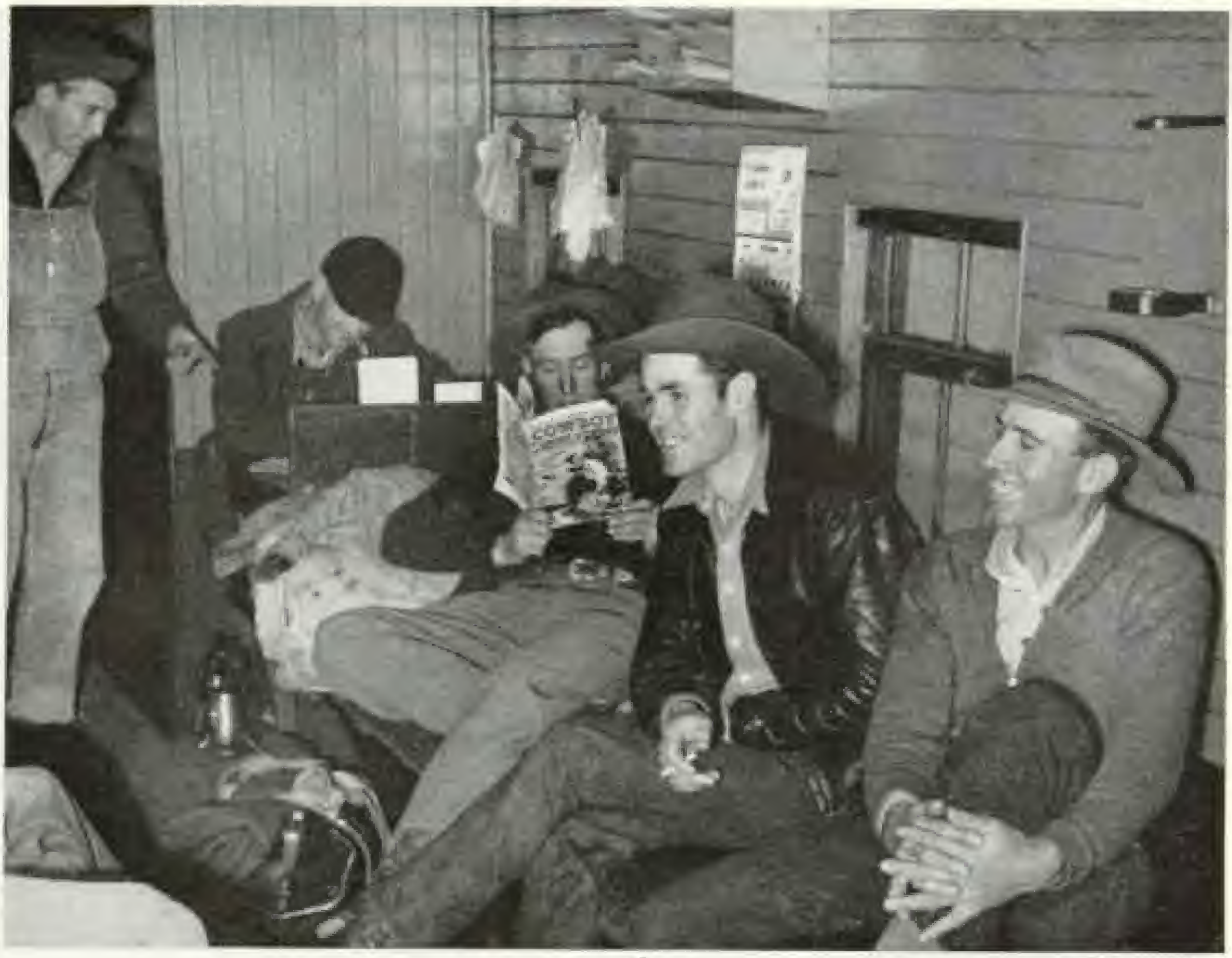
It should not be concluded that only Brahmans and Brahman crosses exist in Florida. For example, the Glades Sod Company and the B & O Ranch at Fort Lauderdale raise purebred Aberdeen-Angus; so does the Perdido Ranch of Pensacola. R. G. Heine, a transplanted North Dakotan, specializes in Shorthorns at Ocala. Herefords and Polled Herefords are raised near Alachua, Crescent City, Plant City, Fort Meade, and elsewhere.

Drugs Stimulate Pigs' Growth

In the Department of Animal Husbandry of the University of Florida I learned how the "wonder drugs" aureomycin, streptomycin, and terramycin are being used to promote fast growth in pigs at reduced prices. Here the pig's diet has come in for searching analysis.

Tests conducted by Dr. T. J. Cunha show that an addition of aureomycin to corn-peanut meal rations increased the growth of pigs by 100 percent by keeping down destructive bacteria, decreased the amount of feed required, increased the pigs' appetites, and made their coats of hair smoother. A vitamin B_{12}-aureomycin supplement produced similar results.

Cattle raising is expanding in the southern part of Alabama. The Experiment Station operated by Alabama Polytechnic Institute in Baldwin County has helped to stimulate that growth. Here, on 800 acres, an extensive pasture-improvement program and breeding



87 Charles J. Backus

Cowboy Fiction Entertains a Rider on a Stock-train Trip

Most livestock moved by rail travels long distances; short hauls are handled by truck. These boys tend cattle shipped from Western range to Eastern market. They delight in attending cowboy movies, principally for the pleasure of criticizing the authenticity of dress, speech, and manners.

and grazing experiments are under way. I ran into many ex-GI's raising cattle on their south Alabama farms.

One of the fastest-growing cattle States is Mississippi. I drove from one end of it to the other and was astonished at the number of beef cattle, all breeds, to be seen in the fields alongside the highways. Since 1930 the State's cattle population has increased by almost 100 percent. Last year it showed a seven-percent growth.

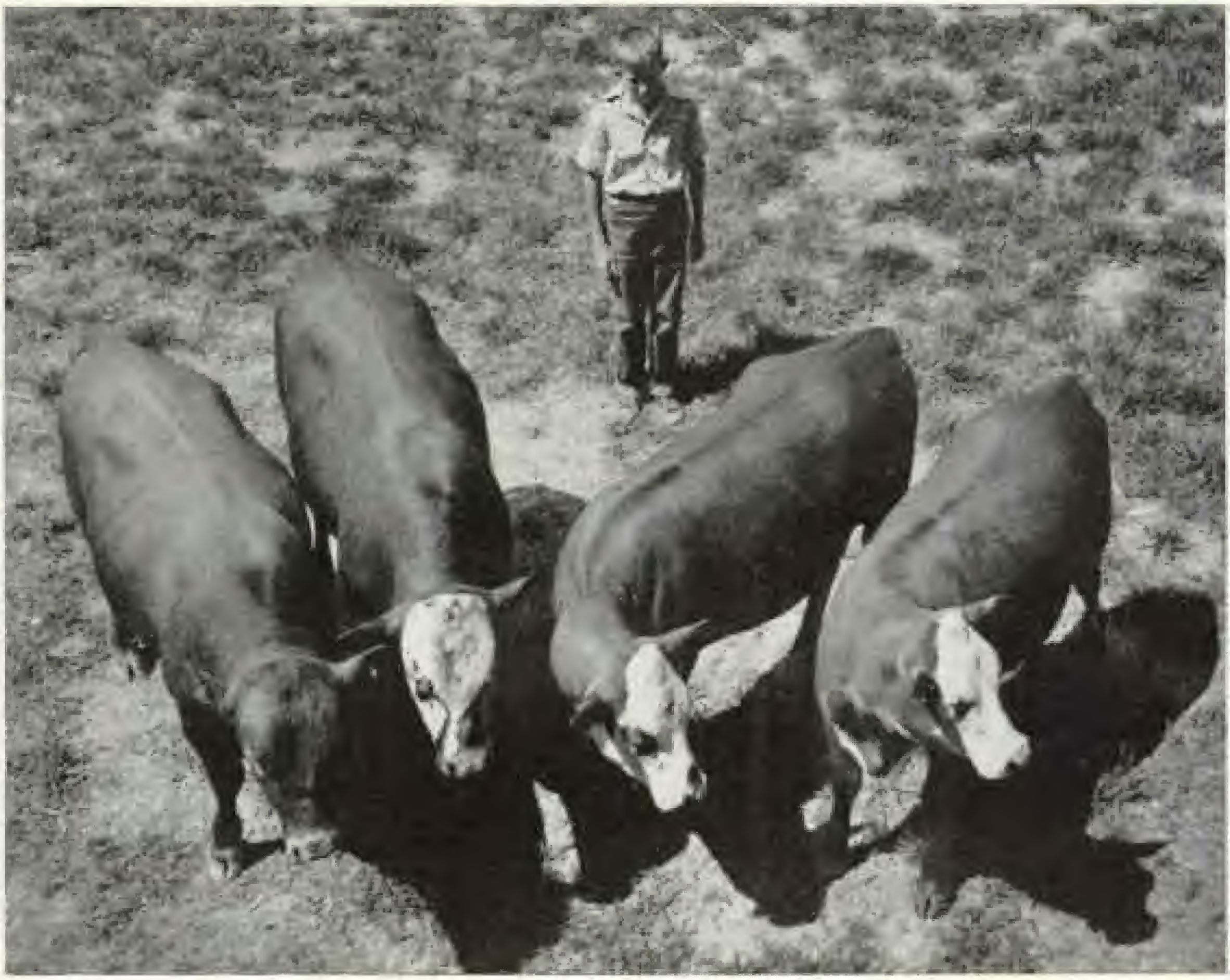
At Senatobia I visited two of America's leading Polled Hereford farms, Circle M Ranch, operated by M. F. ("Hot") Moore, and Double E Ranch, operated by his brother, E. E. Moore. At Circle M's annual 1950 sale, C. C. Potts, of Pottstown, Pennsylvania, paid $40,500 for CMR Anxiety Domino 25th, highest price for a Polled Hereford bull.

Sheep also are increasing in Mississippi, even moving into the rich Delta region between Memphis and Vicksburg, where once cotton was the only crop. Farm value of Mississippi sheep in 1951 was $1,484,000, almost a 175-percent increase in five years.

Sheep have moved into the 17 parishes comprising the sugar-cane belt of Louisiana. A few years ago they were introduced in limited numbers to keep down the Johnson grass, a pest in the cane fields. They were an immediate success. Instead of spending money for labor, mechanical equipment, and chemicals to control growth of the grass, cane raisers now put the sheep to work. They eat the grass and return a profit to the owners. Now about 16,000 head of sheep thrive here.

Louisiana has numerous show herds of purebred cattle. But of more significance to commercial cattle raisers is the U. S. Department of Agriculture's Iberia Livestock Experiment Station at Jeanerette.

Principal experiments in recent years have been with Brahman and Angus crosses. Tests showed that crossbreds have a definite place in the beef-cattle industry of the Gulf Coast. For example, in one test 15 first-generation Brahman-Angus half-breed steer calves reached a weaning weight of 454 pounds at 232 days of age. Eleven purebred Angus steer calves required an additional month to



National Geographic Photographer Willard R. Culver

Hereford Mothers of These Crossbreds Never Saw the Romo-Sinuano Father

North Carolina State College, looking for a new beef type to withstand the humid coastal climate, investigated Columbia's Romo-Sinuano breed, which is inured to heat and ticks (page 56). Columbia refused to sell a bull but permitted artificial insemination.

reach only 404 pounds. The crossbreds also needed less time in the feed lot to attain a final weight of 754 pounds.

Driving along the Texas Gulf Coast from Orange to Galveston, then over to Houston, I saw thousands of head of cattle. Nearly all were Brahman crossbreds.

Southwest of Houston, at Hungerford, is one of the country's leading purebred Brahman herds, on the J. D. Hudgins Ranch. The herd, founded in 1915, now includes 1,000 brood cows. In the Hudgins office is mounted the head of the famous herd sire, Manso, which established a line of beef-type Brahman, with short, stocky legs, wide rump, flatter back, and better beef conformation in general.

King Ranch Developed Only U. S. Beef Breed—Santa Gertrudis

In extreme southeastern Texas, below Corpus Christi, lies 900,000-acre King Ranch, largest in the United States (pages 41-48, 57-64). Its contributions to the industry have been many, but most significant has been its development of the only distinctive beef cattle breed in the United States.

Robert J. Kleberg, Jr., and associates have developed Santa Gertrudis cattle over more than a quarter of a century, to meet climatic and grazing conditions of Gulf Coast and other semitropical and tropical areas.

The breed stems back to a cross between Brahmans and Shorthorns. After much intensive effort, a young bull of this mixed parentage, named Monkey, was branded in the fall of 1920 and turned into a selected breeding herd in the spring of 1923. Monkey showed he could pass on to his calves his fine beef quality, deep-red color, and ability to thrive in Gulf Coast conditions.

With Monkey as the sire, a scientific program of inbreeding and line breeding was carried on until eventually the breed was established—something quite different from a mere crossing of Brahman and Shorthorn blood. Today 90 percent of some 65,000 head of cattle on the King Ranch carry the blood of Monkey by way of 150 sons, and

their sons, grandsons, and great-grandsons.

The first public auction of Santa Gertrudis bulls did not take place until November 10, 1950. Twenty-nine bulls were sold for $99,000—an average price of $3,414. Nine of the animals went to Cuba. The rest were purchased by Florida, Texas, and Louisiana cattlemen.

Among other contributions to the cattle industry, King Ranch has pioneered in the development of grasses in its area. It was among the first to introduce Rhodes grass from Rhodesia. This still is the best grass for the region, although recently it has been attacked by a deadly scale (page 47). Two new grasses are doing extremely well, because the scale has never damaged them. These are King Ranch bluestem and Kleberg grass, slight variations of other species, developed by accident.

69

Jack McMasters

First Come First Served

How many of the 11 Spotted Poland China pigs in this litter will grow up to become ham and bacon? A third of the pigs born in the United States die before weaning (page 53).

The ranch's famous "running W" brand (page 41) was registered in 1869. It was picked because rustlers couldn't alter the flowing design easily. Vaqueros say markings on the coral snake inspired the design.

Beyond its coastal strip Texas is principally Hereford country. Shorthorn ranches like that of Carnway & Sons, at De Leon, or Aberdeen-Angus ranches in the southwestern part of the State are notable exceptions. But the whitefaces outnumber all others.

Ranching De Luxe at Flat Top

Of the purebred Hereford ranches I visited, none was more impressive than Flat Top Ranch at Walnut Springs, in Bosque County—a cattle showplace. It stretches over 17,000 acres of semiprairie country, with live-oak trees crowning the low ridges to relieve the monotony of flat land and, more practical, to afford shade to the cattle.

Here 850 purebred brood cows and 15 prize bulls lead a contented life, as pictured in a recent Hollywood film entitled "Lone Star Roundup." Charles Pettit, the owner, a former Dallas oil man, has spent a fortune in the erection of a palatial ranchhouse, paved roads, concrete bridges, a water system based on an artificial lake, and a modern auction barn. The barn, built five years ago, has never been used as such; private agreements have taken care of all the animals offered for sale in that period.

Here, as on other ranches, I noted with some dismay the scarcity of horses.

"We operate the whole ranch with only seven horses," William B. Roberts, the manager, told me. "We saddle them and put them in a trailer truck and haul them to any point where they are needed to work the cattle. This requires only a few horses, saves them work, saves the cowboys more, and is an entirely efficient operation."

Ardmore, Oklahoma, lies at the southern end of a strip of territory loosely defined as "Hereford Heaven," which stretches to within a few miles of Ada. The name was coined by a newspaperman who was describing a tour through the region by members of the Oklahoma Hereford Breeders' Association.

U. S. Department of Agriculture

Three Little Pigs from the Tall Corn State

Iowa farmers, old doggerel goes "buy more land to raise more corn, to fatten more hogs, to buy more land, to raise more corn," etc. Most of them raise pigs in modest numbers, but, combined, they were feeding 13,211,000 head early in 1951, making Iowa the leading hog State.

In Ardmore I encountered a group of Hereford enthusiasts who piloted me about part of this strip to visit a half-dozen ranches.

Hereford Heaven is rolling limestone country with nutritious native bluestem grass. Showplace of the area is the Turner Ranch, owned by Roy J. Turner, former Governor of Oklahoma, seven miles east of Sulphur. The purebred herd includes 450 brood cows, and a commercial herd is about the same size.

The Turner herd, one of America's finest, was enriched in 1937 when Mr. Turner purchased most of the outstanding animals at the dispersal sale of the world-famous Hazlett herd near Eldorado, Kansas. Robert H. Hazlett, who died in 1936 in his 90th year, was the outstanding Hereford breeder of his generation. His entries consistently won blue ribbons at the Nation's leading livestock shows. His prize bulls were incorporated into the Turner herd, and the shrewd, careful breeding methods employed by Hazlett have been continued.

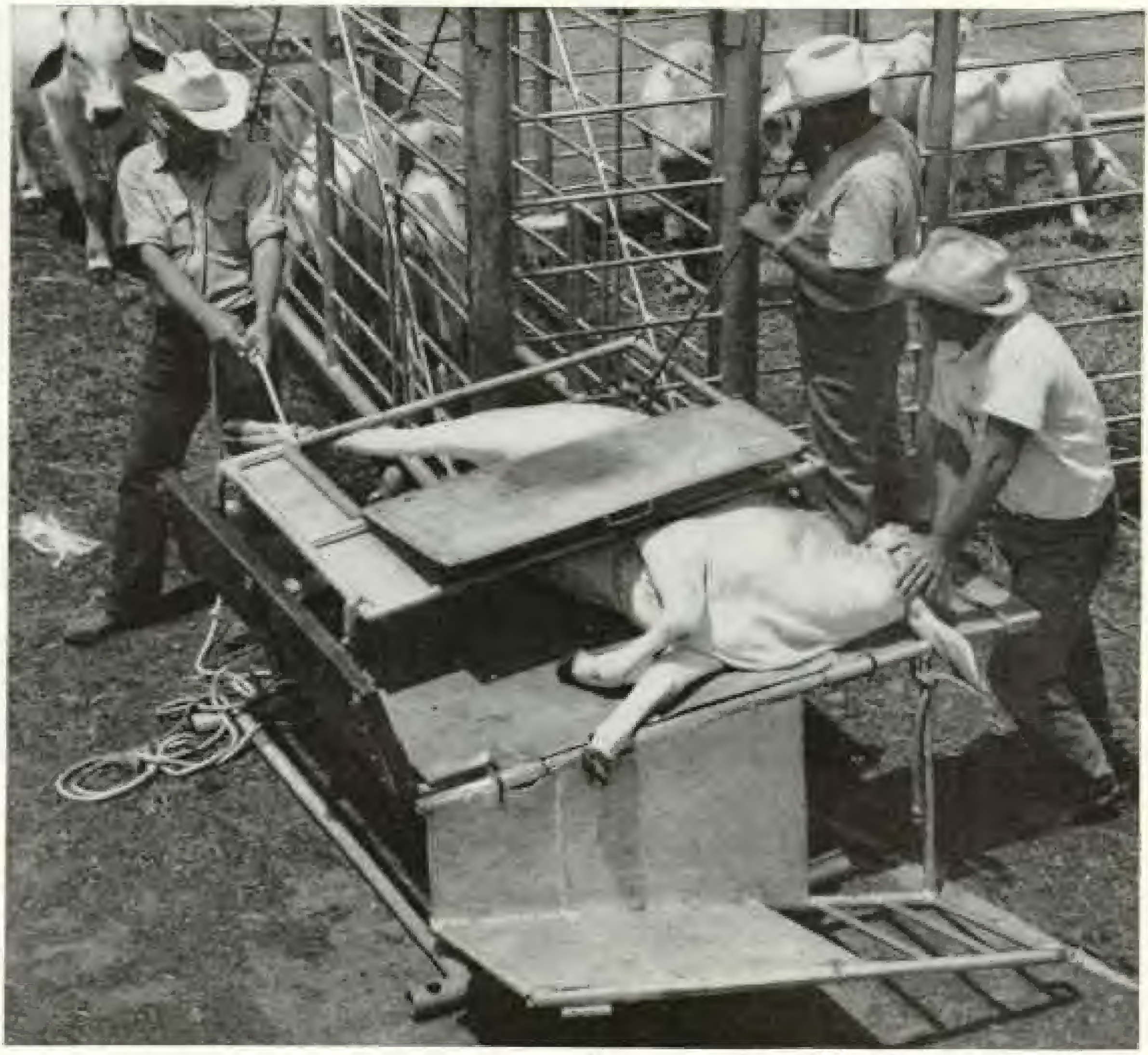
But the numerical superiority of Herefords in these parts fails to terrify Judge William G. Davisson. The Judge is one of the largest Aberdeen-Angus raisers in the country and operates a 10,000-acre ranch outside Ardmore. He simply calls his charges "Angus angels in Hereford Heaven."

I visited his ranch at calving time and admired the little black fellows. At one point, however, I observed two with white faces, and pointed them out to the Judge. He smiled wryly. "That neighbor's bull must have got over the fence when no one was looking," he observed.

Oklahoma A. & M. at Stillwater has made important contributions to the livestock industry for many years under the direction of the distinguished Dean W. L. Blizzard. Its researches cover a wide range, including inquiries into the feeding of livestock, diseases of cattle, sheep, and swine, breeding tests, pasture fertility and improvement, and kindred subjects.

With the cost of cottonseed cake rising, tests to find a cheaper protein for livestock in a synthetic substitute are under way. Urea, manufactured by E. I. du Pont de Nemours & Co., Inc., has been the subject of much experimentation. It is a chemical combination of ammonia and carbon dioxide, formed under high pressure and temperature. Urea is rich in nitrogen, which is converted into a form of protein in stomachs of cattle and sheep.

Oklahoma A. & M. maintains a show herd of Herefords, Aberdeen-Angus, and Shorthorns. Four times an A. & M. steer has won the grand championship at the International



71 National Geographic Photographer Willard R. Culver

Cage Branding Is Less Exciting but It Saves Time and Avoids Injuries

Broken legs, common with the old roping and throwing technique, are eliminated by the metal branding cage here demonstrated on the J. D. Hudgins Ranch in Hungerford, Texas. This Brahman calf was led from the chute into the cage, then flipped over on its side. An opened door exposes the flank. One cowboy holds the head, another secures the leg, and a third applies the brand.

Live Stock Exposition in Chicago—in 1926 with a Hereford, in 1936 with an Angus, and in 1937 and 1946 with Shorthorns.

On my way east I stopped in at the offices of the American Hereford Journal in Kansas City to chat with Don R. Ornduff, its editor. The tremendous interest in beef cattle today is reflected in the size of that magazine.

The 1951 Herd Bull issue of the Journal surpasses any beef-cattle publication ever issued, with its total of 940 pages. This is 136 pages larger than the 1950 edition.

Driving through the Middle West, I passed through hundreds of feed lots in Illinois, Indiana, and Ohio. Some are operated on a large scale, but there are few to compare with those of the California Cotton Oil Corporation in Los Angeles.

This firm operates two cattle-feeding yards, where cattle are fattened for market, with a capacity of 13,000 head. Cattle come not only from California but from most of the Western range states.

Feed is mixed in an automatic plant where one man, with the aid of hydraulic valves and electric switches, controls ingredients for mixing more than 300 tons of feed a day.

After the feed is mixed it is conveyed to finished feed bins where it is accurately weighed and put in specially built feed trailers, which distribute it to the cattle. They are left on feed from 90 to 120 days.

In Chicago, center of the meat-packing industry, I visited the Nation's largest stockyards and the country's largest packers. Their handling of meat is a story in itself.

Jay E. Smith, American Shorthorn Breeders' Association

End Results! Prime Grain-gorged Shorthorn Steers Raise Visions of Steaks and Roasts

These three won first prize in their group class at San Antonio Livestock Exposition last year. Alike as peas in a pod, they were brought to the peak of perfection by Irvine & Timm, commercial feeders, of Dysart, Iowa. Tails were combed and coats brushed for the show ring.

But in this complicated age science has greatly increased the number of meat by-products until the packer today finds at least as much profit in the by-products as in the meat itself. The cushions we sit on, the soap we wash with, some of the medicines we use are among the packing industry's nonfood products.

Armour and Company recently published a list of some of these by-products, many of which are made from materials once thrown away as useless waste. Its soap department handles scores of grades and varieties of soaps —toilet, laundry, industrial; flakes, chips, granules, liquid, and deodorant—utilizing inedible tallow and grease.

Glycerin, a syrupy liquid liberated from tallow, is a by-product of soap.

Medical Wonders from By-products

In the field of pharmaceuticals, glandular products are high in importance. Insulin comes from the pancreas glands of animals to treat diabetes; liver extract helps anemia sufferers; thyroid is beneficial in cretinism. From the pituitary glands of hogs comes adrenocorticotrophic hormone, known as ACTH, to treat rheumatoid arthritis, rheumatic fever, gout, and asthma.

Epinephrine (suprarenalin), first hormone to be isolated in pure form, comes from the inner portion of the adrenal glands just above the kidneys. It has proved effective in treating bronchial asthma, in controlling whooping cough spasms, and in stimulating the heart muscles.

Fifteen percent of American wool is "pulled wool," a by-product of the packing house. It is used in soft-twist knitting yarns, bed blankets, carpets, and rugs.

Wool fat recovered in cleaning the wool is refined into lanolin, base for ointments.

Hair from cattle, especially from the tails, goes into manufacture of curled hair for mattresses and furniture upholstery. Now even hog hair is curled and combined with latex as an upholstery filler.

From sheep intestines come strands of gut for ligatures and violin strings. Intestines also are used as casings for sausage.

One of the chief nonfood by-products of the packing house is glue. Bones find use as combs, handles, chessmen, and other novelty items, but their chief uses are for gelatin, glue, and bone meal.

Years ago it was observed that the packer made use of every part of a pig but its squeal. Today the statement holds true even more forcibly, as additional uses for parts of all slaughter animals continue to be discovered.

Your National Gallery of Art After 10 Years

By John Walker

Chief Curator, National Gallery of Art

AMERICANS by nature are hopeful. During the darkest days of the Civil War the rebuilding of the National Capitol continued; and it is under the shadow of another struggle for survival that the National Gallery of Art has reached its tenth anniversary.

Though danger menaces today, the Gallery continues to grow, just as all over the country new churches, new hospitals, new schools, and new museums are being built. These are our affirmations that we have not lost faith in the ultimate victory of humane and Christian values.

Art can strengthen our faith in these values. A serviceman who came to the Gallery during the war wrote in the visitors' book: "Through an understanding of what this building holds, our lives will have more meaning."

A consciousness of the importance of art in human life persuaded the late Mr. Andrew W. Mellon to provide the resources to build the Gallery and induces Congress each year to appropriate funds for its maintenance.*

Great and Growing Treasury of Art

Originally the collection consisted of only 111 paintings and 22 pieces of sculpture, but these works of art acquired by Mr. Mellon were among the greatest masterpieces in the world. The building on Constitution Avenue was designed to provide five and a half acres of exhibition space. Naturally Mr. Mellon planned for a greater density of works of art than 24 to the acre! He had faith that the beauty of the new building would have a magnetic effect on masterpieces in other collections.

He was right. Before the Gallery opened, Mr. Samuel H. Kress gave his large group of Italian paintings and sculpture, trebling the size of the original donation. His gift, so significant to the Gallery intrinsically and also because of its opportune timing, has been increased on several occasions by magnificent additions not only of Italian art but also of other schools.

The Widener Collection, one of the finest ever formed in America, was the next donation. Later Mr. Chester Dale sent the Gallery many of his distinguished and brilliantly chosen paintings, principally of the French 19th-century school; and Mr. Lessing J. Rosenwald assembled for the print department a superlative collection, a donation which has steadily grown. Others have given until the paintings and sculpture alone in the permanent collection now number more than ten times the original 133 objects.

Thus in a decade, to quote Emily Genauer, art critic of the *New York Herald Tribune*, the National Gallery of Art "came into possession of a collection which ranks it among the top three or four museums in the world." And of this collection the National Gallery has purchased only two paintings, both American, and both bought with funds donated for this purpose by a private individual. All the other works of art have been given.

Probably nowhere but in America could this have happened. Collecting here has not been the same as elsewhere. None of the principal donors to the Gallery bought works of art with the intention of leaving them to his heirs; and, even more remarkable, all made their donations while still able to enjoy their works of art. The greatest collectors in America have looked upon their treasures as being in temporary custody, destined from the beginning for public benefit.

Taxation seems to have ended the era of great private collections. It is of immense significance, therefore, that the Samuel H. Kress Foundation has assumed the responsibility individuals find almost impossible to undertake—that of buying works of art for public museums. Through an imaginative and carefully conceived plan, the Foundation intends to extend the benefits of art to regional galleries throughout different sections of the country.

The basic aim of this unique philanthropy has been stated by Mr. Rush H. Kress † as the development through art of "a deeper spiritual character on the part of our coming generations."

Newly Acquired Paintings Reproduced

During the last five years the Kress Foundation has acquired many of the outstanding masterpieces still available. More than 130 examples of painting and sculpture and some 1,300 medals, plaquettes, and small bronzes—all from these acquisitions of the last few years—have recently been shown at the National Gallery of Art in honor of its tenth anniversary (page 75). A selection from this exhibition is reproduced to accompany this article (pages 77-100).

* See "Old Masters in a New National Gallery," by Ruth O. McBride, National Geographic Magazine, July, 1940.

† Brother of Samuel H. Kress and vice president of the Foundation.

79 National Geographic Photographer Ernest J. Cornell

A Student Painter Copies a Masterpiece to Learn How the Master Did It

Amateur artists eager to improve their technique besiege Washington's National Gallery of Art for permission to copy its famous paintings, but only a few can be accommodated. To prevent taking, copies must be labeled as such, and must be larger or smaller than the originals. Here Thelma DeAtley reproduces "The Old Bridge," a picture of a crumbling structure near Rome painted about 1760 by Hubert Robert (page 81).

Only collectors, curators, and dealers can realize the difficulty today of bringing together such a collection. On several occasions someone has said to me, "I paid x millions of dollars for my collection. Did I pay too much?" And because of the high quality of his works of art, I have honestly replied, "Give me the same amount of money and I could not, under present circumstances, assemble a comparable group of paintings and sculpture."

Examples by the Old Masters of secondary quality are easy to buy, but today masterpieces are so scarce as to be literally priceless.

Not only have most of the important collections entered museums; nearly all European countries have restricted the export of significant works of art. Thus, while American museums have increased in number, there is less and less for them to acquire.

In these difficult circumstances Mr. Rush Kress and the trustees of the Kress Foundation have acted with wisdom and speed. They have neglected no opportunity to add to America's store of art. For example, during the winter of 1950-51, an emissary flew three times from America to various parts of Europe to bring back only four paintings, but each is of immense significance.

One, "The Attentive Nurse," by Chardin, is reproduced (page 85). It was purchased from the artist in the 18th century by Prince Liechtenstein and remained in the collection of his family until it was flown across the Atlantic last winter.

As Switzerland is still a free market for works of art, some of the most important masterpieces were acquired there. Among these, particularly fascinating is the Dürer "Madonna and Child" from the collection formed by the German industrialist, Baron Heinrich Thyssen, at Lugano. The reverse of this panel is reproduced (page 94). It shows Lot and his daughters fleeing, like elegant refugees, from what appears to be an atomic explosion over Sodom.

The greatest single coup made by the Kress Foundation, however, secured the paintings from the Cook Collection, panels and canvases known to generations of connoisseurs, at Richmond, on the outskirts of London. Before World War II, Sir Francis Cook sent his

Guests Crowd the Gallery on Its Tenth Anniversary to See a New Collection

The National Gallery was founded a decade ago with funds and art works given by the late Andrew W. Mellon. Last March 17, for its tenth birthday, it received priceless paintings, sculptures, medals, plaquettes, and small bronzes from the Samuel H. Kress Foundation in New York. Here, at the first night's showing, Chief Justice Fred M. Vinson (center, right), greets Rush Kress, vice president of the Foundation.

most important pictures to America for safekeeping. This shipment contained the famous tondo, or circular painting, "The Adoration of the Magi," by Fra Angelico and Fra Filippo Lippi (a supplement to this issue), a work that would stand among the greatest masterpieces in any gallery.

Circular Painting Marks a Crossroad

The tondo is a climax of beauty, a summary in itself of the whole evolution of the Italian schools of painting in the 15th century. For it stands at a crossroad of art. The old style, the gay, colorful, fairy-tale painting of the Middle Ages, is ending in an outburst of splendor, and the new style, scientific in observation, studious in anatomy and perspective, realistic in its portrayal of life, is beginning its long development (page 140).

After the war all the paintings from the Cook Collection were crated for reshipment to England. It was an unforgettable experience in 1947 to see in the vault of a New York warehouse the flood-lit radiance of each picture as the covers were removed from stacks of packing cases for inspection by representatives of the Kress Foundation and the National Gallery of Art.

The negotiations between the owner and the Kress Foundation were complicated. Sales to museums in Great Britain have certain tax advantages, and this is a further hardship to American buyers. It seemed several times as if all the paintings in the Cook Collection would leave America for good. However, each time, at the last moment, shipment was postponed; and ultimately a large number of paintings were acquired by the Foundation from Sir Francis Cook.

Besides the tondo, four of these Cook Collection pictures are reproduced. In the "Calvary" (page 78) a band of Renaissance mercenaries, their armor glinting, their doublets and hose strongly patterned, act out their triumph at the foot of the cross. The truculence of their gestures and the violence of their movements convey the almost brutal force of Signorelli's style and explain the profound attraction it exerted for Michelangelo.

By contrast, the lady painted by Sebastiano del Piombo is the epitome of Renaissance charm (page 92). So fascinating is this

portrait that the subject has been traditionally considered the most gifted woman of her time, Vittoria Colonna. A poet herself and the subject of some of Michelangelo's finest sonnets, she was a center of the literary life of Rome.

There is an old inscription in the lower right-hand corner which reads "V. [C]olonna," but can we rely on its accuracy? In art history we live in an age of skepticism, and therefore we have labeled the painting simply "Portrait of a Young Woman."

Alessandro Alberti was painted in Venice at the age of 30, says the letter on the table (page 88). But as a historical personage he is a nonentity. What we want to know is the name of his brilliant portraitist.

X-rays have given us useful information about the original appearance of the fourth Cook Collection painting reproduced (pages 98 and 103). This fairy-tale scene of "St. George and the Dragon," generally considered the masterwork on panel by Giovanni Antonio Bazzi, known as Sodoma, had when acquired a flowery meadow in the foreground.

X-ray shadowgraphs showed that some squeamish collector had carefully buried under repaint the remains of the dragon's previous meal, apparently eaten just before the arrival of his last course, the Princess Cleodolinda! The picture now appears as originally painted.

How Paris Looked When America Was Discovered

Some pictures among the recent additions to the Kress Collection came to America when export restrictions were less stringent. As important in French painting as the Fra Angelico-Fra Filippo Lippi tondo in Italian art are the two panels attributed to the Master of St. Gilles, so called from the two paintings by him in the National Gallery, London, representing scenes from the legend of St. Gilles. These are documents precious not only for their intrinsic beauty but also because they show certain sections of Paris as they appeared about the time Columbus discovered the New World.

The first painting represents "The Baptism of Clovis" by St. Remy (page 90). The scene, which actually took place at Reims, is shown as happening in the Sainte Chapelle in Paris. The artist has taken liberties with the interior, combining details of the upper and lower chapels, but the porch and the statue are familiar to countless travelers as belonging to the lower part of the building. The Gothic section of the Palais de Justice, seen outside on the left, has been replaced.

The second panel shows an early view of the façade of Notre Dame (page 91). St. Remy stands on the steps of St. Jean Le Rond, which is no longer in existence. The Gothic building on the right was part of the Hôtel Dieu, one of the oldest hospitals in Paris or indeed in Europe. In the middle distance is the quay of the Seine, and the tower against the sky probably belonged to the Church of St. Geneviève, which actually stood more to the east. Badly damaged by fire in the 18th century, this region of Paris, except for Notre Dame, is utterly changed today.

An Artist Interested in Music

Other paintings among those reproduced give us glimpses of the past. One, representing "Mary Queen of Heaven" surrounded by a choir of angels, is by an anonymous artist known as the Master of the St. Lucy Legend. He must have been as interested in music as in painting, for he has carefully depicted many of the musical instruments known in the 15th century (page 100).

This artist used color in a musical way, for the angels' robes, like chromatic chords, form together a polyphonic harmony of hues. Though apparently trained in Flanders, he was probably active in Spain, as the panel came from a monastery near Burgos.

Another painting (page 99), also from Spain, uses the subject of "The Marriage at Cana" as an excuse, it would seem, to depict one of the important dynastic marriages of history. This was the wedding of Juan, Prince of Asturias, son of Ferdinand and Isabella and heir to the Spanish throne, to Margaret of Austria, daughter of Maximilian I, Holy Roman Emperor.

How much, one wonders, is the woebegone expression of the groom related to the ceremony? Perhaps he had dined too well, or perhaps it was the appearance of the bride seated beside him, surely one of the ugliest on record. High hopes were placed in this union of the major powers of Europe, but the result was disappointing, for Juan survived his marriage by only six months.

Robert Louis Stevenson, writing of Sir Henry Raeburn's paintings, says: "These portraits are . . . a piece of biography . . . racier than many anecdotes, and more complete than many a volume of sententious memoirs." Could words indeed describe a Renaissance woman of intellect as adequately as she is embodied in the portrait of a young girl (page 89) with bulging forehead, high cranium, and wan complexion?

This panel, attributed by many critics to Leonardo da Vinci himself, is thought to represent Beatrice d'Este, who married at 16, undertook a vital political mission to Venice at 17, and was the friend of such geniuses as Leonardo, the architect Bramante, and Baldassare Castiglione, diplomat and man of letters. With her husband, Lodovico Sforza,

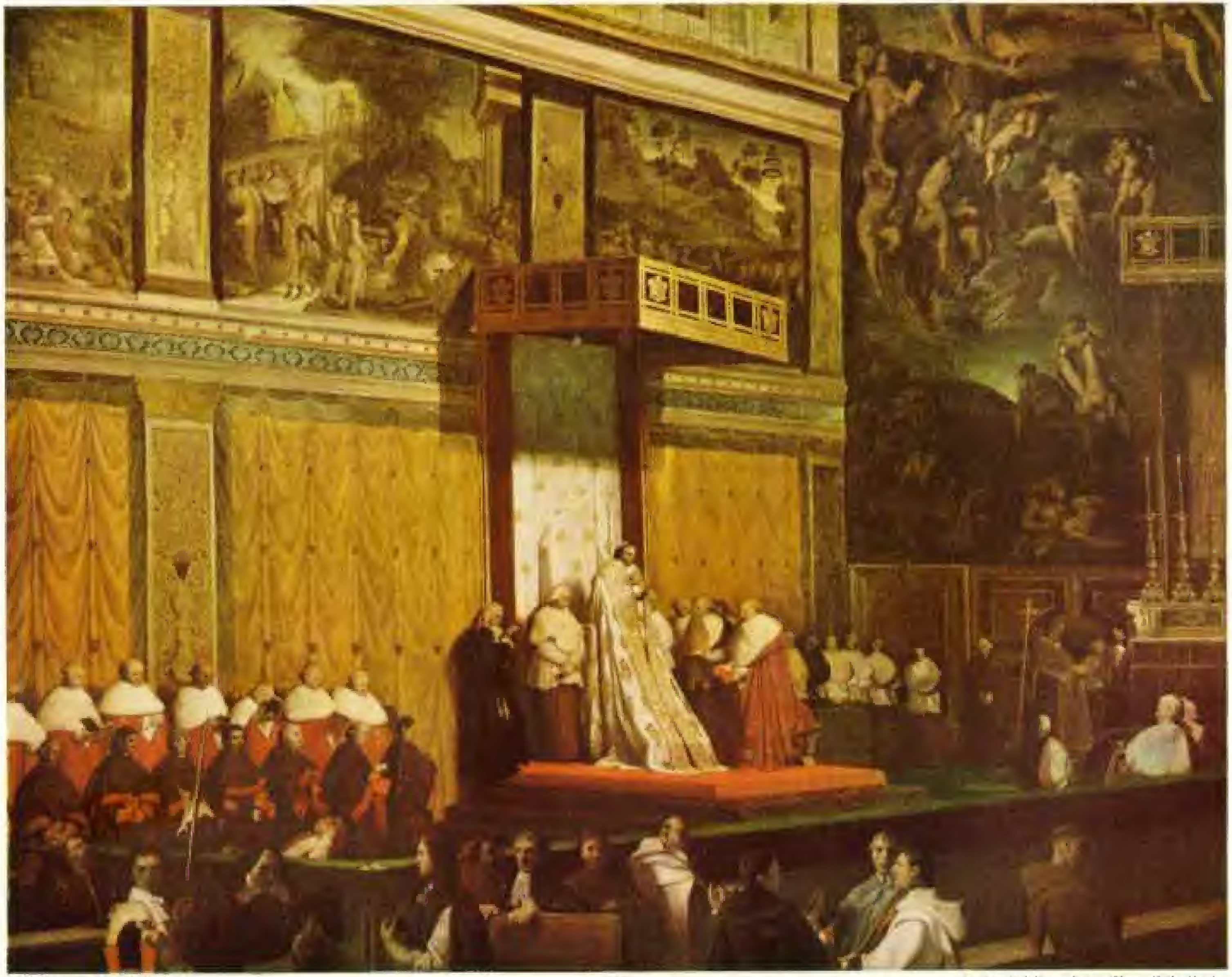
TITIAN (1477?–1576), Italian • *Portrait of a Young Lady as Venus Binding the Eyes of Cupid*

With this painting the NATIONAL GEOGRAPHIC MAGAZINE introduces 24 works of art from the Kress Collection in the National Gallery of Art, Washington, D. C. "Portrait of a Young Lady as Venus" is one of the 119 paintings and 18 sculptures recently acquired from the Samuel H. Kress Foundation and shown at the Gallery's tenth anniversary exhibition.

While approaching a century of age, Titian died of the plague. Venetians so idolized him that, disregarding a law that no plague victim could be buried in a church, they laid him to rest in the Church of the Friars near two of his altarpieces. In this painting, a recent cleaning brought to light the gift-bearing arm (right). Originally sketched in, it had been painted over.

LUCA SIGNORELLI (1441?–1523), Italian • *Calvary*

SEBASTIANO DEL PIOMBO (1485–1547), Italian • Cardinal Bandinello Sauli, His Secretary, and Two Geographers



JEAN AUGUSTE DOMINIQUE INGRES (1780–1867), French • Pope Pius VII in the Sistine Chapel

National Gallery of Art (Kress Collection)

HUBERT ROBERT (1733–1808), French • The Old Bridge

CANALETTO (1697–1768), Italian • *The Basin of St. Mark's*

The fame of Antonio Canale (Canaletto), son of a theater decorator, rests chiefly on his Venetian scenes. His glorious canvases keep alive memories of the days when Venice was the world's loveliest and gayest city. On and off for eight years the Italian painter worked in England, where he was immensely popular, but he always returned to paint his Venice. Five domes of St. Mark's Cathedral rise to the right of the bell tower (center).

National Gallery of Art (Kress Collection)

PIETER BRUEGEL THE ELDER (1525?-69). Flemish • Landscape with the Temptation of St. Anthony Abbot

PHILIPPE DE CHAMPAGNE (1602–74). French • Omer Talon

Born in Brussels of Flemish parents, Champagne went to Paris when he was 19 years old; hence he is classed by the French School. As a portraitist, he achieved lifelike resemblance. His glimpses of Richelieu are so real they make the Cardinal seem still alive.

In this life-size painting of Omer Talon, 17th-century writer and jurist, Champagne developed a dramatic harmony of reds. Talon's eyes seem to follow any beholder walking past the portrait. Until recently the picture remained a possession of the De Buffet family in their French castle.

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JEAN BAPTISTE SIMÉON CHARDIN (1699–1779), French • The Attentive Nurse

Chardin, a simple man, lived in the workers' quarter of Paris. Such mundane things as pots, bread, bottles, and fruit interested the artist, who painted them with passion. Child, nurse, scullery maid, and old man—such humble folk helped him grasp the meaning of everyday life. Chardin's reputation has grown with time. Today he is esteemed as perhaps the first modern artist.

"The Attentive Nurse," a possession of Liechtenstein's princely family since it was painted, was flown to the United States last winter.

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SIR ANTHONY VAN DYCK (1599–1641). Flemish • Doña Polyxena Spinola Guzmán de Leganés

BERNARDO STROZZI (1581–1644). Italian • Bishop Alvise Grimani

UNKNOWN ARTIST (Mid-16th Century), Italian • *Alessandro Alberti with a Page*

There can be no doubt about the identification of this handsome Italian gentleman: his name and age (30) are given in the letter on the table.

Critics are sad and very curious about the model, however. What they would like to know is the name of his brilliant portraitist. It seems likely that they will never learn. The painter's signature has been so tantalizingly obliterated that even the infrared ray cannot decipher it.

Whoever the artist was, he appears to have been a pupil of Titian (page 77). He resembles the master in his straightforward, convincing portrayal of features and personality; and it is known (again the letter) that he worked in Venice, Titian's headquarters.

Something of Lorenzo Lotto, Titian's competitor, may be seen in the page's sad, appealing gaze.

UNKNOWN ARTIST (Early 16th Century), Italian • Portrait of a Young Lady

Most authorities identify the sitter as Beatrice d'Este, Duchess of Milan, a beautiful and accomplished lady of the Italian Renaissance. She was betrothed at the age of 5 to Ludovico Sforza, a diplomat who later became the Duke of Milan, and married him when she was 16. Presiding over a glittering court, Beatrice surrounded herself with scholars, poets, and artists. She revealed political ability as her husband's ambassador to Venice in 1492 and as his assistant at the peace conference at Vercelli three years later. Death cut short her brilliant career at the age of 22.

Beatrice and her husband were patrons of the gifted Leonardo da Vinci. Many critics believe Leonardo himself painted this portrait, but the Kress Foundation prefers to follow the more modest attribution to the master's studio.

Head in profile and bust turned slightly forward give the pose a dynamic quality. Leonardo was the first to introduce this attitude in portraiture.

MASTER OF ST. GILLES (Late 15th Century), French • *The Baptism of Clovis*

Legend says Clovis I, King of the Franks, locked in battle with the Germans in 496, swore to become a Christian if he won. He did. This painting represents his baptism by St. Remy as having occurred in Sainte Chapelle, Paris. Actually, Clovis was baptized in Reims. The old facade of Paris's Palace of Justice (left) has vanished.

MASTER OF ST. GILLES • The Conversion of an Arian by St. Remy

The anonymous artist is known as the Master of St. Gilles because in two paintings in the National Gallery of London he represented scenes from the legend of that holy man. Here he shows the Arian bishop's conversion to Catholicism before the façade of Notre Dame. The Gothic chapel of the original Hôtel Dieu, founded about 660, appears on the right.

SEBASTIANO DEL PIOMBO • *Portrait of a Young Woman*

Sebastiano Luciani (Piombo) was influenced by four great masters of Italian art. As a youth in Venice he studied under Giovanni Bellini and Giorgione. After going to Rome in 1511, he came under the sway of Raphael and Michelangelo.

Sebastiano started his career as a lute player. In later years he was appointed to the lucrative Vatican job of the piombo (keeper of the seals). So highly did he prize this office that he adopted its name as his own. Thereafter he seldom painted. Many pupils sought training from him, but the self-indulgent Sebastiano taught them little.

Late in life the artist quarreled with Michelangelo over the latter's "Last Judgment." Sebastiano encouraged the Pope to insist it be executed in oil. Michelangelo, who wanted to do it in fresco, told the Pope that oil was fit only for women and sluggards like Fra Sebastiano.

Sebastiano is best known for his portraits (page 79), which are often mistaken for those of Raphael. One of his best is that of Christopher Columbus in New York's Metropolitan Museum of Art.

This portrait, loosely inscribed "V. [Colonna]," may represent Vittoria Colonna, a Renaissance poet whom Michelangelo made the subject of some of his finest sonnets.

National Gallery of Art (Kress Collection)

GIROLAMO ROMANINO (1485?–1562), Italian • Portrait of a Man in Armor

Though he worked chiefly for provincial patrons, Romanino insisted upon generous compensation. Rich but stingy peasants in one hamlet were made to feel the artist's scorn when they complained of the sandy dress he gave to the St. Christopher in their altarpiece. Short skirts, Romanino told them, were the result of short pay.

By this red-bearded sitter's elegant sleeves we may conclude that he did not cavil at the painter's price. His luxurious plumed hat is as large as any in his day; his armor is ample and gleaming.

In spite of his provincial training (in Brescia), Romanino's portraits have often been confused with those of Giorgione and Titian. This picture, for example, reflects Giorgionesque elements in the full face pose and the figure's rigid horizontal and vertical lines. Sharp reflections on the armor give evidence of Titian's influence.

Romanino's large religious compositions do not command the esteem of his portraits. They are sometimes marred by exaggerated movement and oppressive coloring.

Authentic Giorgiones are few. Many of his works, frescoes on the walls of Venetian palaces, have been destroyed. His surviving paintings are marked by luminous colors and harmonious composition.

ALBRECHT DÜRER (1471–1528), German • Lot and His Daughters

About 1500, Nürnberg was the Florence of Germany. Where the Italian city emphasized beauty, its German counterpart stressed expression. Champion of the Nürnberg School was native Albrecht Dürer, a goldsmith's son. A thinker as well as artist, he had an insatiable intellectual curiosity. In that respect he rivaled Leonardo and Michelangelo.

Italians have said Dürer would have been their greatest artist had he been one of them. The German Goethe wrote, "When we know Dürer, we recognize that in truth, solidity, and even grace, his only equals are the greatest of the Italians."

As a painter, Dürer was the most important and gifted of the German School. As an engraver, he was perhaps the greatest of all time. His paintings, though original and vigorous, were often marked by stiffness and unimspired color, but his engravings are beyond criticism.

In this painting, executed in a free, water-color-like manner, Dürer pictures Lot and his unmarried daughters fleeing Sodom's rain of brimstone (Genesis 19:24). Gomorrah burns in the distance. Lot's wife, turned into a "pillar of salt" for looking back, is left standing on the road. Violent explosions suggest the unleashing effect of an atomic bomb.

UNKNOWN ARTIST (Late 15th Century), French • ***A Miracle of St. Benedict***

Born in Norcia, young Benedict studied in Rome, but, shocked by urban corruption, retreated to the mountains of Subiaco. There he spent three years of solitary prayer as a hermit.

As word of Benedict's austerity and wisdom spread, disciples gathered around him. To bring order to his new community, he organized 12 monasteries. Catholicism's famed Benedictine Order dates from that act. Later St. Benedict moved to Monte Cassino and established the mountaintop abbey which served as a lighthouse of knowledge during the Middle Ages. Allied artillery crushed the abbey during World War II.

This painting, believed to have originated in the studio of Simon Marmion, records one of Benedict's holy deeds. While praying in his cell (left), he saw a vision of his disciple, St. Placidus, who, while drawing water, had fallen into a lake. Benedict sent St. Maurus to the rescue. Here Maurus, walking on the water as if on solid ground, pulls Placidus to safety.

A. D. 543, St. Benedict foresaw his own death of fever. Six days before the event, he ordered his grave to be opened. After being carried to his chapel, he died in prayer.

GIOVANNI BATTISTA PIAZZETTA (1682–1754). Italian • Elijah Taken Up in a Chariot of Fire

National Gallery of Art (Kress Collection)

BENOZZO GOZZOLI (1420-97), Italian • Dance of Salome and Beheading of St. John the Baptist

SODOMA (1477–1549) Italian • *St. George and the Dragon*

UNKNOWN ARTIST (Late 15th Century), Spanish Flemish • The Marriage at Cana

UNKNOWN ARTIST (late 15th Century), Flemish • *Mary Queen of Heaven*

This anonymous artist "transplanted into Heaven a musical performance of his own time," as one critic put it. He made the old fashioned instruments stand out with precision. Even the musicians' finger positions are correct, and the musical scores are legible. The heavenly orchestra plays lutes, shawms, harps, vielle (viol), and portable organs.

Angel musicians in two groups surround the throne of the Holy Trinity (background) and the Virgin Mary at the moment of Assumption.

"Mary Queen of Heaven" contains evidence that the painter received his training in Flanders. Discovery of the panel in a monastery near Burgos suggests he was active in Spain.

she wove that delicate fabric of intrigue which supported his supremacy at Milan. At 22 she was dead, and with her death disaster pursued her husband until, as a contemporary wrote, everything fell into ruin, and the court which had been a joyous paradise was changed into a black inferno.

Early Atlas Shown in Painting

An equal misfortune overtook with similar speed Cardinal Bandinello Sauli. Some hint of this appears in the painting by Sebastiano del Piombo, signed and dated 1516 (page 79). The melancholy Cardinal seems bemused, his eyes rimmed and sleepless. The figure leaning forward on the left whispers, while two geographers discuss some point connected with an open atlas, perhaps the unlucky war then being waged by the Vatican against the city-state of Urbino.

Less than a year after this group portrait was completed, Cardinal Sauli, opposed to this senseless and costly struggle, was implicated in the plot of another cardinal to poison its instigator, Pope Leo X. The conspiracy failed, Sauli was confined in the lowest dungeon of Castel Sant' Angelo and, though shortly afterwards released, died within a few months.

On the Cardinal's white cassock appears a fly. So well drawn and shaded is this insect that the guards at the Gallery are constantly on the alert lest some visitor try to flick it from the painting (page 102). Such a touch of illusionism is rare in 16th-century Italian art. Perhaps the fly was added to suit the taste of this Cardinal from Genoa, a city in close contact with the Netherlands, where artists delighted in such effects.

A hundred years later the same city, Genoa, was a temporary residence of Sir Anthony Van Dyck, one of the greatest Flemish artists. While there he painted the local nobility and among them several members of the Spinola family. One of these was Polyxena (page 86), daughter of Ambrogio Spinola, the general who so gracefully receives the keys in Velásquez' painting of the "Surrender of Breda."

As Polyxena wears a Flemish dress, she may have been painted at Antwerp after Van Dyck's return from Italy. In the 17th century, society and art take on a new internationalism.

The interchange of artists between Italy and the North after 1600 became, in fact, so common that it is sometimes difficult to determine not only the attribution but even the nationality of a painting. The portrait of Bishop Alvise Grimani (page 87), for example, was at one time attributed to Van Dyck, but is now recognized to be by Bernardo Strozzi, known as Il Prete Genovese, or the Genoese Priest.

Though Strozzi took vows as a Capuchin, he left his monastery to support his mother. After her death he refused to return to monastic life and was condemned to three years' imprisonment. He escaped and fled to Venice. There his lost vocation proved no handicap to his work for the Church, and during the last 13 years of his life he turned out numerous religious paintings.

Paintings offer insight not only into the character of individuals but also into the spirit of cultures. Contrast, for example, two pictures which may even have been painted the same year, around 1560, one in Italy (page 77), the other in Flanders (page 83).

Titian reflects the opulence of Venice, of the Renaissance where man is the measure of all things, and the refined satisfaction of his senses an ultimate purpose of art. Pieter Bruegel the Elder, on the other hand, lived beyond the Alps in a country swept by the anguish of reform, where the soldiers of Alva with fire and blood were trying in vain to reforge the lost unity of Europe. This world is more like ours. In "Landscape with the Temptation of St. Anthony Abbot," the warfare in the skies and the evil things on the ground seem a preview of that Armageddon we fear today.

Painters Played Tricks with Time

The paintings in the Kress exhibition extend in date from Giotto to Ingres, from the 13th century to the 19th. Among the most important 15th-century paintings to come to America is the small panel by Benozzo Gozzoli (page 97). Medieval and Renaissance artists, refusing to be limited by the fact that a picture can show only one moment in time, often represented several scenes of a story in a single composition. So Salome dances in the foreground, and, as a consequence, John the Baptist is shown being decapitated on the left, while in the middle distance Herodias receives the head of the Saint.

The scene has the intensity of high tragedy: Salome dances with a lithe insouciance; Herod Antipas, enthralled and aghast, grasps a knife and touches his heart, a wonderfully apt gesture. Each courtier acts a different role. The sycophant at the end of the table looks away; the older man turns to the King with a glance of sorrowful pleading; and the young dandy on the right stares at Salome with cold but possessive passion.

Of about the same time is a panel by a northern artist working in the studio of Simon Marmion, which likewise represents more than one event in a single picture (page 95). Here St. Benedict is shown sending St. Maurus

Hill National Geographic Photographer Ernest J. Ostrell

"Look! A Fly on the Picture!" A 16th-century Artist's Joke Still Fools Beholders

Sebastiano del Piombo, perhaps at the request of his subject, Cardinal Sauli, added a rare touch of realism to this painting—a butterfly so carefully drawn that many persons try to shoo it away (pages 79 and 161). Guards watch to see that they do not actually brush the painting.

to the rescue of the drowning St. Placidus. Though the scene is dramatic, its mood is serene, timeless, with even the colors subdued to the grays and blacks of monastic life.

How explosive by contrast seems another painting, two centuries later! Elijah is carried to Heaven in a chariot of fire (page 90). Giovanni Battista Piazzetta in this ceiling decoration represents every figure as if tossed by a whirlwind of flame. But in all this turbulence a wonderful clarity of draftsmanship is maintained. The hands of Elisha are among the most beautiful in art.

Later in the 18th century the tempo again changes, becomes slower, as if people were weary from excess of thought and emotion. Taste turns to the charm of "far-off things and battles long ago." Robert's nostalgic love of the crumbling monuments of the Campagna, as in his Ponte Salario, heralds the coming vogue of Romantic sentiment (pages 74, 81).

Venice was the pleasure resort of the 18th-century world. Its popularity fostered an insatiable desire for paintings of the more famous views, such as the Grand Canal and the Basin of St. Mark's (page 82).

Antonio Canaletto painted these scenes so often and so vividly that, after looking at many of his works, actuality and fantasy merge in the mind until, sight-seeing in Venice, I have sometimes admired the perspective and reached out to touch the canvas before realizing that I was myself standing inside the picture.

But while Canaletto painted, Venice was dying; and with the end of its independence the center of Italian life moved to the Vatican. It is appropriate that the most recent painting (page 80), done by Ingres and dated 1810, shows a scene in the Vatican with Pius VII surrounded by ecclesiastical dignitaries, each carefully portrayed.

Ingres himself appears as the fourth brown-clad figure below the Cardinals. In the background are frescoes by Cosimo Rosselli, Botticelli, Perugino, Pinturicchio, and Michelangelo which decorate the Sistine Chapel. Thus Ingres's picture seems a symbol of the indestructible connection between the Old Masters and the beginnings of modern art.

The Kress Foundation has acquired sculpture as well as paintings. Fortunately it was possible to buy the entire Dreyfus Collection of Renaissance bronzes, some 1,300 in number. These were assembled by a French connoisseur, Gustave Dreyfus, who was determined to have a collection as great as any existing in the world.

After the Franco-Prussian War and continuing until his death in 1914, Dreyfus spent almost all his time trading, exchanging, and seeking unique pieces, early castings, and perfect examples. Because bronze becomes more beautiful the more it is polished, two of his daughters, who never married, spent their days polishing and repolishing.

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A Squeamish Owner Painted Out the Dragon's Dinner Course

Two human heads, an arm, and a foot originally decorated the foreground of Sodoma's "St. George and the Dragon" (page 98). After the Kress Foundation acquired the painting, X-rays revealed the alteration, and the overpaint was removed (page 76). Restoration is a ticklish process, involving chemical analysis of both the original and the new paint, then the use of solvents removing one and not the other. In some cases overpaint can be eliminated only with a scalpel, flake by flake.

Fortunately, the Renaissance bronzes were kept together after Dreyfus died. Addition of this collection has placed the National Gallery on a par with the greatest museums in Europe in the field of medals, reliefs, plaquettes, and small bronzes.

Likewise, in the field of French 18th-century sculpture Kress Foundation gifts, added to the pieces in the Widener Collection, place the Gallery in the foremost rank.

But benefactions on this scale, though received several times in the Gallery's short history, are not likely to be repeated. In the future its exhibition space will probably fill more slowly.

But already in its first decade the National Gallery of Art has received a great treasure of visual beauty. This has happened at an opportune time. All over the country the desire to see works of art has increased. During ten years more than 18,000,000 visitors have come to the Gallery.

People today are beginning to get such pleasure from looking at masterpieces as generations have received from listening to fine music. They are learning at the same time that all art is a stirring witness to human creativity, a witness that fortifies our faith in the dignity of man and our belief in the final triumph of Christian ideals.

For additional articles in the National Geographic Magazine on the National Gallery, see: "American Masters in the National Gallery," September, 1948, and "The Vienna Treasures and Their Collectors," June, 1950, both by John Walker; also "Masterpieces on Tour," by Harry A. McBride, December, 1948.

JESSE RICHARDSON HILDEBRAND

1888–1951

With profound sorrow the Board of Trustees and Officers of the National Geographic Society record the death, on September 18, 1951, of Jesse Richardson Hildebrand, senior Assistant Editor of the National Geographic Magazine since 1930 and a Life Trustee of The Society since 1946.

He was a brilliant writer on The Magazine's staff from 1919, a keen and sympathetic observer of human affairs, and a meticulous seeker for accuracy. Throughout 32 years of loyal, efficient service to The Society's journal he gave unstintingly of the riches of a mind made full by reading and wide travel. He was a scholarly lover of the finest in literature and music, as his extensive private collection of books and phonograph records attests.

Before joining the Editorial Staff of the National Geographic Society, Mr. Hildebrand had been a practicing newspaperman, rising from young reporter and dramatic critic on the old Washington *Times* to editorial and feature writer on the Washington *Evening Star*. He also for three years lectured on applied geography in the School of Foreign Service, Georgetown University, Washington.

Able, gracious, modest, and fair-minded, he won the respect and admiration of all his colleagues. He was ever ready to share and lighten the burdens of his friends. His passing is felt as a personal loss by all who were associated with him.

The Spotlight Swings to Suez

By W. Robert Moore

AS OUT of place as a camel on the ocean, a seagoing freighter crosses the desert. Invisible to desert folk two or three hundred feet away, the man-made waterway she plies is one of the most important on earth, the 82-year-old Suez Canal through Egypt's golden sands.

Even long-visioned Ferdinand de Lesseps, the Frenchman who brought Suez into being, woefully underestimated its possible usefulness. At best, he thought, the short cut cleaving the land bridge between Africa and Asia would serve only a few hundred ships a year.

Now in a typical year some 11,700 vessels ply the route, bearing more than 72,000,000 long tons of cargo and paying nearly $80,000,000 in transit fees—6,200 more ships and 43,000,000 more tons than the Panama Canal.

"To open the earth to all peoples"—this was De Lesseps' conception of the waterway's purpose as expressed in his favorite Latin phrase, *Aperire terram gentibus*. The heroic statue erected in his honor at Port Said seems eloquent of that intention (page 114). Of late the giant bronze figure has looked down upon scenes of disorder and tension as nationalistic Egyptians claimed the right to replace British troops as guardians of the canal.

Flags of the World on Parade

Until Egypt's abrupt scrapping of its 1936 treaty with Great Britain turned the Suez area into an armed camp, one could stand peacefully at the Mediterranean entrance of the canal, on the stone breakwater near De Lesseps' statue, and watch the parade of ships move by.

Often I have used that vantage spot to count the varied flags that flutter from sterns of passing ships—proud passenger liners, rust-splotched freighters, and long, heavy-laden oil tankers. All peoples were benefiting, far beyond De Lesseps' dreams.

This Mediterranean-to-Red Sea channel scooped through Egyptian sand and marsh brings the raw material-rich East closer to the industrial West by the length of a continent. A voyage between London and Bombay via Suez is 5,100 miles shorter than the old sea route loping around Africa's southern tip.

Money saved in moving billions of barrels of oil from the Persian Gulf and Saudi Arabia fields alone has totaled more than enough to pay the bill for the canal's original cost.

De Lesseps' success in finally giving substance to his dream was due in part to horsemanship, marksmanship, and macaroni! All three had a bearing on his long friendship with Mohammed Said.

As a youth Mohammed Said was fat. His father, the sinewy Mohammed Aly, often put him on short rations and strenuous exercise. Hungry, the youth visited his friend De Lesseps, then a consular officer, and filled his stomach's void with good macaroni. The French official also taught him to ride.

The marksmanship incident came later, after Mohammed Said, grown to manhood, had been named Viceroy of Egypt under the Turkish Sultan. A display of accurate target-shooting by De Lesseps gave him his golden opportunity. He told the admiring Viceroy of his ambition to build the canal. His friend immediately pledged support.

Canal Board French-controlled

Khedive Ismail, successor to Mohammed Said, likewise supported the project, and it was this free-spending ruler who played host at the fabulous entertainment heralding the canal's opening on November 17, 1869. The French yacht *L'Aigle*, with Empress Eugénie of France aboard, led the grand inaugural procession through De Lesseps' ditch.

When De Lesseps had broached his ambitious plan, London at first had opposed it, and the shares he offered failed to attract many British investors. But Queen Victoria's Prime Minister, the astute Disraeli, recognized the mistake and successfully repaired it. Six years after the canal's completion, he borrowed $20,000,000 from the Rothschilds to buy for Britain 176,602 shares offered for sale by the bankrupt Viceroy Khedive Ismail.

The canal is owned and operated by a corporation called the Compagnie Universelle du Canal Maritime de Suez, incorporated in Egypt. Its 32 directors meet in Paris. They include 16 Frenchmen, who retain permanent controlling interest; 10 British; four Egyptians; a Netherlander; and (since 1948) one American, S. Pinkney Tuck, former U. S. ambassador to Egypt.

By the Suez Canal Convention of 1888, the present waterway is "always to be free and open, in time of war as in time of peace, to every vessel of commerce or of war, without distinction of flag."

When De Lesseps gained his original concession, he secured a lease for 99 years. In normal course, Egypt would be due to gain full control of the canal in 1968.

As ships grew bigger, there was a constant demand for a wider, deeper cut than the original "ditch in the desert," 72 feet wide and 26 feet deep. Squealing dredges poured out torrents of mud to keep up with requirements.

By World War II the channel's width had

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Drawn by Herbert E. Harwood

Suez Canal Divides Continents, Links Seas, Saves 5,100 Miles London-to-Bombay

Called "jugular vein of Empire," the sea-level ditch is 100 miles long and an average 198 feet wide. In 1950 it carried 72,669,000 long tons of cargo, more than 2½ times as much as the Panama Canal but less than the Great Lakes' Soo Canal. Ferdinand de Lesseps opened the channel in 1869 after 10 years of digging. Last October Egypt demanded that Great Britain, guardian of the waterway, withdraw her troops, but London reinforced the canal zone with men, planes, and warships. Clashes followed.

been expanded to 198 feet and the cut deepened to accommodate vessels with a draft up to 34 feet. The Canal Company has since been pushing an even larger expansion program to handle the greatly increased traffic, particularly behemothlike oil tankers.

Dredgers have set about deepening the channel by another 20 inches to handle ships drawing up to 36 feet of water. This alone involves removal of 8,800,000 cubic yards of earth and rock.

Suez never sleeps. Administrators, pilots, and workmen operate in shifts. Ships move in both directions, day and night, passing in wide spots afforded by lakes. Even so, delays persist. Ships with dangerous cargoes and those carrying royal mail have priority. Those lacking priority must halt.

New By-pass to Speed Canal Traffic

To remove the no-passing bottleneck of the 45-mile stretch between Port Said and Lake Timsah, a new seven-mile bypass has been cut near El Qantara. A tanker mooring station in Lake Timsah has been deepened.

In pre-canal times there was no Lake Timsah—only a marshy depression. When the northern section of the canal was completed and Mediterranean waters were let in, the lake materialized in five months. The town of Ismailia on its shore, and the gardens now blossoming in the desert sands, also owe their existence to the canal.

Port Said, at the Mediterranean entrance, and Port Taufiq, on the Gulf of Suez at the southern end, likewise are offspring of the waterway. But how they differ!

To ships, Port Taufiq is no port, for they pause only briefly here for pilots. Port Said, on the other hand, is as international a spot as one can find. In its shops passengers may buy goods from almost any port on earth. Hawkers on bobbing bumboats display a variety of cloth, rugs, jewels ("all genuine!"), and all sorts of gewgaws (pages 108-109).

Picturesque argosies glide through the canal beside trim modern ships. They are lateen-sailed craft of the East, winged with tall, plumelike, tilted sails. When winds fail, their crews harness themselves to lines and tow.

Before the big canal could be dug, fresh water had to be brought to the site for workers. It took four years to dig the Sweet Water Canal, which brings Nile water eastward to Ismailia. There it forks to extend north and south along the Suez Canal route.

In building the Sweet Water Canal, workmen found plenty of evidence that they were not the first to construct a watercourse through this section of the land. They came upon long-forgotten channels in the natural depression, called Wadi Tumilat, which stretches between the Nile and Lake Timsah.

(Continued on page 115)

Like a Ruled Line, the World's Longest Man-made Short Cut Splits the Sinai Desert

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Without the Suez Canal, Bustling Port Said Would Be a Bare Sandspit

The city's growth began in 1859 when diggers started erecting huts; now the population is 178,000 and buildings are still going up. Until oil replaced coal, the port was the world's largest and possibly sootiest coaling station.

Bargaining Bumboats Besiege Vessels Moored at the Mediterranean Entrance

When travelers stay aboard during short stops, Egyptians row out in floating stores and offer everything from gewgaws to genuine oriental rugs. Most water taxis here lie idle, as passengers take the pontoon bridge (center).

National Geographic Photographer J. Baylor Roberts

Suez Company's Office Seems to Float in Port Said Harbor. Nerve Center of the Canal, It Directs 24-hour-a-day Traffic

Opposite: When Mediterranean waters flowed into the man-made channel in 1862, they created Lake Timsah at the midway point and, beside it on the upper left, the city of Ismailia (page 113). Here the canal, coming in from the upper right, makes a sharp turn toward the port of Suez (map, page 106).

Suez Canal, most vital link in Britain's lifeline to the East, has never been captured. Germany's Rommel almost broke through in 1942; Britain's Montgomery chased him back. Turkey tried in vain in 1915.

United States Navy Secretary Dan A. Kimball said recently: "There is no argument—we have to keep the Suez open. That is up to the British at the moment."

Paul Thom Lloyd

A Canal-borne Liner Steaming Through Grasslands Appears as Unlikely as a Locomotive at Sea

Opposite: Strategic Ismailia lies beside Lake Timsah in the heart of the canal zone. When Egypt threatened the canal, British reinforcements rushed in by air and sea. They took over railroads, public utilities, and El Firdan Bridge (out of sight to the right), Egypt's land link with her army in trans-Suez Asia. Runways of Ismailia Airfield (left) and El Firdan field (right) form arrows pointing to Sweet Water Canal (center), which, flowing from the Nile, quenches the thirst of desert communities along the Suez waterway. Road in foreground leads to the port of Suez.

National Geographic Photographer J. Baylor Roberts

His Dream Came True. De Lesseps Stands in Port Said at the Head of His Canal

With no engineering experience, this Frenchman planned, promoted, and built the waterway. He talked Turkey's Viceroy of Egypt into giving right of way; four years passed before he raised the capital. Successful in building Suez, he failed when he tackled the mountain-blocked, fever-ridden Isthmus of Panama.

An Arab Dhow in the Gulf of Suez Calls to Mind the Canal's Age of Sail

Steam had not won the seas when the canal opened in 1869. Business was so slow that its owners faced ruin. Now the French-controlled Suez company is fabulously rich; gross earnings in 1950 exceeded $80,000,000. The British Government owns almost half the 800,000 shares, including a block bought from Egypt's bankrupt ruler by Prime Minister Disraeli (page 105). Egyptians normally hold most canal jobs.

Unlike De Lesseps' big ditch, which cuts the isthmus in virtually a straight north-south line, earlier canals were linked to the Nile. History indicates that the first of these may date back to the reign of Seti I of the 19th dynasty, about 1300 B. C.

Herodotus, the great Greek historian, records that about 600 B. C. Necho, son of Psametik I, began digging a canal to the Red Sea. He abandoned the project when an oracle warned that the canal might aid an Asiatic invader. A later project was given up because learned men feared that salt Red Sea water would flood the Nile Valley.

Centuries later, incidentally, Napoleon's engineers made a similar mistake—they calculated that the Red Sea was more than 30 feet higher than the Mediterranean. Actually their level is the same and Suez needs no locks.

Darius, Persian conqueror of Egypt, eventually completed Necho's canal, "the width being such as to admit two triremes being rowed along it abreast." It finally fell into long disuse, but in the year 640 Caliph Omar ordered it reopened. A little more than a century later it was closed again to keep goods from going to Arabia.

As far back as history can take one, the Isthmus of Suez has known the stresses of contention and rivalries. They existed when ancient Egyptian, Assyrian, and Persian armies marched and countermarched along its old caravan paths; when Joseph was sold into bondage in Egypt; when the Israelites began their 40 years of wandering; and when another Joseph fled into Egypt with Mary and the Infant Jesus.*

In both World Wars the Suez Canal was a prize sought in vain by the powers that ultimately lost. In troubled 1952 the free world watches lest the keys fall into unfriendly hands.

* See, in the NATIONAL GEOGRAPHIC MAGAZINE, "Sinai Sheds New Light on the Bible," by Henry Field, December, 1948, and "Suez: Short Cut to Empires," by Maynard Owen Williams, November, 1935.

Hans Bertram

Man Seems a Helpless Mite When Tortured Earth Belches Volcanic Fire

Erupting volcanoes show where our planet's crust is shifting (page 131). This lone explorer appears lost in an inferno on Mexico's Paricutin. Red-hot ash from the crater rises 24,000 feet at times. Cooling lava emits vapor.

Our Home-town Planet, Earth

Examining the Iron-hearted Globe, Science Gains New Knowledge of Earthquakes, Volcanoes, and Earth's Birth and Future

By F. Barrows Colton

SEEN from as far away as Mars, our native planet, Earth, would look like a bright star, a tiny island out in space, shining by light reflected from the sun.

For most people this is a new way to think of Earth, as a heavenly body, a planet, so accustomed are we to seeing it only as the solid ground beneath our feet.

But today everyone is growing "planet-minded." Rockets already have climbed to the upper borders of the atmosphere. There is serious talk of flying to the moon. New telescopes are exploring stupendous distances out into the vast universe. Constantly it is becoming easier to see Earth in its true perspective.*

So it is timely to take a new look at our old "home-town" planet, to see it for what it really is, a mighty whirling ball of rock, carrying more than two billion human passengers on a journey through the depths of space.

Mysteries of Mother Earth

Though man has been living upon the earth for tens of thousands of years, only recently has he begun to penetrate its inner secrets.

We still know more, in some ways, about stars billions of miles away than about what is happening inside the earth, a few hundred miles beneath our feet.

Our globe has been rolling around the sun for perhaps three billion years, but even today we know less about whence it came than of what may be its ultimate fate.

Fascinating mysteries still remain.

Was Earth condensed from one of many clouds of dust particles scattered through space when the universe was young? Or was it born as a globule of molten rock torn from the sun by a passing star?

Will our globe speed on forever at 66,600 miles per hour around the life-giving sun, or will it some day break up, sharing the suspected fate of one nameless planet?

How long can man survive on this little outpost in the infinite? How long can he count on continued stores of minerals, stowed away in Earth's crust?

We are just beginning to learn answers to some of these questions, and to understand the gigantic forces at work deep down in our restless globe.

Scientists by the thousands today are delving intensively into Earth's buried secrets, spurred on not only by curiosity but even more by the pressing need to find new supplies of oil, metals, and radioactive minerals to help keep modern civilization going.

"X-ray View" of Earth's Vitals

New understanding of earthquake waves gives us an "X-ray view" of Earth's interior down to its very center. As these vibrations spread out from earthquakes, some of them travel right through the globe. Reappearing on the other side, they record information about the kind and condition of the rocks they have passed through.

To pick up these messages, the earthquake experts constantly "keep their ears to the ground," day and night, around the clock, at 400 stations all over the world.

With a seismologist at Harvard University I watched these tremblings as they happened, "play-by-play." The shocks recorded wavy lines on a moving strip of paper that fed out like stock quotations on ticker tape (pages 120, 128).

Other scientists showed me how they squeeze rocks and metals in powerful presses and super-heat them in electric furnaces to duplicate terrific pressures and temperatures several hundred miles inside the earth. Under these conditions familiar substances undergo weird, almost unbelievable, changes. Brittle-hard rocks are plastic at the same time; they can flow like cold molasses.

All over the world geologists are exploring between decks in our "spaceship" to learn what stores remain on hand for the long voyage ahead. Most supplies are believed ample for a long time still.

Earth as Seen from the Moon

For an over-all look at Earth, take a trip to the moon in imagination and look back at the planet you've left behind.

Seen from that distance, averaging 239,000 miles, Earth would loom up in the sky as a whitish disk four times the diameter of the sun. It would show outlines of our continents, white cloud banks drifting across it, and perhaps flashes of sunlight reflected from seas and lakes.

Circling closer on a spaceship, you would see what most of us forget, that water covers

* See "Mapping the Unknown Universe," by F. Barrows Colton, National Geographic Magazine, September, 1950.

U. S. Navy, official

Sired by a Volcano, an Island Is Born Out of the Sea Off Japan

Erupting islands arise at intervals in this region of frequent earthquakes and volcanic outbursts. Usually they sink or wash away. Bogoslof, the Aleutians' jack-in-the-box island, has emerged and disappeared periodically.

nearly three-fourths of our planet (71 percent), with continents rising like gigantic islands out of the enveloping sea.*

With a weight of more than six sextillion tons, this mighty globe measures 7,926.68 miles in diameter at the Equator and 24,901.96 miles around. Centrifugal force of rotation bulges it out 13 miles more at the Equator than at the slightly flattened poles. It is both more rigid and more elastic than steel.

In proportion to our globe's huge bulk, its surface is smooth. Were it the size of a basketball, the five-mile-high peaks of the Himalayas would rise no higher than the thickness of a half dozen dabs of paint. The deepest troughs in the ocean bottom would be pin scratches.

Of the 29 percent of the earth that is not covered by salt water, about two-fifths is desert, if one counts both waterless areas, like the Sahara and Gobi, and regions too cold for crops (pages 130 and 131). Another 30 percent is pasture, forest, marsh, wasteland, and lofty mountains.

Only a third of all the land, a mere one-tenth of the Earth's surface, is suitable for raising crops. Yet this fraction feeds more than two billion people, augmented by the herds that graze on the pasture lands, fish from lakes and oceans, and some wild game.

Vast areas of "perma-frost," frozen ground that never thaws below the surface, take up

* See "Our Global Ocean," by F. Barrows Colton, National Geographic Magazine, January, 1945.

119 Bob Bryant, International News Service

Too Close for Comfort! Tumbling Blocks of Steaming Lava Chase a Sight-seer

Two theories may explain volcanic "fire": (a) radioactivity deep underground or (b) Earth's primeval, unexpended heat. This mass pours from Minami Dake, Japan. Molten lava pushes the cooling fare forward.

one-fifth of Earth's land area, in Asia, Alaska, and northern Canada. Almost half the territory of Soviet Russia is permanently frozen. Some perma-frost areas have been frozen for tens of thousands of years, in places as deep as 1,300 feet.

Thick ice blankets one-tenth of the globe's land area, most of it locked in Greenland and Antarctic icecaps (page 134).

Heavens Rain Iron and Stone

A hail of missiles from outer space rains down upon Earth as it spins along on its endless elliptical course, but its tenuous outer blanket of air protects our homes, farms, cities, and all of us from harm.

Ultraviolet rays from the sun would destroy all life, if they were not stopped about 20 miles up by a thin layer of ozone gas.

Now and then, too, Earth plows through a swarm of millions of meteors, mostly no larger than a grain of sand. Since they move as fast as 45 miles a second, their impact could be as deadly as a .45-caliber bullet at point-blank range. Earth's atmosphere saves us from this lethal barrage by burning up the speeding particles before they strike.

Occasionally, larger chunks, pieces of meteoritic iron or stone weighing up to 50 tons or more, do get through to the earth's surface. About 1,450 of all sizes have been found so far.

Now and then part of a comet or a giant meteor rams into the earth with an impact

120 Walter R. Fleischer

A Seismograph Takes the World's Quaking Pulse

With this device Prof. L. Don Leet of Harvard University can see earthquakes recorded as fast as they occur, all over the globe, even as a broker watches market changes on a ticker tape. Wavy lines drawn automatically on the moving paper register tremors minute by minute as they are picked up in a vault below. Some 2,700 quakes a day jar the earth (page 128).

that would be disastrous if it struck a populated region. Newest evidence of such a collision is Chubb Crater, 1,325 feet deep and averaging 11,300 feet in diameter, gouged out of the hard granite of northern Quebec's wilderness in the distant past (page 1).

Two such bodies have struck the earth in modern times. In 1908 some vagabond object from outer space hit eastern Siberia with a crash heard 900 miles away. Forests were devastated over 100 square miles; earth shocks were recorded 3,500 miles away and persisted for 30 hours. Pressure waves in the atmosphere threw people to the ground many miles from the scene.

In 1947 another comet struck Siberia, 200 miles north of Vladivostok. A shock wave of compressed air, pushed ahead of the plunging body or bodies, shattered rocks and is believed to have thrown trees miles high.

Certain of these objects, some scientists believe, may be all that is left of another planet that burst, or was otherwise destroyed, long, long ago. Like Earth, this planet is thought to have had an iron core. The iron meteorites that fall today may be pieces of it. This "lost planet," probably smaller than Earth, moved in an orbit between Mars and Jupiter.

Earth Wobbles Like a Top

Our native spaceship travels a complicated course. Like a top, it rotates on its axis, once every 24 hours, spinning faster than 1,000 miles per hour at the Equator.

Also like a top, Earth wobbles as it turns, but so slowly it takes 26,000 years to complete one "wobble." In that time the North Pole slowly moves around a circle. About 12,000 years from now it will point toward the bright star Vega, which will then replace Polaris as the North Star.

This slow-motion wobble is caused by varying pulls exerted on the earth by the gravitation of the sun, moon, and planets.

Our spinning Earth moves once a year around the sun, at 18½ miles a second, and travels along with the sun and other planets at 13 miles a second with respect to the nearest stars. With the sun, too, we travel in a local group of stars that speeds at 200 miles a second in relation to other star groups in the Milky Way.

Moving with the Milky Way

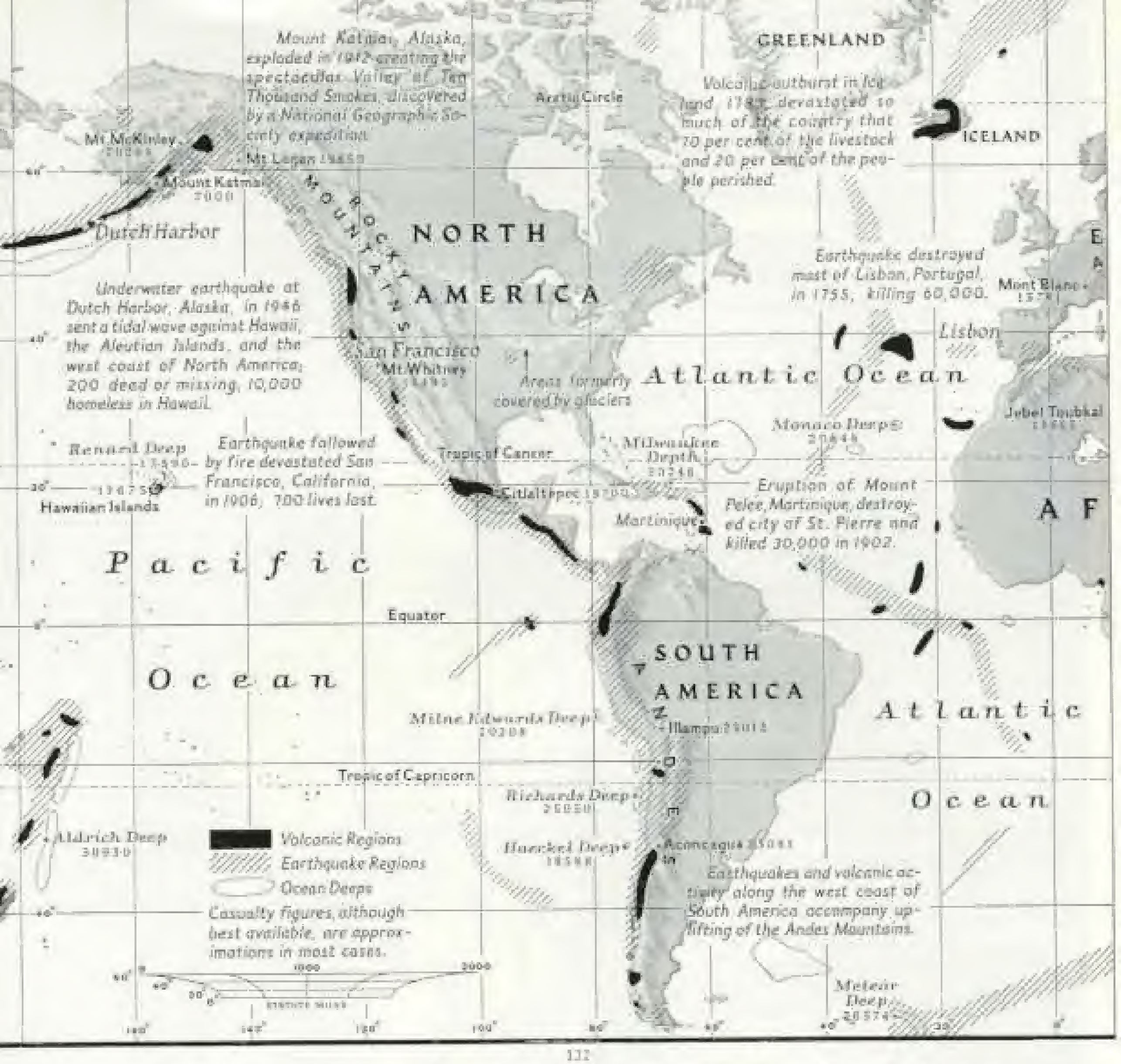
As if all these movements were not enough to make us dizzy plotting them, Earth also is carried along with the whole Milky Way as this vast star system turns ponderously, like an enormous wheel, once every 200 million years.

When and how did Earth begin? It is easier to tell when than how. Scientists cal-

121 National Geographic Photographer J. Baylor Roberts

A Make-believe Quake Rocks Building Models, Showing What Happens in a Real Temblor

Multiple images caught by the camera reveal how miniature skyscrapers whip back and forth on the shaking table in a demonstration at California Institute of Technology. Such tests help design safer structures.



Earthquake and Volcano Zones Reveal Where Earth's Restless Crust Is Heaving

culate Earth's age from the rate at which radioactive elements, such as uranium and thorium, decay and change into lead. From the amount of lead formed, it is possible to tell how long the uranium has been decaying. It is somewhat like estimating how long a fire has been burning from the size of the pile of ashes.

Uranium in the oldest known rocks of the earth has left a residue of lead that indicates it has been decaying for more than three billion years.

Ideas differ on Earth's origin. Some astronomers have thought it and its fellow planets split off somehow from the sun, as fiery globules of hot gas or liquid that cooled and solidified.

A newer theory is that Earth and maybe the rest of the solar system condensed from a cloud of dust and gas. If so, Earth was cold at first, then was heated later by radioactive material in this dust.

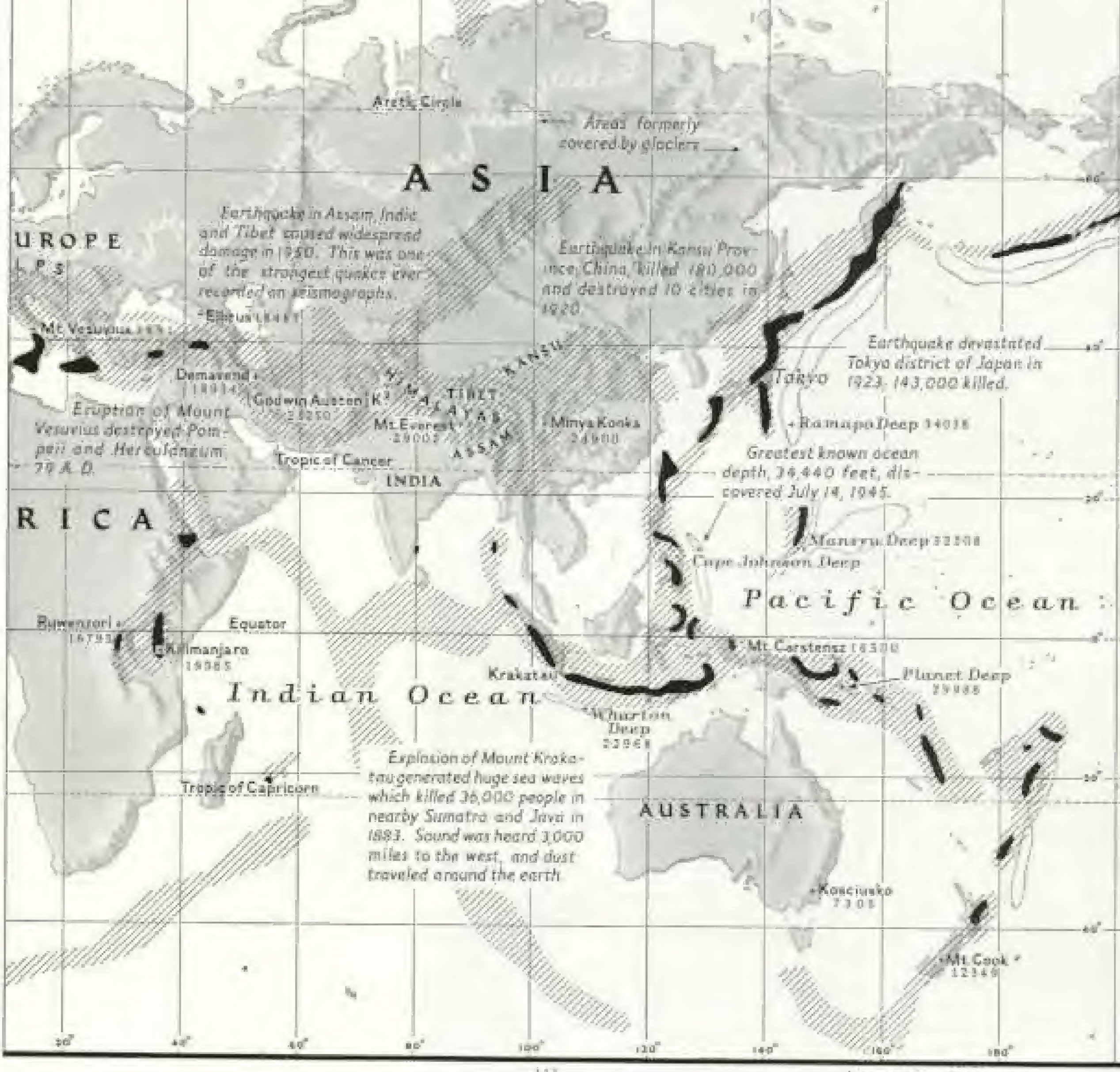
Many astronomers think the earth, the sun, the other planets, the distant stars, and all the rest of the universe were created at about the same time.

Old Earth Still Slowly Changing

Since earliest youth the earth has passed through torment and travail. Today it seems solid enough, save when an earthquake jars it.

Yet even now, after more than three billion years, this still is a moving, changing, restless body. Almost alive, it still heaves, cracks, shakes, and shifts.

In Earth's far-off youth, many geologists think, molten rock and metal churned and seethed within it like melted ore in a smelter. Just as in a smelter, the heavier iron sank,



123

Drawn for Irene B. Hickman

Mountain Chains Are Rising, Ocean Deeps Are Dropping along the "Belts of Fire"

while mixtures of rocks and minerals floated to the top like slag.

At last the surface cooled, but tremendous volcanic eruptions poured out masses of molten rock from below. These hardened to form an outer skin that still blankets the earth today.

Most of this material was dark and heavy basalt, which now covers the whole planet, forming the floors of the oceans and underlying the continents as well (page 135).

Granite, too, spewed up from below. Lighter than basalt, it rode higher, forming the base of the continents, which "float" like rafts on the heavier basalt "sea," but with roots that extend deep down.

Contraction of the earth's crust as it cooled may have played a part in mountain making. Slowly changing the face of Mother Earth, mountains are rising still.

Deep down inside, the earth is not quiet, geologists believe. Gigantic, sluggish currents are thought to move slowly in the solid but plastic rocks, circulating between the planet's hot interior and its cooler crust.

Rising or sinking under the crust, these currents may help to push up mountain ranges or pull down the crust to form depressions.

Moving horizontally under the crust, they may exert a drag that helps wrinkle it into mountain ranges, as a rug wrinkles when one edge is shoved.

One of History's Greatest Earthquakes

Slowly but inexorably mountain chains are rising around the edge of the Pacific, in the West Indies, beneath the Atlantic, and elsewhere. Some grow at the geologically high speed of inches a century.

U. S. Forest Service

San Andreas Fault Triggered the San Francisco Earthquake

This deep fracture in Earth's crust stretches 600 miles across California from Mexico to Point Arena. When its rocky sides slid past each other in 1906, shock waves toppled buildings in San Francisco, and some 700 people died. This San Luis Obispo County view shows the fault as a straight line. Huge bows indicate displacement of river beds. Ground movements on the left of the rift have broken streams and shifted segments a fifth of a mile apart. This motion has gone on for centuries. Tension still builds up (page 128).

What was possibly the strongest earthquake ever registered on seismographs, devastating upper Assam and part of neighboring Tibet in August, 1950, was a symptom of "growing pains" in the nearby Himalaya Mountains, which have been reaching higher and higher for 40 million years. Literally changing the face of Nature, the earthquake leveled hills, threw rivers out of their courses, destroyed villages and bridges, and twisted miles of railroad track.

Great faults, or cracks, caused by slipping of one rock mass over another, occur periodically in the earth's outer layers. They are seldom visible because many are beneath the sea, while on land many are buried by surface material.

Faults are fractures or breaks extending from the surface deep down into, or even through, the earth's crust. A block or section of the crust on one side of the fault has moved horizontally or vertically relative to the block on the other side.

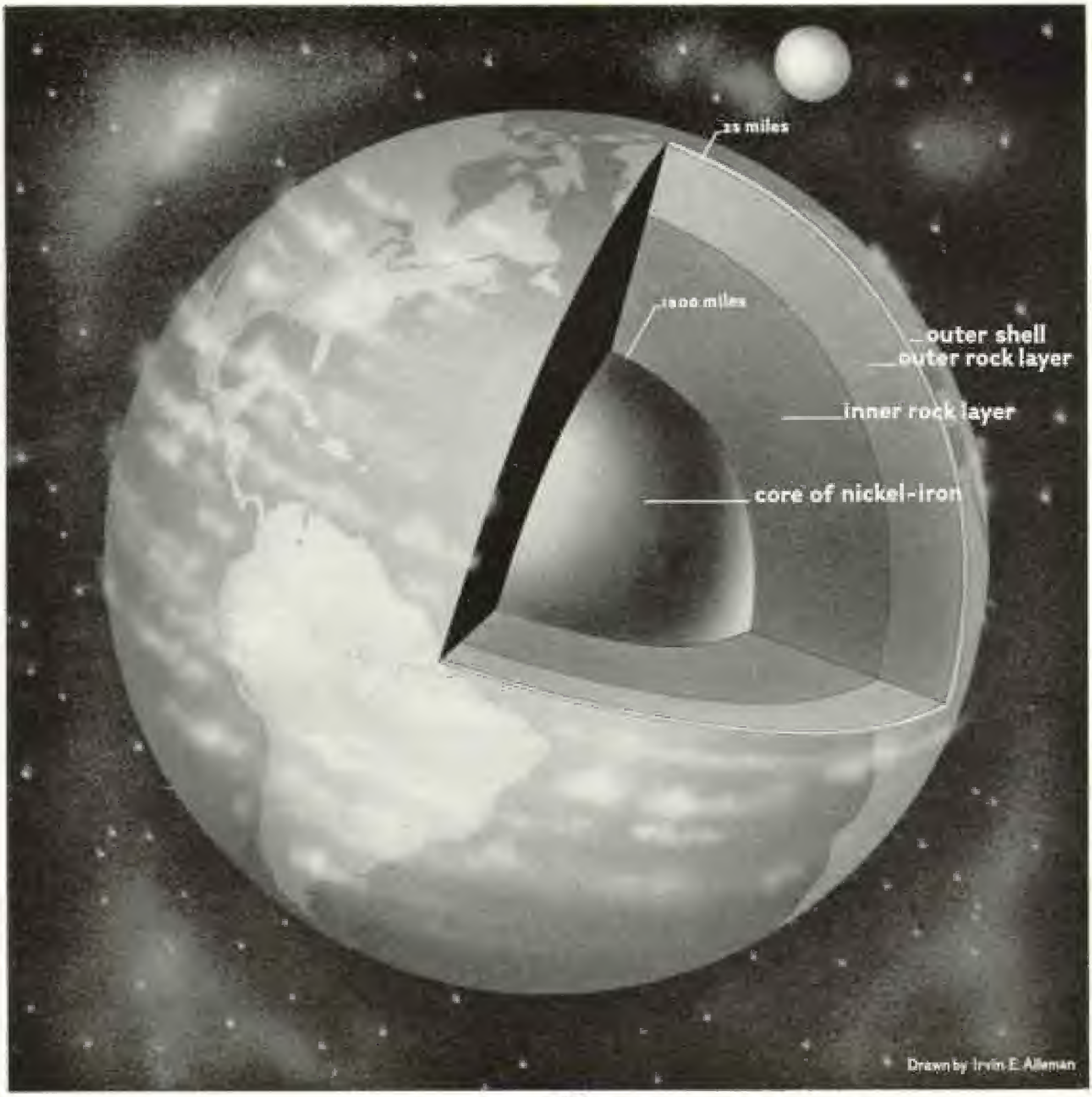
Some of these fractures are vertical, others inclined, and a few horizontal. In the horizontal type, the block or slab of rock above the fault may have moved forward horizontally for miles or even tens of miles across country. Faults range in length from a few yards to hundreds of miles.

Some faults are more like warps in the earth's crust than cracks. Two tremendously long faults have been discovered recently. One extends 1,500 miles under the South Pacific between Tonga and Kermadec Islands. The other roughly parallels South America's Pacific coast for 2,700 miles. Both reach down nearly 400 miles into the earth.

The great "deeps" in the ocean bottoms probably result from down-warping faults.

As mountain chains keep rising, the rocks below are subjected to greater and greater strain until something has to give way. When it does, there's an earthquake. Some 2,700 earthquakes shake the globe daily, on an average, though most are too minor to be noticed or to do damage.

Earth also constantly vibrates



125

Earthquake Waves, "X-raying" the Globe, Give This Picture of Its Interior

Vibrations picked up by seismographs increase sharply in speed as they pass below the thin 25-mile crust, indicating differences in material. Penetrating middle layers, the waves change velocity more slowly. As they reach the nickel-iron core, vibrations show a sudden drop in speed. This heavy mass, some 4,200 miles in diameter, probably sank when Earth was forming. The center is under pressure of 25,000 tons to the square inch; its temperature may be as high as 5,400° F. (pages 126 and 127).

with tiny jiggles, called microseisms. Surf pounding on the seashore sets some going. Sudden weather changes and even winds blowing hard against mountains start others. Probably the most intense are caused by vibrations in the lower strata of the sea set up by changing air pressure in the central vortices of hurricanes and other storms. The U. S. Navy has made use of microseisms to help detect and trace the course of storms offshore.

Gravitational attractions of the moon and sun also keep Mother Earth disturbed. They pull up slight bulges in the seemingly solid surface of the globe. As the earth turns, these bulges travel around it once every 24 hours. The gravitational forces draw moving "bumps" across the oceans to make the tides. On land they actually pull up the ground a few inches, then let it settle back, though not enough to be observed or to cause harm.

Man's Borings Mere Mosquito Bites

Man so far has probed down into the earth relatively only about as far as does a mosquito biting an elephant. In drilling the world's deepest hole in search of oil, we have penetrated less than four of the 4,000 miles

from the surface to the center. The deepest mine, in the South African gold fields, goes down less than two miles (page 127).

What lies hidden in the unknown depths below? What would be found if a tunnel could be bored through the earth, or if some cataclysm should slice the globe in two?

A little more than 100 years ago many people believed the earth was hollow, containing an inner world of living creatures and vegetation which could be reached through openings somewhere in the polar regions. They even petitioned Congress in 1822 to support an expedition to explore the "hollow earth."

The idea died, but it helped to stimulate the growing interest in discovery that led the Government to send out the United States Exploring Expedition under Capt. Charles Wilkes, in 1838, which investigated Antarctic and Pacific waters.*

Outpourings of hot lava and gases from volcanoes once made people think the infernal regions were somewhere underground. Later it was theorized that all the earth's interior must be filled with a sea of hot molten rock that gushed out in volcanoes.

But most geologists now believe the earth's interior is about seven-eighths rock, arranged in layers like the skin of an onion, around a central core of nickel-iron (page 125).

Where the iron came from nobody knows certainly, but scientists think it may have sunk to the center during an early stage in Earth's history, being heavier than the material that formed the rocks above. If the core were rock, the earth would weigh less than it actually does. But if the core is assumed to be iron, the weight comes out about right.

Earth's Inside Story

Bore into bedrock on any of the continents and you will normally drill first through a mile or two of sedimentary rocks—limestones, shales, and sandstones. Beneath lie granitic rocks six to eight miles thick. Below these in turn lies the layer of basaltic rock that wraps the entire earth, reaching a depth of 20 to 25 miles. If you bored into bedrock under large areas of the sea, you would hit the basalt right away.

Sedimentary rocks, granites, and the basalt layer together make up the earth's crust. Scattered here and there within the crust are masses of hot molten rock called magma.

When a fault or fissure in the crust thrusts down far enough to tap a mass of magma, the molten rock wells up through the opening. If it rises to the surface and spills out, the result is a volcano.

Minerals also come directly or indirectly from magma. Most of the minerals we mine today were formed originally in magma masses deep in the earth. They were brought up to, or near, the surface in the distant past when magma welled up through faults. As the hot magma cooled, the metal-bearing minerals formed ore deposits. Magma is still bringing minerals up from below, but far too slowly to replace what man is using.

Boring beneath Earth's crust, one next would strike a thick belt of rock extending down 400 to 600 miles. Under terrific pressure of the material above, this rock is closely packed and seemingly rigid, yet still plastic enough to flow in a sluggish way.

From the bottom of this level for about 1,200 miles down, the rock is thought to be different from that immediately above, either in crystalline form or in density.

Below this depth in turn lies the earth's core. It is probably a gigantic mass of iron mixed with some nickel, about 4,200 miles in diameter. This core is not hard and solid like an iron cannonball. More likely it is liquid or even vaporized iron.

Quakes Indicate Globe's Structure

Existence of these inner layers and the core is revealed by earthquake vibration waves. As the waves travel down through the earth's interior, their velocity increases with depth. At the bottom of the crust, about 25 miles down, the speed of the waves increases suddenly, showing a sharp change in the nature of the material at that point. Changes in speed at greater depths indicate further minor differences in type of rock.

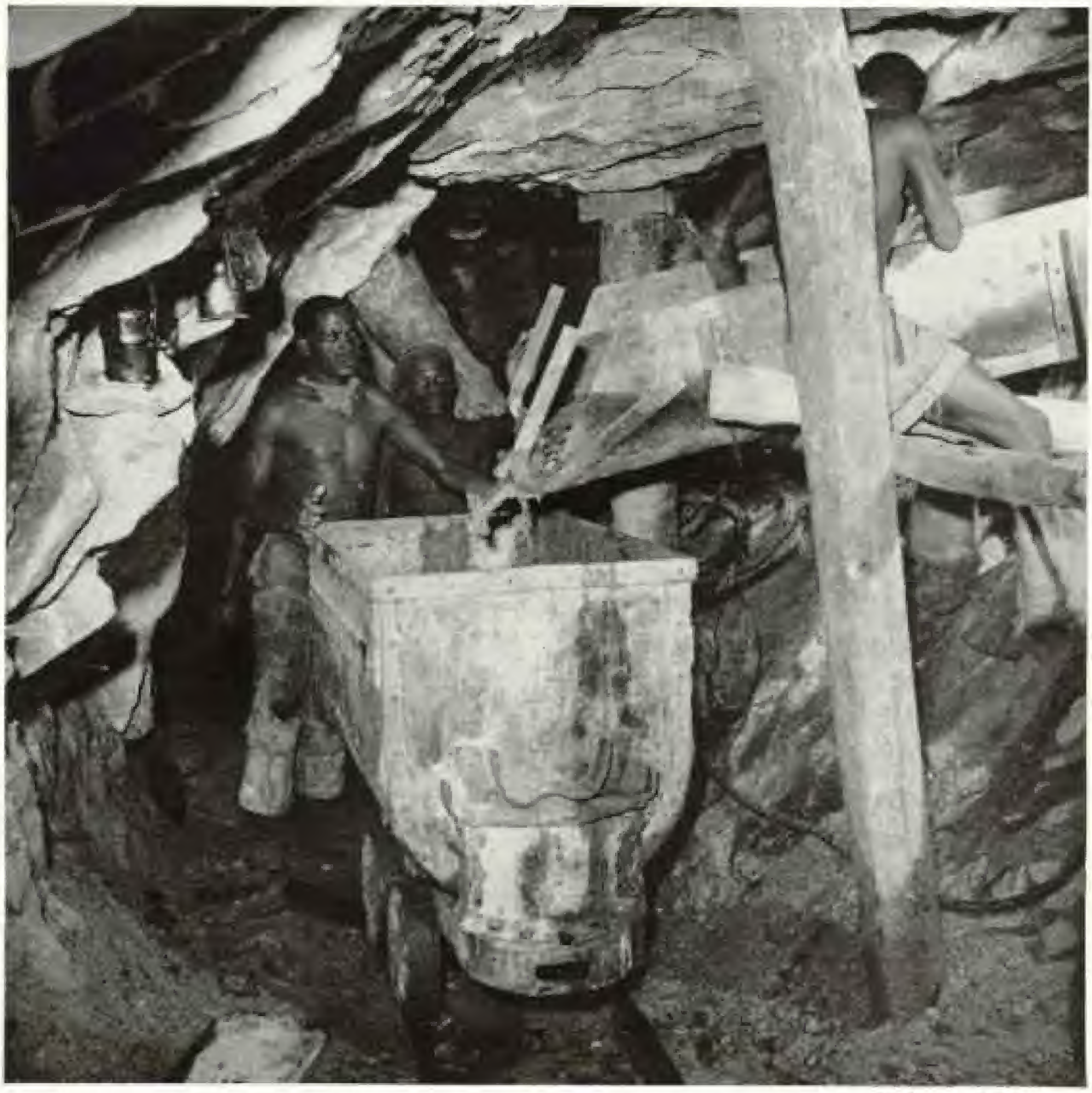
When the waves reach the earth's core, about 1,800 miles down, their velocity suddenly and sharply drops. Experiments in the laboratory have shown that this is what happens when such vibrations move from certain silicate materials into iron, a good reason for thinking that the earth's core is iron.

One reason for the belief that the earth's core is liquid or vaporized is that earthquake waves of one type do not travel through it. These waves will pass only through solid material. But if the iron in the core is liquid, it surely is not sloshing around like soup in a can. Under tremendous pressure from above, it is held as rigid as if frozen.

The core is probably very hot. Heat increases an average of five degrees Fahrenheit every 300 feet down in the earth, as deep as men have penetrated.

Heat does not increase this fast all the way to the center, however. Less than 400 miles down, some geologists think, the earth may still be as hot as when it first began to solidify

* See "American Discoverers of the Antarctic Continent," by Maj. Gen. A. W. Greely, National Geographic Magazine, March, 1912.



Vic Jorgensen, Three Lions

South African Gold Diggers Burrow 9,000 Feet in Earth's Deepest Mines

Here in the Transvaal heat increases one degree for every 250 feet of depth. This mine may have a rock temperature of 105° F. or more. Air conditioning makes work possible. Oil drillers have pushed bits down 20,521 feet (Wyoming); they have found temperatures of 400°.

from molten rock, since this heat has been unable to escape. Temperature at the earth's center may be 5,400° F.!

But some scientists disagree. They think the heat in deep mines and wells may come from radioactivity in the earth's outer skin.

Colossal Squeeze at Earth's Core

Pressure inside the earth is stupendous. On the surface the atmosphere exerts a pressure of only 15 pounds to the square inch. At the center, under 4,000 miles of rock and iron, pressure is estimated at 50 million pounds—25,000 tons—to the square inch.

Pressures existing 500 to 600 miles down in the earth—up to 6,250,000 pounds to the square inch—have been duplicated by scientists at Harvard, using powerful hydraulic presses (page 133). Sometimes the presses cannot stand the strain; parts break and fly off with explosive force. For safety's sake, the operators work behind heavy steel shields.

Queer things happen to familiar substances under such high pressures. Solid metals, normally rigid and stiff, become so plastic they flow like wax. A piece of ½-inch steel put under 300,000 pounds' pressure stretched to 300 times its original length, yet actually

became stronger. When squeezed by University of California scientists under pressure equal to that 20 miles down in the earth, marble flowed like tar.

Water is usually considered incompressible, but the Harvard experimenters have compressed water to half its normal volume under 1,000,000 pounds per square inch, equivalent to cramming a quart into a pint bottle.

Under the same pressure iron compacted to only five percent less than its normal volume, but these men believe that the far greater pressures in the earth's core squeeze the iron there to half its normal volume, too.

Using 600,000 pounds' pressure, the Harvard scientists have made "hot ice" that will not melt until heated to 370° F., the temperature at which solder melts. Such dense, compacted ice would not melt in boiling water, and it would not float.

These experiments reveal how materials probably behave under pressure inside the earth. They show that the higher the pressure on a substance, the higher as a rule the temperature at which it will melt. This means that pressure keeps rocks solid deep in the earth even though they are more than hot enough to melt if brought to the surface at the same temperatures.

1,000,000 Earthquakes a Year

Every year a million earthquakes shake and jar the planet. Settling, heaving, and readjusting of great masses of rock in the earth's crust set them off. In some earthquakes thousands of cubic miles of rock are displaced.

Most earthquakes are too slight to be noticed, except on delicate seismographs. Only about ten a year are strong enough to cause major catastrophes, and some of these are under the oceans. About 100 do serious damage; 100,000 are felt over fairly wide areas. Far more quakes occur under the sea than on the land.

Most earthquakes take place along two weak areas of the earth's crust, where it is crisscrossed by thousands of faults or cracks extending deep under the surface. One circles the Pacific Ocean; another runs from the Mediterranean across southern Asia; and a minor one extends from Mexico into the West Indies (map, pages 122-123).

In these earthquake belts, the earth's youngest mountains are being pushed up on land or are still being folded beneath the seas. This process puts heavy strains and stresses on the rocks below. When a rock mass is strained beyond endurance, it breaks or slips. The resulting jar is an earthquake.

Most of these fractures and slippages are 10 to 30 miles deep, but a few have occurred as far down as 400 miles. They center usually on the line of a fault system. A shift of only an inch by a slab of rock hundreds of miles long is enough to start an earthquake.

Strains that set off earthquakes seem to be built up and released in cycles, with periods of numerous quakes followed by intervals of quiet. Quakes may be triggered into action when the earth's crust adjusts itself to the varying pull of the sun, moon, and planets.

Some major faults where earthquake action centers are clearly visible on the surface and can be traced on aerial photographs. One is the San Andreas fault, running 600 miles from Mexico through western California (page 124). The Great Rift Valley in Africa is another.*

Sudden release of a strain built up for 100 years along the San Andreas fault caused the famous San Francisco earthquake of 1906. Rocks on either side of the fault slipped as much as 20 feet past each other. Earthquake men still keep a close watch on the San Andreas fault.

How Seismographs Work

When an earthquake happens, vibration waves spread out in all directions, like ripples from where a pebble strikes a pond. A strong quake sets waves in motion that shake the entire globe. Some pass along the surface of the earth; others go through it.

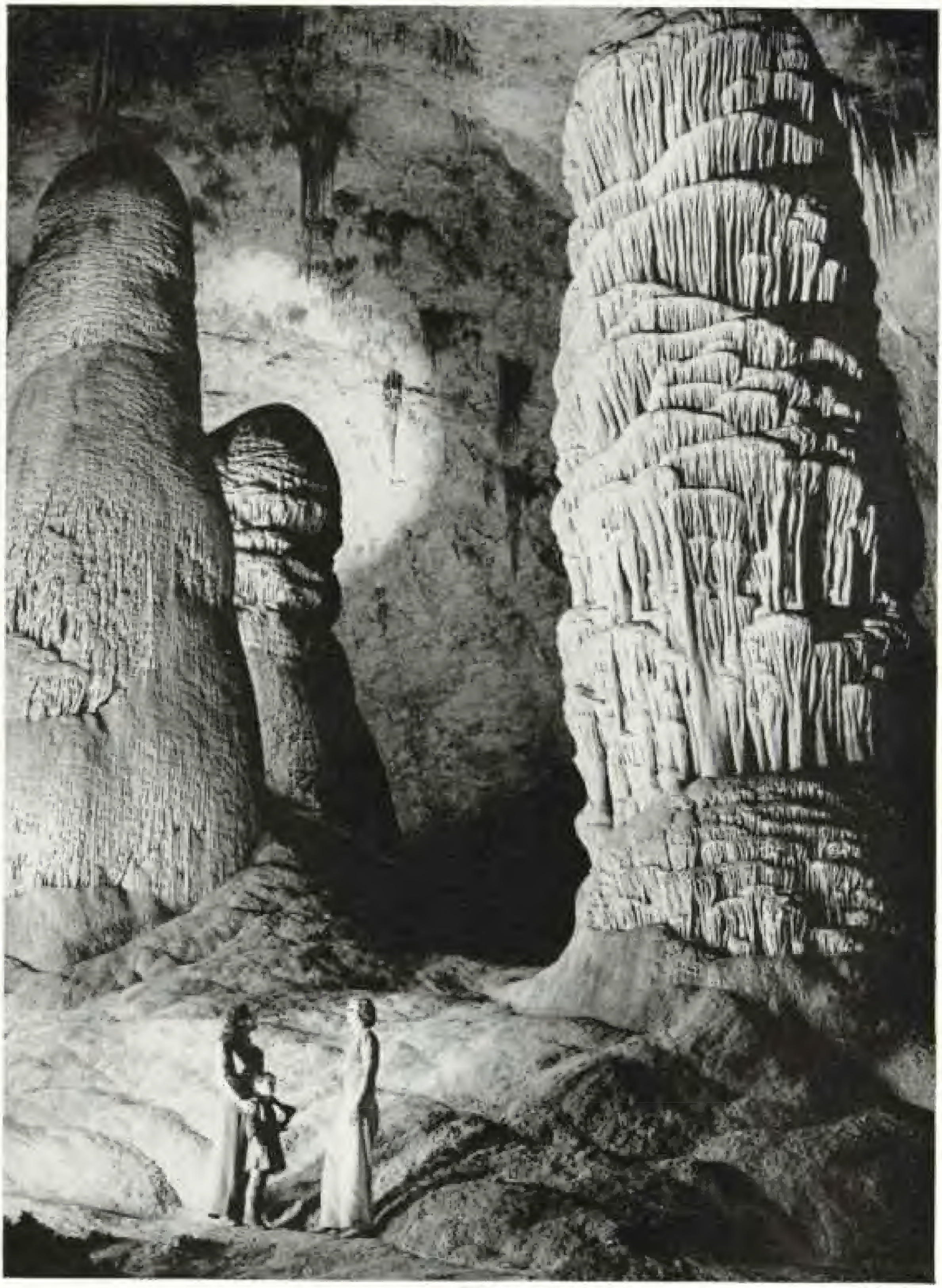
With delicate instruments called seismographs, these waves are recorded for detailed study. Seismographs are placed in underground vaults, preferably hewn out of bedrock, away from the jars of passing trucks and trains.

One common type of seismograph has a pendulum and a mirror that greatly magnifies its motion. A tiny beam of light, reflected from this mirror, is focused on a strip of photographic paper continuously unrolled by clockwork in the darkened vault. The paper is mounted on a pier set in bedrock.

As long as the earth stays quiet, the tiny pencil of light draws a straight line on the unrolling paper. When the earth quakes, the pendulum and the pier both move, but generally the pier moves more. A wavy line is then recorded on the paper. The extent of its waviness shows how intense the earthquake was (page 120).

Reading the seismograph record, scientists know how long the earthquake waves have been on the way and how deep they have penetrated. They can tell how fast they traveled at each point on their path, and can see some indication of the kind of material through which they passed.

* See "The National Geographic's New Map of Africa," National Geographic Magazine, March, 1930.



Santa Fe Railway

Water, Slowly Dissolving Limestone, Hollowed New Mexico's Carlsbad Caverns

Depositing minerals as it dripped, the water built Twin Dome stalagmites (left) up from the floor of the Big Room. This chamber is 300 feet high, 4,000 feet long, and a maximum 625 feet wide. A National Geographic Society expedition led by Dr. Willis T. Lee in 1924 explored, mapped, and photographed the Carlsbad wonder and made it known to the world. President Coolidge set aside the caverns as a national monument.

U. S. Department of Defense, Official

North Pole, Which Peary Attained after Terrible Hardships, Now Is Visited in Comfort by Weather Planes

There is no land at the Pole; winds and sea currents keep the ice constantly in motion. This photograph from a United States Air Force B-29 shows the dreary, snow-covered pack criss-crossed by pressure ridges where ice has buckled.

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Arnold Heim, National Aerophotographic Service of Peru

Rain Almost Never Falls on Peru's Pampa de Chunchanga. Dry Winds Drive Crescent Dunes Across the Desert

The Andes block Atlantic rain clouds, but the coastal plain lies open to the Pacific's dry winds. Years pass with hardly a speck of moisture; suddenly a torrent falls. Vagaries of the cold Humboldt (or Peru) Current are held accountable for droughts and floods.

National Geographic Photographer B. Anthony Stewart

Balloon-borne Counters Measure Cosmic Rays Constantly Bombarding Earth

More powerful than X-rays, cosmic rays plunge through every human being 10 to 20 times a second, but with no known effect. Dr. Martin Pomerantz (right), leader of the National Geographic Society-Bartol Research Foundation Cosmic Ray Expedition, here prepares to send aloft a counter to check rays entering the atmosphere, some of them probably from the sun. Six balloons fastened in tandem will carry the apparatus up to about 100,000 feet. Man has never reached this height, but rockets have exceeded it by 250 miles.

To learn more about how earthquakes damage buildings, the U. S. Coast and Geodetic Survey has designed special seismographs that record only the big vibrations, the kind that cause destruction. About 63 are set up at strategic points in California, Montana, other parts of the West, and in some South American countries.

Records of these instruments showed that the 1940 quake in California's Imperial Valley moved the ground as much as nine inches back and forth.

Saving Lives in Earthquakes

"Powerful as earthquake forces are, few if any people are killed or injured by the actual shocks alone," a Coast Survey man told me. "Most of the injury and loss of life is caused by debris falling on people in the streets below, or by fires that start in the ruins where people are trapped.

"Today, buildings can be made almost 'earthquake-proof,' if they are built with sturdy, well-braced framework (page 121).

"It is possible, at very little added cost, to construct buildings that will withstand without serious damage the kinds of earthquakes reasonably to be expected in California.

"Walls and cornices need to be firmly fastened to the frames," the Coast Survey technician continued, "so they won't fall on people rushing into the streets. Often, in fact, it's safer to stay inside under a door frame or sturdy table, as protection against falling ceilings.

"California has learned by experience and revised its building codes to eliminate earthquake hazards as far as possible.

"If you live in earthquake country, it's a good idea to emulate the wise man of the Bible who 'built his house upon a rock.' Rock is moved far less violently by earthquake vibrations than dirt, sand, or 'made land.'"

Volcanoes are close relatives of earthquakes. It is no coincidence that most of the active ones are strung out along the three great

National Geographic Photographer Willard R. Culver

Tremendous Pressures Bring About Fantastic Changes in Earth's Deep Rocks and Metals

Metals flow like wax, and "incompressible" water is compressed to half its normal volume under loads up to 6,750,000 pounds to the square inch (pages 137 and 138). This hydraulic press at Harvard University can duplicate pressure 500 miles down and give clues to structural changes. Prof. Percy W. Bridgman attaches wires to measure the electrical conductivity of compressed copper.

earthquake belts. Here faults reaching down inside the earth tap reservoirs of molten magma (pages 116, 118, 119).

Gases are trapped inside this upwelling magma; releasing the pressure inside a volcano is much like uncapping a bottle of ginger ale. In both cases bubbles of gas froth out. The hot lava that flows forth in a volcanic eruption is really magma froth, a mixture of molten rock and gas bubbles.

When Volcanoes Explode

When lava boils up inside a tight-plugged volcano, the gases trying to escape may build up enough pressure to blow up the entire mountain. This happened when Mount Katmai exploded in Alaska in 1912, creating the spectacular Valley of Ten Thousand Smokes.* It happened again when Mount Krakatau (or Krakatoa) in the Dutch East Indies exploded in 1883, destroying 36,000 lives.† Rising there today is a new volcano, called by the natives Anak Krakatau, "Child of Krakatau."

Lava spewed out by volcanoes becomes highly fertile soil through weathering. The volcanic island of Java, only the size of New York State, supports 40 million people and is one of the most densely populated areas of the globe.

Ice Once Covered Third of Land

Another slow but mighty influence on man's earthly destiny is the gradual march of the Ice Ages. Fed by accumulating snow, enormous masses of ice, in places perhaps as much as two miles thick, have crept outward periodically from Arctic and Antarctic centers and down from high mountains and tablelands. At least once these glaciers covered nearly a third of the earth's land area.

* The National Geographic Society's discovery and investigation of this remarkable volcanic region was described in the National Geographic Magazine by Dr. Robert F. Griggs, leader of The Society's expeditions, in "Valley of Ten Thousand Smokes," January, 1917, and February, 1918; and "Our Greatest National Monument," September, 1931.

† See "Eruption of Krakatoa," by Sir Robert Ball, National Geographic Magazine, June, 1902.

Bradford Washburn

Earth-sculpturing Glaciers Retreat as Climate Warms. They May Advance Again in a New Ice Age

Nearly a third of Earth's land has been covered at least once by ice creeping from highlands, as Alaska's Susitna Glacier does here. Rivers of ice converge from the the slopes of 13,740-foot Mount Hayes and other peaks southeast of Fairbanks. Dark bands of rock scraped from mountains streak the glacier (page 133).

Hot Basalt Ejected from Earth Cooled in Massed Columns Off Scottish Coast

Basaltic lava beneath Earth's surface forms a shell of heavy rock that now encompasses the entire globe, underlying both land and sea. Lighter granite shapes the continents, which "float" like icebergs on the heavier basalt (page 123).

Basalt and other igneous rocks tend to cool in Nature's six-sided columns. Wyoming's Devils Tower and Hudson River's Palisades (of diabase) expose examples known to Americans. Northern Ireland's famous Giant's Causeway is composed of hexagonal columns of basalt formed in the same way.

Contraction created these pillars on the uninhabited island of Staffa, whose name comes from a Norse word meaning "Isle of Pillars." Stresses on the molten rock or uneven cooling shaped columns on the right like the ribs of a ship.

Staffa, one of the Inner Hebrides, stands near the Island of Mull off the west coast of Scotland.

Water Has Shaped Fantasies in Rock Around Rainbow Natural Bridge

Soft, reddish-brown limestone of southern Utah's Rainbow Bridge region was laid down in the Jurassic Age, when dinosaurs wandered over what is now the American West. Succeeding eras saw water erode the rock into these weird sculptures.

A meandering stream carved out the bridge, first passing around the end, then straightening out and cutting through the rock.

The bridge is 309 feet high, taller than the United States Capitol dome, and 278 feet from pier to pier. The Nation preserves it as Rainbow Bridge National Monument. It can be reached only by a long hike or pack-train trip.

Paiute Indians called the arch *Nonnezoshi*, meaning "Rainbow." To the Navajos it was *Nonnezoshi*, "Hole in the Rock."

Natural Bridges National Monument, also in Utah, has other water-carved stone arches, the three largest ranging in height from 108 to 222 feet.

Scientists predict that water and wind eventually will wear down all the land on the globe to a featureless plain. Such total erosion can occur only after Earth has exhausted its internal heat, putting an end to mountain building (page 139).

In one ice age, in the distant past, glaciers spread over large parts of South America, Africa, India, and Australia.

Only 11,000 years ago an ice sheet pushed down over most of Canada and blanketed the United States as far south as Buffalo, New York; Saginaw, Michigan; Milwaukee, and Minneapolis. Gradually it melted back toward its center of origin.

The retreat of this ice is still going on all over the world. Some glaciers found when the western United States was first explored and settled have disappeared entirely. Others are receding so fast that water power of some cities, drawn from melting glacier ice, eventually may be threatened.

Even the Antarctic icecap, estimated to contain about 90 percent of the world's glacier ice, is slowly melting back. The vast areas of permanently frozen ground in the Arctic and sub-Arctic are shrinking too.

Melting Glaciers Raise Sea Level

Sea level in the distant past dropped many feet when untold tons of water were locked up in advancing ice sheets. Now, in the last 100 years, water released from melting glaciers and ice sheets has raised sea level about 2½ inches all over the world.

If all the natural ice on Earth should melt today, it would release enough water to raise sea level perhaps 100 feet, flooding out many coastal cities and lowland areas.

No one knows just why the ice advances and then retreats. Changes in the amount of heat given out by the sun may be one cause. The uplifting of mountains in Scandinavia, Greenland, and Labrador also may have played a part. These lofty regions spawned the glaciers of the last ice age that spread over large areas of Europe and North America. In those altitudes snow did not completely melt each summer but kept piling up over the years, pushing the glaciers farther and farther outward.

The ice may advance again if Earth's climate once more turns cold enough. Eventually it might overwhelm much territory now occupied by civilization, but so slow would be its progress that there would be plenty of time to make adjustments.

Searching the Global Treasure Chest

Of far more immediate concern is the pressing problem of finding new supplies of oil and metals to keep modern civilization going. More than two-thirds of the 15,000 geologists in the United States are working in the oil industry, seeking out new petroleum stocks to replace the four billion barrels the world uses every year.

In the last 25 years more metals and mineral products have been dug, extracted, pumped, and blasted from the earth than in all preceding history, experts estimate. But even so, during the past decade, new supplies of minerals discovered have equaled, in most cases, the quantities consumed.

Stowed in the holds of our spaceship, Earth, there is oil enough for many years even at the present rate of consumption, some geologists believe; iron (excluding the earth's core) for a long time to come; coal for several thousand years; lime and phosphate for fertilizers to help raise food for an indefinite time.

A new process for treating billions of tons of taconite rock along the Great Lakes is expected to yield enough iron to last the United States for many generations.* Many other minerals are running low, but optimistic authorities feel sure of finding new supplies.

One leading geologist is confident that all the continents except Australia have large undiscovered oil reserves, proportionately as great as those of North America. These will be found, he thinks, when other parts of the world are prospected for oil as thoroughly as the United States has been.

Under shallow water along the borders of the continents there may be as much as 1,000 billion barrels of oil, another expert estimates. Some new wells in the Gulf of Mexico off Louisiana are beyond sight of land.

New Oil from Old Wells

Much new oil also is recovered from old wells by flushing them out with water or gas. Engineers estimate this may supply 7 to 12 billion additional barrels. They think 150 to 200 billion barrels may be extracted from old wells eventually by some other method.

If we run short of liquid oil, we can make it from oil shale, natural gas, and coal. Experiments are under way, too, in burning coal in the ground to produce gas—easier and cheaper than mining coal where seams are thin.

Heat from inside the earth or from sun power may sometime be used on a large scale. Experts have figured out that the sun sends to the earth as much heat energy in one minute as the human race utilizes in a year.

"World War II gave a big boost to the world-wide hunt for minerals," a leading mineralogist remarked to me. "So great were the demands of war that even the mineral-rich United States had to import some of all the minerals and metals it used, except iron, coal, and salt, from 53 different countries. Our geologists prospected most of the globe for new supplies."

*See "Minnesota Makes Ideas Pay," by Frederick G. Vosburgh, National Geographic Magazine, September, 1949.

Tarascan Boys, Playing Volcano, Start an Eruption by Puffing Through a Pipe

This toy cone is built of ash spewed out from Paricutin, the volcano that burst out of a Mexican cornfield in 1943. Since that year it has grown to a height of 1,500 feet (page 115).

"To reach new stores of ore, we have had to go down deeper and deeper, until some mines now are nearly two miles deep. Below that, heat and pressure make mining difficult and expensive.

"But even if some metals become seriously depleted, we can replace them for many purposes with plastics, glass, fiber glass, ceramics, laminated materials, and plywoods."

Forecasting Earth's Future

Many geologists believe there are still plenty of mineral resources left in the upper two miles of the earth's crust. All the continents have essentially the same rock structure, and in all of them, presumably, Nature has placed supplies of ore in about the same proportions, just as in the case of oil.

What about Earth's more distant future? For countless millions of years more, scientists say, our planet will go on very much as now. As long as the supply of internal heat holds out, new mountain ranges will continue to push up as the old ones are eroded down.

But at last the supply of internal heat will fail, putting an end to the building of new mountains. Rain, wind, frost, and growing things will wear down existing elevations until all the land is merely a flat, monotonous plain, barely above sea level.

Possibly the sun may get hotter and burn up all earthly life. It might even explode, as other stars do occasionally, and melt all the planets in the resulting wave of heat sweeping out through millions of miles of space.

More likely, astronomers say, the sun eventually will run out of hydrogen, the fuel that keeps it shining, and its heat will fail. When that takes place, life on Earth will end, unless in the meantime we've found some other way to keep going. Our frozen planet, however, will continue to swing on through its orbit around the dying sun, still held by the force of gravitation.

"How long before this will happen?" I asked an astronomer friend. He laughed.

"It's too far off for anyone to worry about in the foreseeable future.

"Once, after an astronomy lecture, an old lady asked the speaker how long he had said it would be before the sun stopped shining.

"'About ten billion years, madam,' he replied.

"'Oh, I'm so relieved,' she said. 'I thought you said ten million!'"

A Color Masterpiece for the Christmas Season

NOW when Jesus was born in Bethlehem of Judaea in the days of Herod the king, behold, there came wise men from the east to Jerusalem.

. . . They saw the young child with Mary his mother, and fell down, and worshipped him: and when they had opened their treasures, they presented unto him gifts; gold, and frankincense, and myrrh. (Matthew 2.)

That holy scene in all its glory and brilliance lives for all time in one of the greatest masterpieces of color in the history of painting, "The Adoration of the Magi," by Fra Angelico and Fra Filippo Lippi. As a special Christmas-season supplement, a full-color reproduction of their glowing 500-year-old tondo, or circular painting, is sent to the 2,000,000 members of the National Geographic Society with this New Year number.*

The scene portrayed is familiar to Christians everywhere as part of the Christmas story, although in most Western churches the coming of the Magi is not observed until January 6 (Epiphany).

Colors from Crushed Jewels

Fra Angelico and Fra Filippo Lippi were mendicant friars in Florence, Italy, when the Renaissance and the Medici were coming into full flower. As painters, both are classed among the greatest colorists who ever lived. In this work they combined their talents with almost dazzling results.

The retinue of the Magi and the stream of spectators flow toward the Holy Family like a cascade of jewels. The brilliance of color was attained in part by the use of pigment made from minerals or semiprecious stones: All the blues in the painting, for example, were made of crushed lapis lazuli.

Blue, the most expensive of Renaissance colors, was used lavishly and indicates that the picture was commissioned by an exceptionally rich patron. An entry in the inventory of the Medici, rulers of Florence in the 15th century, prosaically lists the following:

"A large tondo in a gilded frame, with a painting of Our Lady and Our Lord, and the Magi, who are bringing gifts, by the hand of Fra Angelico, worth 100 Florins."

The entry seems to fit this painting better than any other existing picture by Fra Angelico. The 100-florin appraisal, high for that time, indicates a large and important work. Today the painting is one of the most prized of recent additions to the Kress Collection in the National Gallery of Art (page 75).

Only one of the artists is mentioned in the Medici inventory, which was compiled in 1492, the year America was discovered. The likeliest explanation is that the commission may originally have been given only to the elder artist, Fra Angelico. The work then apparently was completed by his pupil, Fra Filippo Lippi, either after Fra Angelico's death in 1455 or after his departure for Rome in 1445.

The radiance of color is due not only to the materials used but also to an arbitrary convention, a technical device characteristic of late Medieval and early Renaissance painting. In the draperies of foreground figures the most intense color—the deepest blue, or rose, or lavender—does not come where the light is strongest but instead at the bottom of the folds where the shadow is darkest. Thus drapery is modeled from shadows of saturated color to lights of brighter but more neutral tones.

This system died out with the rise of naturalism in the late 15th century. Shadows became neutral or even brown, and painting lost some of its brilliance.

Fra Angelico and Fra Filippo Lippi, as if to show that they were familiar with the new science of anatomy and with realism, drew nude spectators standing on a wall, and a stable with horses being unsaddled and shod.

Having thus proved themselves as progressive as any painters of their time, they treated the main scene with traditional symbolism.

Rulers in Lavender, Blue, Orange-red

The three Magi are shown kneeling before the Christ Child, Our Lady, and St. Joseph.

The eldest, in lavender, is Gaspar, King of Tarsus. The middle-aged king, in blue, with his hair in a pigtail to suggest the East, is Melchior, ruler of Arabia and Nubia. The youngest, in orange-red, is Balthasar, Prince of Saba, who offers Christ a golden amphora of myrrh because Our Lord was man and doomed to die. In His hand the Child holds a pomegranate, a symbol of the Fall of Man.

On the stable roof is a peacock, an ancient sign of immortality because the flesh of the peacock was thought to be incorruptible. Flying downward are two pheasants, symbols of the rainbow covenant after the Flood.

Thus this glorious tondo is both a poem of devotion expressed in the beautiful symbolism of the Church and at the same time a masterpiece of pure painting, rich in pattern, flowing in line, and flowerlike in color.

* Members may obtain additional prints, unfolded, of the full-color 18-by-18-inch reproduction of "The Adoration of the Magi" by writing to the National Geographic Society, Washington 6, D. C. Price 50c each in United States and Possessions. Elsewhere 75c. All remittances payable in U. S. funds. Postpaid.

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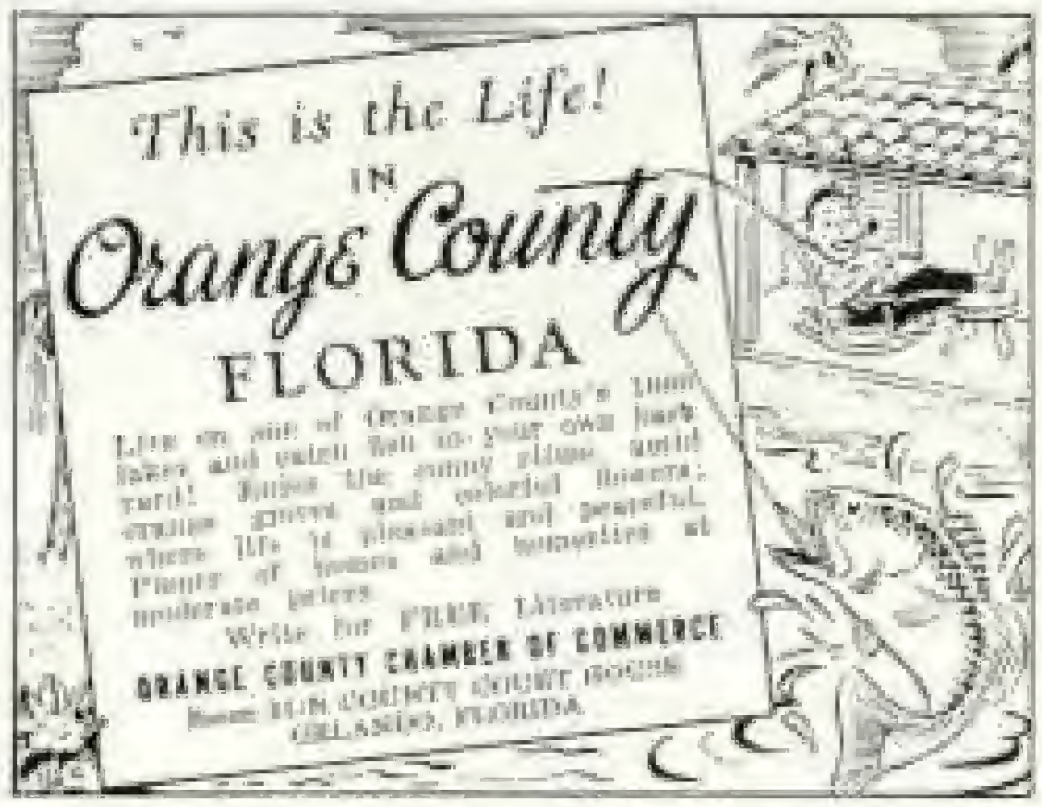

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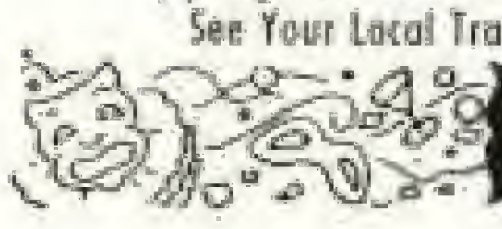

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