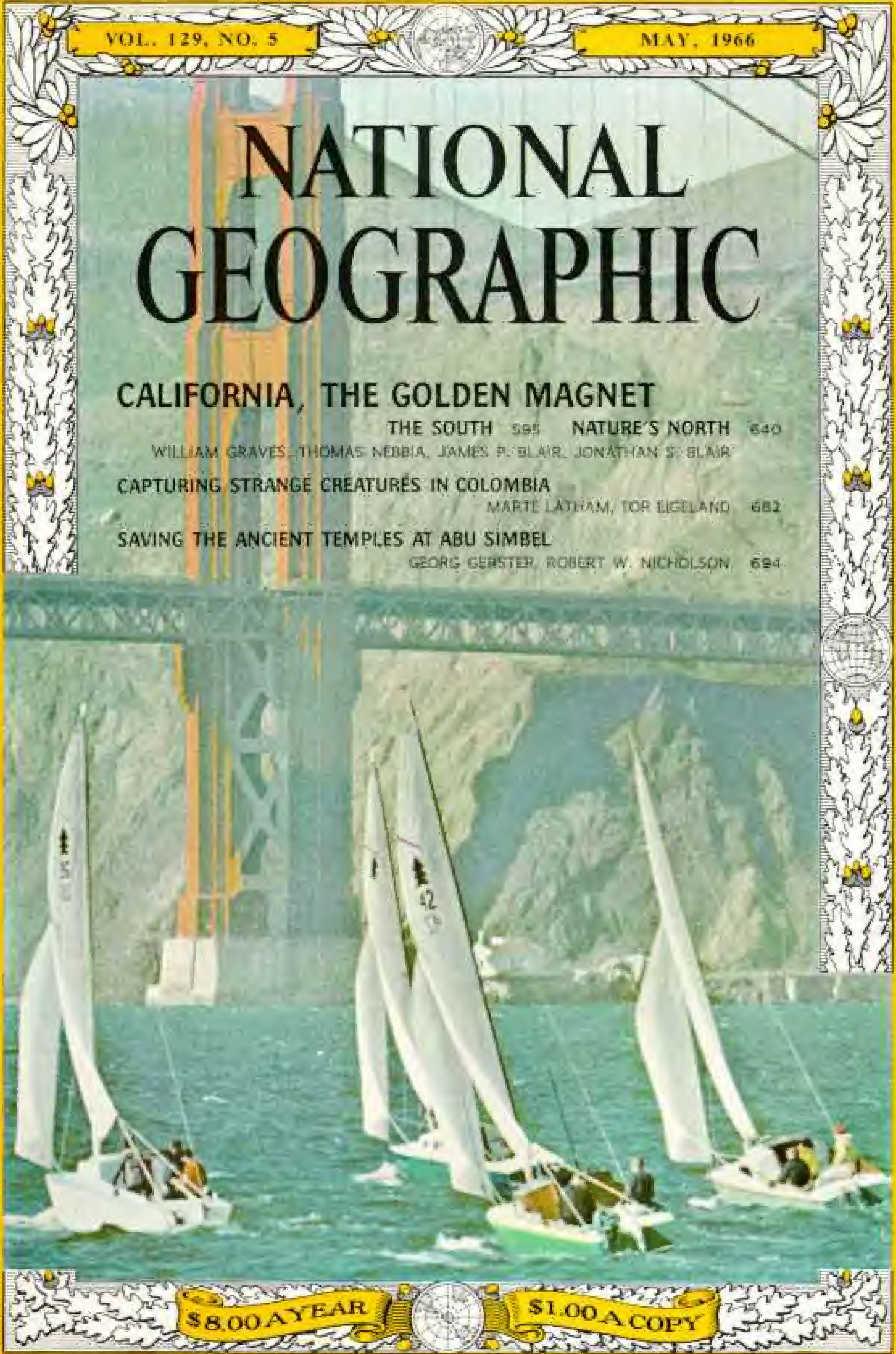
U.S. ATLAS MAP SUPPLEMENT: CALIFORNIA (page 681)



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

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◀ **COVER:** Racing sails skim toward the Golden Gate Bridge, symbol of booming California (pages 646-7).

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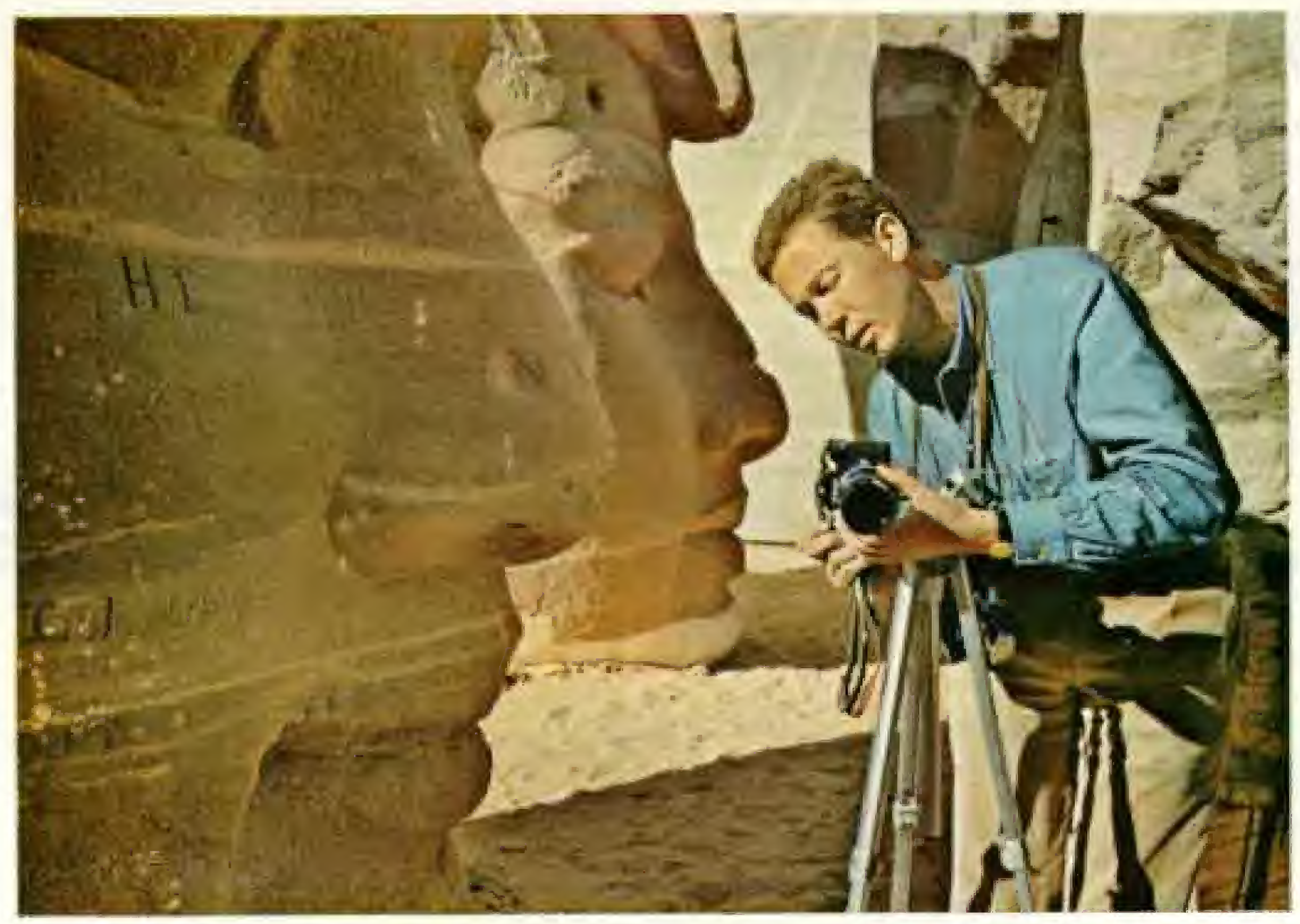

Pharaoh-on-the-move sits for a portrait

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Today a unique salvage operation at Abu Simbel rescues the monument (page 694). On assignment for NATIONAL GEOGRAPHIC, Dr. Georg Gerster, Swiss philologist-turned-archeologist, saw the temple and a smaller one to Ramesses' favorite queen carved into blocks. Here he photographs 3,200-year-old stone heads of Pharaoh in the main storage area, where they await reassembly.

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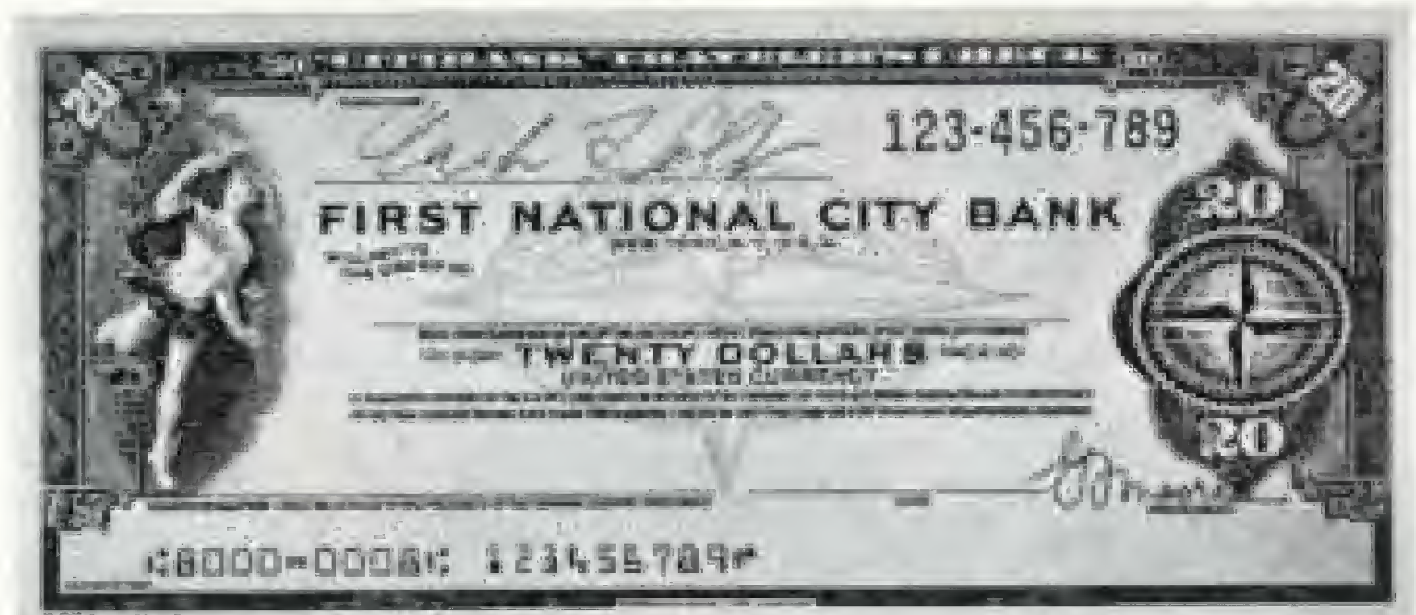

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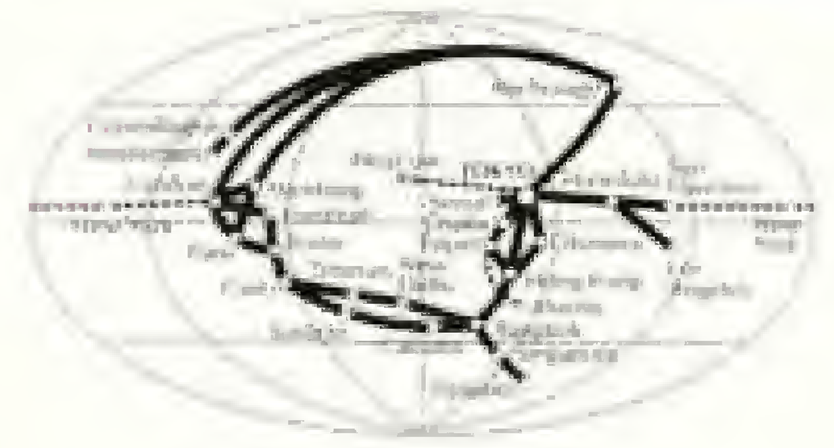

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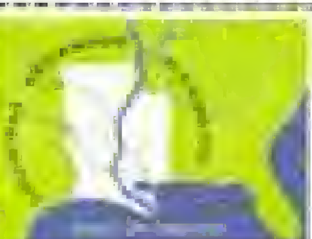

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You can, for instance, board a Boeing jet the evening of your last work day, and be in any part of the country in a few hours. You can begin your vacation *there*, that same night. And you can vacation right through the last day, because a Boeing jet can whisk you back—rested and refreshed — that same evening.

By Boeing jet, two weeks is time enough to vacation anywhere in the world. Boeing jets serve 269 cities in 113 countries. And every 16 seconds a Boeing jet lands or takes off somewhere in the world.

This year, get your vacation off to a flying start — by Boeing jet.

Now flying Boeing jets: *Air Congo, Air France, Air India, Air Madagascar, All Nippon, American, Ansett-ANA, Avianca, BOAC, BWIA, Braniff, Continental, Eastern, El Al, Ethiopian, Flying Tiger, Indian, Iran Air, Irish, JAL, Japan Domestic, Lufthansa, MEA, National, Northeast, Northwest, Pacific Northern, PIA, PSA, Pan American, Qantas, Sabena, Saudi Arabian, South African, TAA, TAP, TWA, United, Varig, Wardair Canada, Western, World.* Later: *Aerolineas Argentinas, Alaska, Braathens (Norway), Caledonian, Frontier, Mexicana, Olympic, Pacific, Piedmont, Southern Air Transport, Wien Air Alaska.*

BOEING JETS

The Province of Nova Scotia is all but surrounded by salt water. And you are never more than 35 miles from the sight and sound of the sea. Nova Scotia's seascape attracts artists, photographers, naturalists and beachcombers.

Nova Scotians are a seafaring folk. On a summer's day, you will find the harbours alive with sail. The famous schooner *Bluenose* was built here, and Nova Scotian shipyards continue to build boats and ships of all sizes with traditional skill and craftsmanship.

Not all Nova Scotia beaches are uncrowded, but along the 4,600 miles of coastline, in quiet bays and sheltered coves, there are countless strands of sand, and opportunity to spend a day by the sea, by yourselves.

The International Tuna Cup Match is held in Nova Scotia. Salt-water sports fishing is a specialty; fully-equipped boats may be chartered for $30 to $75 a day. Fish for tuna, or for swordfish, pollock and mackerel.

Like fish to water, youngsters take to Nova Scotia. Resort area beaches are sunny and safe and slope gently to the sea. Clam-digging, shore cookouts and sand castle construction are favorite pastimes. Nova Scotia summers have a special appeal to families.

Send the coupon for more information on Nova Scotia, including a colourful picture presentation, accommodation guide and road map. If you are interested in tenting and trailer facilities, ask for "Camp and Picnic Sites in Nova Scotia."

You must come down to the sea again. This summer.

For free, illustrated literature, write to the:
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Box 130, Halifax, Nova Scotia, Canada

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WHAT ELSE MOWS AND MANEUVERS LIKE A GRAVELY

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When you're looking for a tractor to handle tough jobs, in tough-to-get-at places or on slopes, there's nothing like a Gravely Tractor. With out-front attachments for maneuverability and safety, the Gravely noses its way into corners, around plantings and under obstacles with powerful ease.

The high-torque Gravely engine with all-gear drive (four forward speeds, four reverse, no clutching) keeps you in complete control all the time . . . even up, down and across slopes.

You enjoy four-season, year-after-year performance from your Gravely . . . and a choice of 39 get-the-job-done attachments. You ride or walk, as the occasion demands. See your Gravely Dealer. Or, wish through our free catalog. Write Now! Gravely, 5605 Gravely Lane, Dunbar, West Virginia 25064.

Look under the hood . . . and you'll get a Gravely

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Latin bold

Brasilia is the Western Hemisphere's first planned capital city since L'Enfant designed Washington, D.C.

SOUTH AMERICA HAS TWO SIDES. AND WE CAN SHOW YOU BOTH.

The West Coast with Panagra: Treat yourself to yards of vicuña in Bolivia. Discover coolness on the equator. Find the lost kingdom of Machu Picchu. Lose yourself in the old-world air of Lima. Play games in the world's largest casino, in Viña del Mar.

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Both coasts are yours for the price of a 30-day Jet economy excursion to Buenos Aires. And that's only $550 from New York.

PANAGRA · PAN AM

PAN AMERICAN-GRACE AIRWAYS   PAN AMERICAN AIRWAYS

Somehow Impala doesn't seem destined to be big with secret agents

Impala SS Sport Coupe with eight safety features, including padded instrument panel and sun visors, now standard.

Imagine nobody noticing you in a car that looks like this

After all, in a year when the lean, clean look is the thing, this Body by Fisher is bound to turn heads.

From the distinctive front styling to the smart new wraparound taillights, the Impala SS demands attention. Not a line's wasted.

The view from the inside is just as pleasing with wall-to-wall deep-twist carpeting and foam-cushioned Strato-bucket front seats standard on this model. It's all accented by touches of bright metal and brushed aluminum.

Of course the interiors are color-keyed to complement each Magic-Mirror finish. Nice? Naturally. Inconspicuous? Hardly.

STYLING THE CHEVROLET WAY

With up-front seating and front-mounted attachments, Bolens Estate Keeper puts you on top of every yard care job

Bolens Estate Keeper is the one compact tractor that puts you up front — on top of the attachment — so you can see where you're mowing. With an up-front view and a tiny 21" turning radius, you'll mow in tight spots where only hand clippers used to reach, circle trees and shrubs and edge right up to walks and drives without backtracking or reversing.

The Estate Keeper's unmatched maneuverability is the result of Bolens exclusive center pivot steering. Turn the steering wheel and the tractor folds in the middle. Front and rear wheels move together to form an arc, or part of a circle. The more you turn, the smaller the circle.

For year round use, the 7¼-hp Estate Keeper powers a 32" snow caster, 32" or 38" rotary mower, 30" reel mower and others. To find out more about the Estate Keeper, clip and mail the coupon now.

Estate Keeper with snow caster

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Jewelry illustrated at left, Ivory Rose: Necklace $8 Earrings $12.50 Brooch $21
Necklace with simulated Aquamarine $9
Twin leaf Earrings $16 Brooch $10.50

Center: Heart Necklace $11.50 Earrings $10.50
Oak Leaf Brooch $12.50 Jade Bracelet $22
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Right: Jade sphere Necklace $7.50
Plume Earrings $13.50 Brooch $12.50
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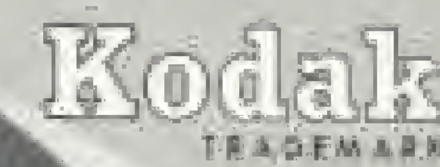


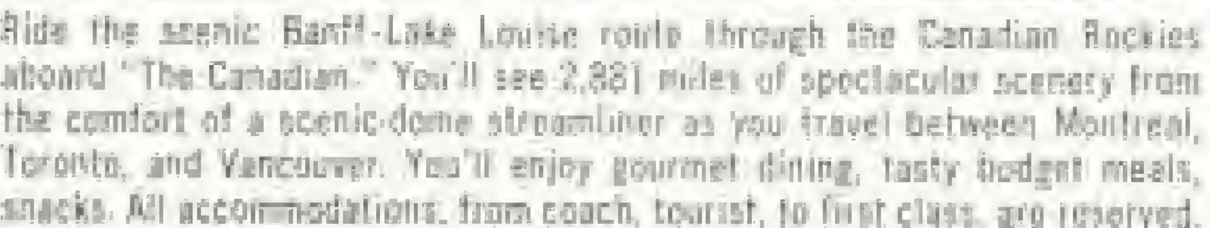
And instant loading is only the beginning...

Kodak invented the new super 8 movie system, so it's not surprising that this KODAK INSTAMATIC M6 Movie Camera takes *terrific* super 8 movies. The f1.8 focusing lens zooms from 12 to 36mm for wide-angle view to telephoto close-up. Extra-bright reflex *through* the lens—no parallax. The battery-operated CdS electric eye operates through the lens, too, for high-exposure accuracy. And battery power drives the film through its full 50 feet *automatically*, cartridge after cartridge. No winding. No film flip-over at mid-point. Plus a fold-away pistol grip and many other features, all adding up to movies that are so much sharper and brighter—*with 50% more picture area on the film than regular 8mm film*—that you can show them only on a KODAK INSTAMATIC or other super 8 projector. The M6 Camera, less than $160.

Price subject to change without notice.

New KODAK INSTAMATIC M6 Movie Camera

We'll give your holiday a foreign flavor all the way (just north of the border)! Rail away with us through the Canadian Rockies. You'll enjoy gourmet food and gracious service while you watch the scenery. Then stop off in Banff National Park at Chateau Lake Louise. Here we'll serve you in the European manner while you relax and play.



Ride the scenic Banff-Lake Louise route through the Canadian Rockies aboard "The Canadian." You'll see 2,881 miles of spectacular scenery from the comfort of a scenic-dome streamliner as you travel between Montreal, Toronto, and Vancouver. You'll enjoy gourmet dining, tasty budget meals, snacks. All accommodations, from coach, tourist, to first class, are reserved.

Get away from it all at Chateau Lake Louise high in the Canadian Rockies in Banff National Park. Here you'll enjoy continental cuisine and gracious service in an atmosphere of relaxing informality. You'll fish, swim, dance, ride, hike to the Plain of the Six Glaciers and the Lakes in the Sky. Or just loaf and enjoy the spectacular scenery. Open from June 14 to September 7

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So we've designed the Electra 225 for you. It's our instant landscape enhancer. Just park it somewhere. Clearly visible.

Not that any Buick won't do: the Electra is like other Buicks—only more so. They're all tuned cars. The ride, styling, performance and handling are *all* tuned—all *together*. (That's the secret of the tuned car.)

And like all Buicks, the Electra has the seven new safety items, standard on all models. Padded dash, back-up lights, and such. Plus front and rear seat belts, which we suggest you use as a standard procedure.

But the Electra 225 also comes with a 401-cu. in. Wildcat V-8. And a Super Turbine Automatic transmission. (You'll find the Electra is much more than just a scenic wonder; since it's an Electra, it will take you to other scenic wonders briskly—*and* in maximum comfort. Need we say more?)

Now the cost. The Electra 225 is not inexpensive. But it probably costs less than you imagine. We build the Electra on the assumption that people who have enough to expect the utmost in automotive luxury achieve that happy condition by having a good eye for value. Besides you may have most of your money tied up in that country place of yours.

And if you aren't buying a country estate? Then get an Electra 225, anyway, and you'll feel as though you have.

That enables you to save money two ways: on your Electra and on the estate you're not buying. Feels good, doesn't it? (And just wait till you see how good that new 1966 Electra 225 will feel.) Your Buick dealer is the man to see about it. Naturally.

1966 Buick. The tuned car.

BUICK MOTOR DIVISION

KICK

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60, 110, 120, 150, 170, 225, 310-hp gasoline; 60-hp diesel

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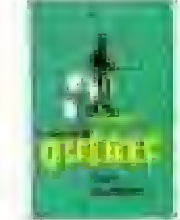

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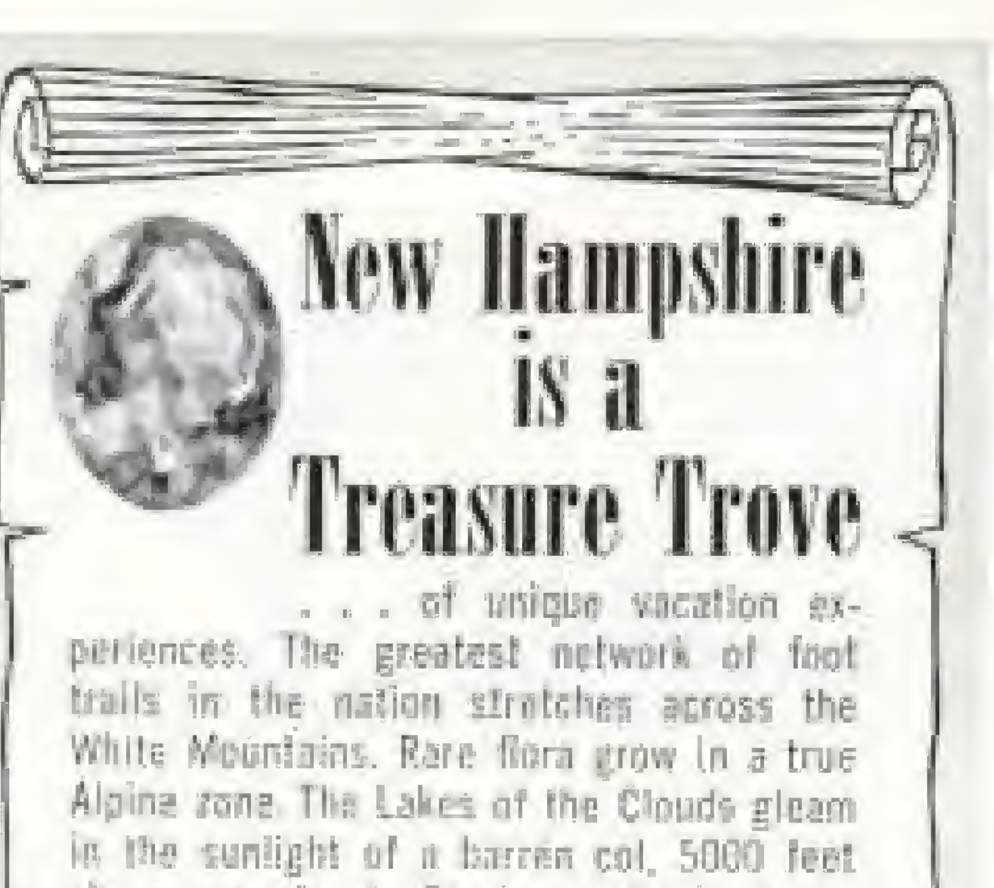
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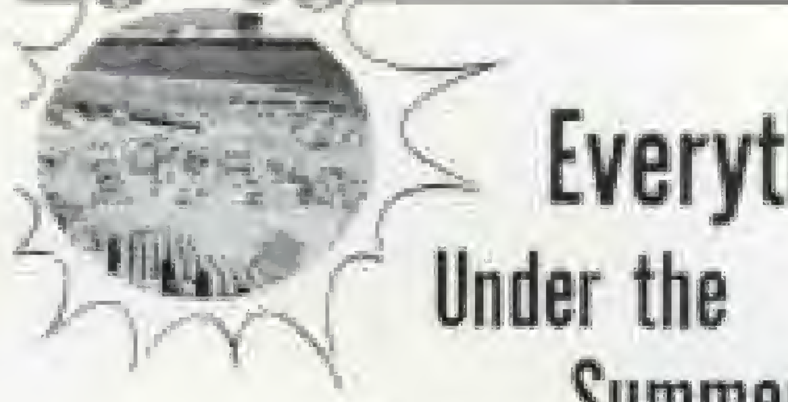

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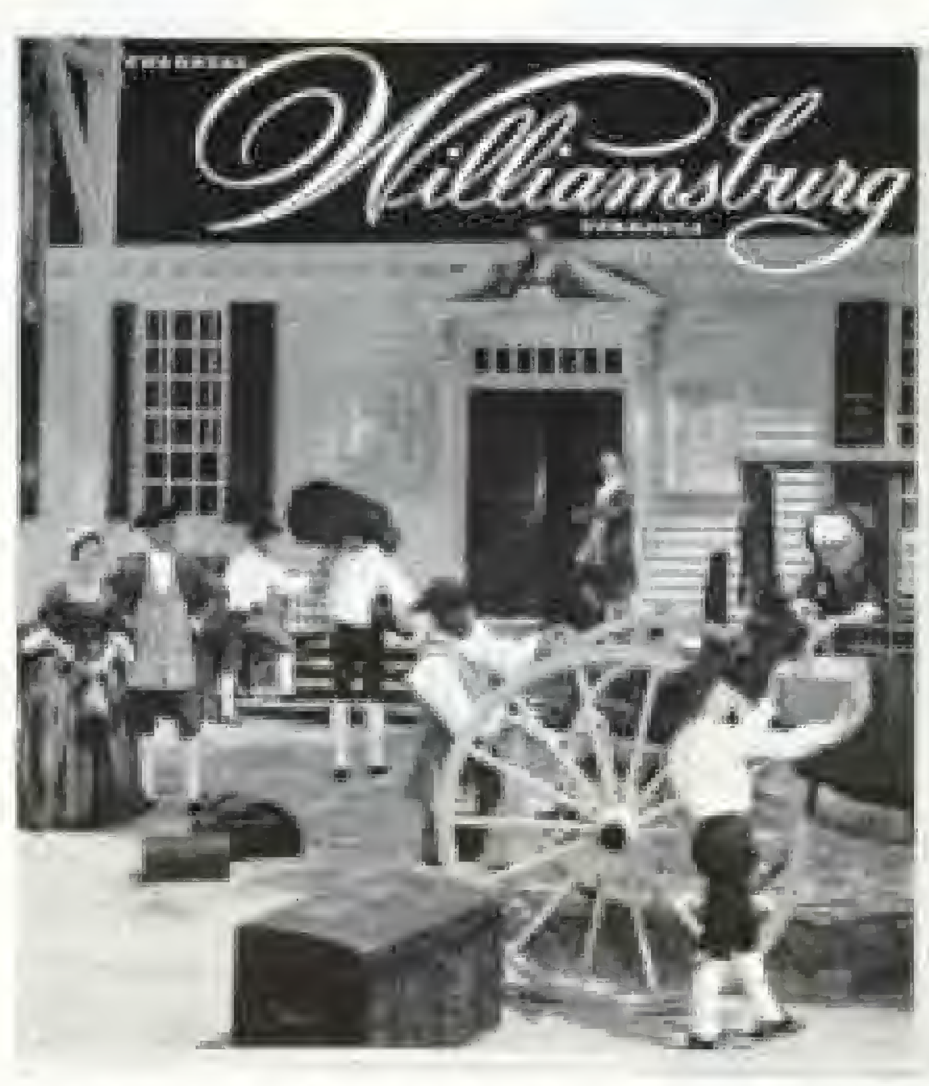

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For the truly young, the surf is gentle. The slope is mild. The caves are for make-believe. For the young-at-heart, that limpid ocean is to play and swim in, water ski and sail upon, dive beneath and explore.

Pomp and ceremony add to the fun.

You needn't even get wet to enjoy a renewal of spirits in Bermuda. Life is relaxed here. Courtesy is genuine; smiles are catching.

How spring and summer reward the visitor! Now, Easter lilies perfume the island air. Sailing and swimming are near perfect. Fishing and golf tournaments are scheduled. Cricket matches are on tap.

Come in late May for our big yachting season, highlighted by a race of Bermuda Fitted Dinghies. These 14' craft carry as much as 1,000' of sail—and lead to acrobatic (and exciting) seamanship.

Come to Bermuda any time at all. Its beauty and antique charm are year-round delights. Sports, shopping and sight-seeing are always great. And our casual way of life never changes. There's fun abroad by day, and by night, too—as hotels and night clubs put on their fine entertainment.

Nautical! Front Street, Hamilton.

There are a thousand things to do, and unwind while you do them, in Bermuda. But you don't really have to do anything but enjoy!

Plan your relaxing Bermuda holiday soon. Ask your travel agent in the U.S. or Canada, or write Bermuda, 610 Fifth Ave., New York 10020 • 6 No. Michigan Ave., Chicago 60602.

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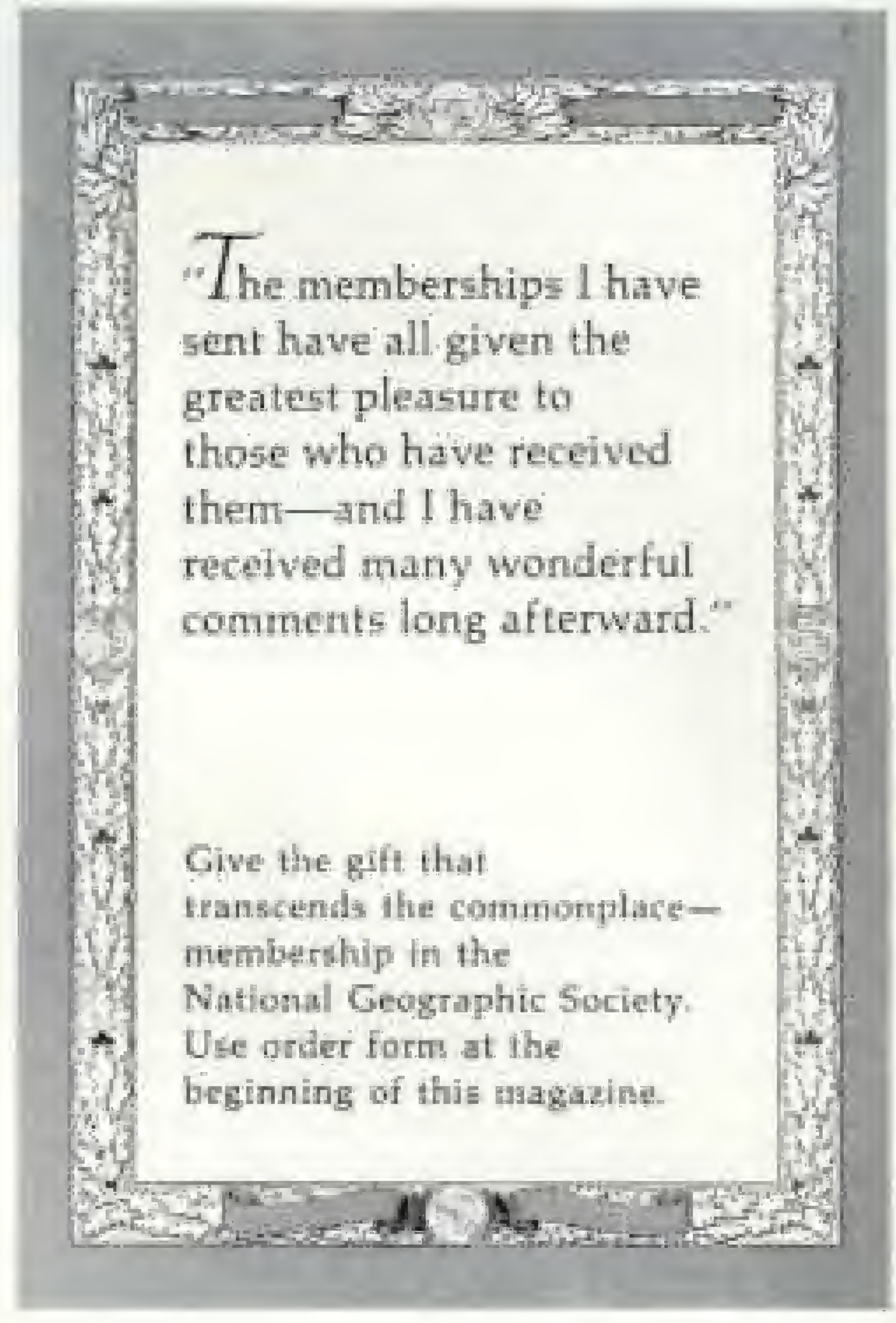

Choose Your Simplicity Way of Life

HEY THERE! — YOU with the showplace that makes tax assessors grin and gardeners quit. YOU with the desire to make more of your Green Thumb. YOU with the suburban home that's so time-demanding. YOU with the "bargain" riding mower that just won't do the job.

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May, 1966

NATIONAL GEOGRAPHIC

CALIFORNIA
The Golden Magnet

PART I: THE SOUTH

By WILLIAM GRAVES
National Geographic Senior Staff

Illustrations by National Geographic photographer THOMAS NEBBIA

WILL ROGERS, the much-beloved humorist, once attended a meeting of the "Old Settlers of California."

"No one," he wrote later, "was allowed to attend unless he had been in the State 2 and one-half years."

Will's settlers were fictitious, but he made his point: California is a land of many newcomers. A friend of mine in Los Angeles recently put it another way. "Californians," he said, "are people who were born somewhere else and then came to their senses."

Human Explosion Creates a Giant

Naturally, that's Los Angeles and you have to make allowances; Angelenos are impossible about their city. So, for that matter, are Californians about their state. They insist it's the only place to live. Of course, that's just talk, and no one else takes it seriously—except about 1,000 new residents every day.

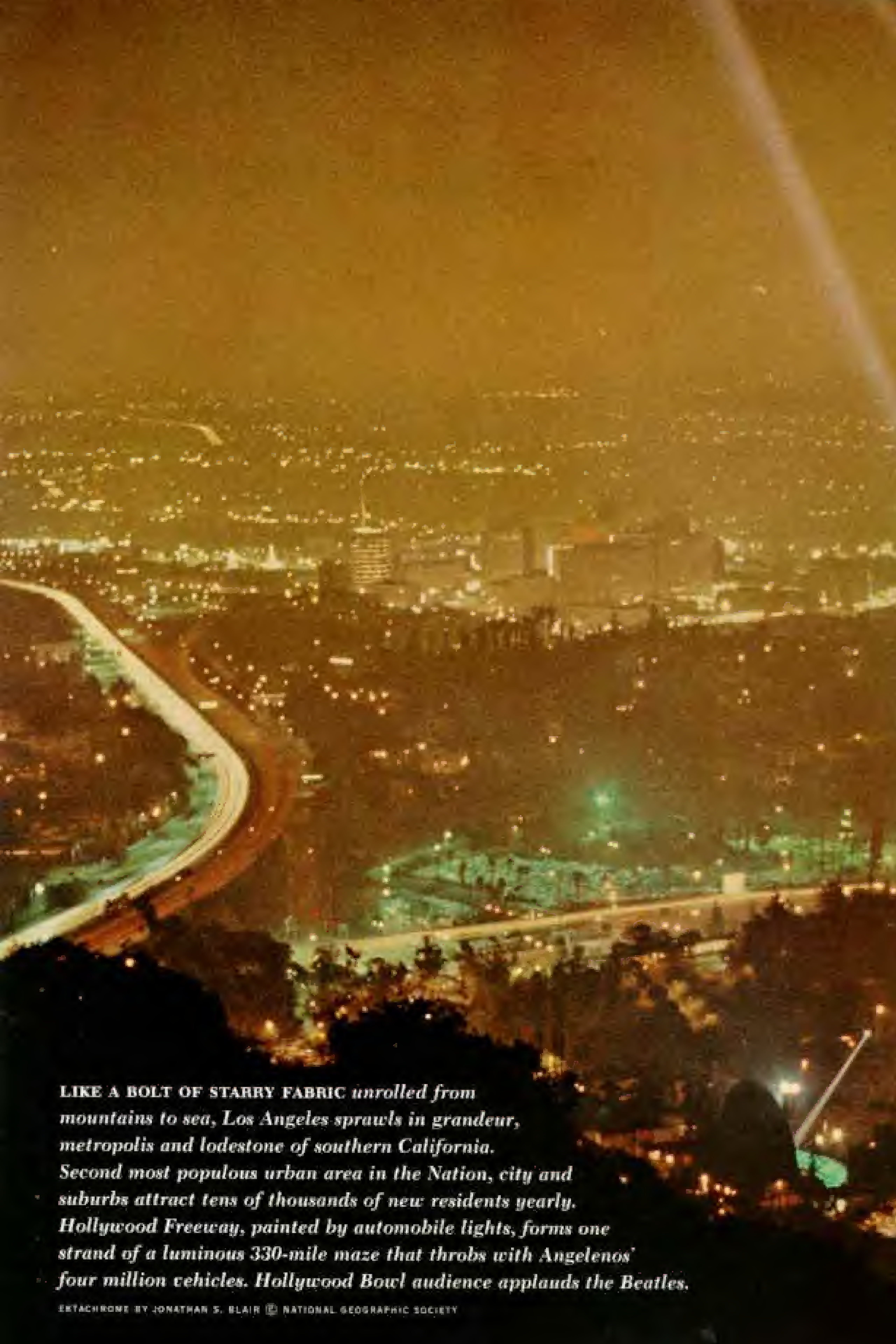
California, in other words, is an irresistible magnet, luring 400,000 settlers across its borders each year. At the moment, some 19,000,000 people—roughly one out of every ten United States residents—make their home in the Golden State.

The trouble with statistics about California is that they rarely stay the same for long. During the three months that I recently spent exploring the state, for example, some 100,000 more people became Californians.

Practically the only thing constant in the third largest state is its vast area—158,693 square miles.

"Everything else," says a census taker wearily, "is in a perpetual state of explosion."

The explosion reaches far beyond population to an endless variety of items. Among other things that California has more of than any other state are national parks, national forests, and military bases. It also has more



LIKE A BOLT OF STARRY FABRIC *unrolled from mountains to sea, Los Angeles sprawls in grandeur, metropolis and lodestone of southern California. Second most populous urban area in the Nation, city and suburbs attract tens of thousands of new residents yearly. Hollywood Freeway, painted by automobile lights, forms one strand of a luminous 330-mile maze that throbs with Angelenos' four million vehicles. Hollywood Bowl audience applauds the Beatles.*

EKTACHROME BY JONATHAN S. BLAIR © NATIONAL GEOGRAPHIC SOCIETY

teachers, students, automobiles, superhighways, and motorcycles—not to mention more major-league baseball teams (three) and more members of the National Geographic Society (640,000)—than any other state.*

What California produces is equally impressive. Golden State manufacturers in recent years have obtained almost a quarter of all prime contracts for military equipment; nearly half the money allocated for civilian space research and development is spent here. In addition, California provides a vast portion of the country's food and 80 percent of all the wine consumed in the United States.

Blessings Mixed With Problems

One thing, contrary to common belief, California does not do—produce more oranges than Florida. The Sunshine State still outharvests its rival by more than three to one.

Not all California's distinctions are enviable ones. Others include one of the largest prisons in the country (San Quentin, with 5,000 inmates), and the greatest number of traffic deaths among the states, 5,000 a year. Recently, too, California suffered one of the Nation's grimmest riots—when, in a single violent week at Watts, in Los Angeles, more than 30 people lost their lives.

California's problems, like many of its blessings, stem mainly from sheer size. In terms of people, the burden falls far more heavily on southern California than on the northern half of the state.

Just where the boundary falls between southern and northern California is a matter of opinion; or rather, of 19,000,000 opinions —every Californian has his own. No one disputes the fact that San Francisco is the center of northern California, or that Los Angeles belongs with the south. Somewhere between —roughly around Fresno, in the San Joaquin

*The most recent NATIONAL GEOGRAPHIC articles on this diverse and colorful state include: "The Magic Worlds of Walt Disney," August, 1963, and "Los Angeles, City of the Angels," October, 1962, both by Robert de Roos; "California's Wonderful One," by Frank Cameron, November, 1959; "Giant Sequoias Draw Millions to California Parks," by John Michael Kauffmann, August, 1959; "Bristlecone Pine, Oldest Known Living Thing," by Edmund Schulman, March, 1958; "Huntington Library, California Treasure House," by David S. Boyer, February, 1958; "Californians Escape to the Desert," by Mason Sutherland, November, 1957; and "New Rush to Golden California," by George W. Long, June, 1954.

Guide to a dream factory, Miss Cherie Hamilton escorts Hollywood visitors around outdoor sets at Universal City Studios. When movie production permits, tourists may witness a mock war or watch lovers emoting before the cameras.

Valley—north and south merge in a geographical no man's land where personal preference or map-making convenience decides the division (see the new supplement map of **California**, which divides it about in half).

Los Angeles: Colossus of the South

There is no question whatever about the focal point of southern California. Los Angeles is less a city than a human galaxy, a vast cluster of 75 smaller cities fused together by endless suburbs and freeways. All lie within gigantic Los Angeles County—4,060 densely populated square miles, the second largest urban area in the country, after New York City. The City of Los Angeles alone, with 2,731,000 residents, ranks third in size in the Nation, behind New York and Chicago.

Los Angeles, like many giants, often suffers the taunts of a world built to a slightly smaller scale. Even Californians make fun of their colossus: "Los Angeles," runs the quip, "speaks unkindly of San Francisco, but San Francisco never mentions Los Angeles at all."

Angelenos are accustomed to being chided about their home: about its smog, its traffic, its endless size, and—most unjustly of all—its lack of culture. Not all Angelenos, especially adopted ones, take it kindly.

"Why do people criticize Los Angeles?" demands Romain Gary, the brilliant French novelist and a former

KODACHROME (LEFT) AND EKTACHROME BY THOMAS NEBBIA © N.G.S.

"Paleface, you die!" The fierce Indian turns out to be quite gentle. Pilgrims to movie shrines join the action at Universal City's Studio Entertainment Center. Even the Creature From the Black Lagoon, from the movie of the same name, plays host behind a thin aquarium that gives the illusion of an underwater lair.

With the opening in 1913 of Hollywood's first film studio in a $25-a-month barn, the obscure hamlet began a climb to world fame. In the twenties, Mary Pickford ruled as "America's Sweetheart"; Charlie Chaplin mixed laughter with pathos. In the thirties, Clark Gable and Carole Lombard enchanted movie-goers. After losing its audience to television and foreign movies following World War II, Hollywood came back strong.

French consul general there. To Gary, Los Angeles has the beauty of endless vitality. "It is a city," he says, "bursting with life." Julie Andrews, another Angeleno by choice, puts it a slightly different way.

I called on Miss Andrews at her home in Coldwater Canyon, a wooded section above Beverly Hills. The slender young Englishwoman who has become Mary Poppins to a generation of Americans had earned an afternoon off from her new film, *Hawaii*.

"The beauty of Los Angeles," she said, "is what I would call 'pulse'—that wonderful steady beat of energy. You feel it in the early morning, when the sun is barely up, the air is cool and quiet, yet there is already a hint of excitement." She waved toward the vast reach of Los Angeles below us.

"Then you drive down into that busy life, and you can't help thinking—'It's going to be another wonderful day!'" She smiled. "What more can anyone ask of a city?"

What more indeed—though whatever one asks, Los Angeles is likely to have it. One morning along Sunset Strip, the famous entertainment section of Sunset Boulevard, I passed a sign that read "Budget Rent-A-Car System." Beside it stood two gleaming Rolls-Royce "Silver Clouds"—each worth about $18,000—for hire.

Fascinated, I stepped into the office and asked the clerk if anybody could rent one of his Rolls-Royces.

"Naturally, sir," he replied with dignity.

And what would it cost?

"Actually, it's quite a bargain—seventy-five dollars the day, and a modest twenty-five cents the mile." He held up a warning finger.

"Of course, sir, you understand that at that rate, you must furnish the petrol yourself."

EKTACHROME (OPPOSITE) BY THOMAS NEBBIA AND (BELOW) BY OTTO ROTHSCHILD, PHOTOGRAPHY © N.G.S.

A dream came true for music-hungry Angelenos when their majestic new Pavilion opened its doors in December, 1964. The soaring glass-granite-and-marble Pavilion dominates a downtown Music Center that will eventually house theater, opera, and ballet companies and a chamber-music society. The grand foyer glitters with chandeliers.

Maestro Zubin Mehta, whose brilliant performances have won critics' acclaim, leads the Los Angeles Philharmonic. Mehta, 30, is the youngest permanent conductor of a major U. S. orchestra.

Night Reveals a Second City

That evening, having reluctantly passed up a bargain Rolls-Royce, I watched what seemed to be all of Los Angeles County's 4,000,000 vehicles in action. In a small plane I took a tour of the city at dusk, just as rush-hour traffic reached the flood stage.

Los Angeles during the day admittedly can be a monotonous sight from the air—a city packed in the dingy cotton batting of its own smog. Only the thousands of back-yard swimming pools glint upward through the haze like scattered bits of bright turquoise.

At night, however, the scene comes alive, pulsing like some vast bed of coals (pages 596-7). To the east, on the great rampart of the San Gabriel Mountains, the first flickerings of light begin. As though tumbling downhill, they collect in pockets and ravines, spilling out at last onto the glowing plain of the city itself. Through it all wind the great conveyer belts of the freeways, heavy with their diamond-and-ruby chips of light.

We flew over the immense darkened tureen of Pasadena's Rose Bowl and swung southeastward toward Anaheim. Suddenly beneath us rose the jagged claw of Disneyland's miniature Matterhorn, its bobsleds still busy in the glare of floodlights.

Other lights rimmed the waterfronts of Long Beach and Los Angeles, two of the country's busiest deep-sea ports. The ports seemed strangely still—their huge traffic, some 39,000,000 tons a year, consists mainly of

Heap of talent: Carol Channing collapses over David McCallum in feigned exhaustion during a show that brings on stage the Spirit of '76, cabaret girls, fur-hatted Russians, and a Bavarian band. The scene highlighted CBS's "An Evening With Carol Channing."

Arrival of television in the 1940's at first hurt the movie industry deeply, but as more and more studios began filming television shows, Hollywood gained new prominence in the world of entertainment. Today television brings the film capital more than $460,000,000 a year.

oil and oil products pumped to and from tankers.

Flying over what sprawling Los Angeles arbitrarily calls its downtown area, we passed clusters of state and federal buildings in the new Civic Center and came on a view dear to the hearts of all Angelenos—the great honeycomb of light marking the superb new Music Center, an architectural masterpiece coveted even by San Francisco (page 600).

San Francisco, in fact, has more than the Music Center to consider in its cultural race with Los Angeles. I talked about this one day with Richard F. Brown, until recently the director of another major landmark, the new Los Angeles County Museum of Art on Wilshire Boulevard.

The museum is a magnificent blending of practical design with the grace of a marble temple. I strolled through elegantly simple rooms of Cézannes, Botticellis, and Van Dycks to Mr. Brown's glass-walled office.

Dues-paying Patrons Stimulate Art

I remarked that the museum certainly should settle any doubts about Los Angeles' love for the arts. Mr. Brown shook his head.

"There shouldn't be any doubts at this late date. Los Angeles has valued great art for years and attracted it with any number of fine institutions—the Henry E. Huntington Library and Art Gallery over in San Marino, for one. And that's not just a native Angeleno boasting," he said with a smile. "I'm an immigrant from New York, myself.

"But the main thing about our new museum is that it's supported by more than just a handful of great fortunes. Today we have some 30,000 dues-paying members—school children, dentists, bus drivers, carpenters."

KODACHROME BY THOMAS NEBBIA © NATIONAL GEOGRAPHIC SOCIETY

He gestured around him. "All Los Angeles helped to buy what you see here."

Los Angeles pays an increasingly stiff price for anything involving space. With the influx of tens of thousands of new Angelenos each year, suburbs and shopping centers have all but erased the city's once-vast fringe of citrus orchards.

"When I bought my first parcel of land here 40 years ago," a friend in the real estate business told me, "it was ten dollars down and ten dollars when they caught me. I should have bought the whole city."

The era of bargains has long since vanished. And owners of choice land in the downtown area usually prefer to lease their property rather than sell it, in the expectation of continued rise in values.

"I don't care if you have the Great Pyramid of Cheops on the acreage I want," another developer said. "I'll take the land and move the pyramid anywhere you say, free of charge."

Fortunately for the developers, pyramids are rare in Los Angeles, although I have seen an Amazon jungle and a Swiss Alpine village. Both were outdoor sets at Universal City, where Charlton Heston and I made our movie.

Mr. Heston of course did most of the work —I spent only a day as one of his extras. Quite frankly, I wouldn't go through it again for half the box office receipts.

I arranged the one-day job through Herb Steinberg, a friend at Universal, the huge movie and television studio just north of the Hollywood Bowl (pages 598-9).

"Don't look for glamor," Herb warned me ahead of time. "Making movies is 50 percent backbreaking work—and 50 percent waiting around to do it over again. Out of eight hours' shooting on a major film, we're lucky to get three minutes of final footage."

Herb's warning proved the understatement of the year: I did the same thing not twice, but 13 times. The casting office had signed me for *The War Lord*, an 11th-century adventure story starring Mr. Heston. With 20 other extras dressed as Norman cavalry and crossbowmen, I rushed into make-believe battle.

Rushing into battle with cavalry and crossbows can be almost as fatal as battle itself —especially when one happens to be nearsighted. The wardrobe department tactfully pointed out that my eyeglasses would hardly lend authenticity to an 11th-century epic. Off they came. After an hour of racing half-blind past the camera along with ten horses and my fellow bowmen, I had multiple shin scars from flying hoofs and a dozen bruises from flailing bows. The only reason I'm alive today is that Norman crossbowmen wore helmets.

Our director proved a hard man to satisfy. After half a dozen unsuccessful takes, he called a five-minute break. I noticed Mr. Heston in costume beside the camera, and I asked him a question that had bothered me all morning. No one had told me whose side I was on.

"You're on my side, one of the good people," Mr. Heston explained, smiling. "It's going to be a tough battle, but we win it."

The director called us back and ran the scene seven more times. Finally it began to rain and we stopped, so I never took part in the battle. I don't regret it. Considering the wounds I got just running onto the field, I'm sure they would have carried me off it.

Lobsters Play a Space Age Role

While Charlton Heston battles flesh-and-blood villains, other Angelenos wage war against an invisible foe. At North American Aviation, Inc., the enemy is the vast, hostile reach of space.

North American is deeply involved in Apollo, the United States' project to land two men on the moon some time before the year 1970.

I walked one morning through North American's huge plant in Downey with

EKTACHROME BY THOMAS NEBBIA © N.G.S.

Alley-oop! Traditional acrobat's signal echoes across Santa Monica's "Muscle Beach" as young athletes rise on the hands of a strong man. Tanned instructor directs the trick with open arms.

Threading the pilings, a surfer "shoots the pier" while riding the curl, or steepest part of the wave, at Hermosa Beach. Surfers may stand almost upright in a "trim" position, or they may "hot dog"—do acrobatics. Moving to the front and sticking his toes over the nose of the board, a surfer "hangs ten." If only one foot protrudes, he "hangs five." Surfing, native to Hawaii, now counts half a million followers in California alone

George Hoover, a program manager in the Life Sciences Division. Among other problems, George's division studies the possible harmful effects of prolonged space travel on the human body.

We inspected a mock-up of the Apollo spacecraft, three separate giant vehicles: one to carry the astronauts on their round trip to the moon; another to furnish fuel and power; and a third, the spider-legged LEM, or lunar excursion module, for actual landing on the moon's surface.

I asked George why North American isn't building all three vehicles.

"We probably could," he said, "but Apollo is really too big, and too complicated, for any one company to handle. Altogether there are twenty *thousand* private firms working on the moon project, not to mention the Government side of things—our overall boss, for example, the National Aeronautics and Space Administration."

The monumental scope of Apollo becomes even clearer when one considers Douglas Aircraft Company, Inc., the contractor for the top stage of the huge Saturn V rocket. Even Douglas, with its vast experience and skill, has hired 5,000 smaller firms to help.

In the endless quest to make space travel safe for man, George Hoover has played some unusual roles. Once, he ran a study on weightlessness with the help of six live Maine lobsters.

"Our purchasing department thought I was crazy when I ordered them flown across the country," George said. "But New England lobsters are very special beasts—quite different from our Pacific spiny lobster. For one thing, they stick grains of sand in their heads to tell them which way is up."

I looked skeptical, and George explained that in its nearly weightless state in water, *Homarus americanus* has trouble keeping its bearings. To solve the problem, the lobster inserts a grain of sand in an opening near the base of each of its two feelers. Gravity exerts a faint but constant downward pull on the grain, giving the lobster what amounts to a built-in plumb line.

"When the lobsters got here," George explained, "we substituted iron filings for the grains of sand in their heads, and then tried to confuse them with magnets.

"We confused them, all right. When we put a magnet against the side of the tank, the lobsters mistook the side for the bottom—they crawled right up and tried to hang on.

"It was interesting work, and we might have learned a thing or two, but we called it off. Another company was studying the same thing with human subjects in a centrifuge."

"What happened to the lobsters?" I asked. George gave me a wink.

"We ran a final experiment with boiling water and some melted butter. Scientifically, it was a great success."

Dazzling Crop Creates a Traffic Hazard

From Space Age Los Angeles I turned to California's past, by driving along magnificent coastal Route 1, roughly following historic El Camino Real, or King's Highway.

El Camino dates back to the early days of Spanish settlement of California, when the great Franciscan from Majorca, Father Junípero Serra, helped to colonize the new land with his chain of missions. The missions, eventually 21 in all, still span California's coast, from San Diego north to Sonoma, with their graceful names, most of them commemorating saints—Juan Capistrano, Luis Obispo de Tolosa, Juan Bautista, Rafael Arcángel....

Beyond Mission San Luis Rey de Francia at Oceanside, I came to what surely is one of the world's most charming traffic hazards—Mr. Edwin Frazee's seed and bulb flower farm.

High-tailing through the blue, a new DC-9 short-haul jet completes a test. Twenty-eight airlines have ordered the plane, built by Douglas Aircraft Company, Inc., on the same Long Beach assembly line that produces its big brother, the four-engine DC-8.

Aircraft manufacturers led California into the space business; last year, 45 percent of the four billion dollars in prime contracts signed by NASA went to the Golden State. From its workshops come the Apollo ships to carry men to the moon, the Mariners to peer at Mars and Venus, the Rangers that photographed the moon close up, and the Surveyors to search out later landing sites.

Villain-black biplane flies out of aviation's youth. It carried evil Jack Lemmon in a contest with virtuous Tony Curtis during Warner Brothers' movie *The Great Race.* The plane, with a four-cylinder Continental engine, copies an early Glenn Curtiss design.

At first sight of the farm, some 500 acres of seed-producing anemones, freesias, and ranunculuses, it is wise to stop the car. On the landward side of the road the eye is almost overwhelmed by an explosion of color—on the other side, far below, lies the Pacific.

At Mr. Frazee's invitation, I wandered knee-deep in a dazzling world of crimson, lavender, orange, and gold that seemed to stretch beyond the horizon (page 614).

As so often in rain-scarce southern California, the crop was heavily irrigated. Scores of rotating sprinklers like giant water pistols threw a perpetual mist over the fields. Now and then the mist trapped a rainbow, the only one I ever recall that seemed colorless.

Shark Appetites Defy Analysis

South of Oceanside I had a close-up view of another brilliant side of California—this one in La Jolla, or more exactly, 50 yards offshore from it. The small community in northern San Diego is famous not only for its quiet charm and its elegant cliffside houses, but also for one of the world's leading centers of underwater research, the famed Scripps Institution of Oceanography.

The institution—actually a branch of the colossal University of California—had just taken part in Sealab II, the U. S. Navy's project to maintain three teams of men 205 feet underwater for a minimum of two weeks. One person who has contributed heavily to the safety of such ventures is James Stewart, the institution's chief diving officer.

Jim has taught hundreds of Scripps graduate students and scientists to use scuba gear as a basic tool in undersea research. His pupils' first meeting with him is likely to be a sobering one, for Jim bears a terrible crescent-shaped scar above one elbow—the result of a brush with a shark off Wake Island in 1961.

"Lots of people have theories about sharks," Jim told me in his office, "and that's about all they are—theories. The only thing certain you can say for sharks is that there's nothing certain about them.

"Take the hammerheads we have here on the Pacific coast. A lot of swimmers will tell you that hammerhead sharks are just curious, and that if you leave them alone, they'll wander off." He shook his head.

"That doesn't prove anything at all about hammerheads; it only proves that some lucky swimmers live to talk."

Another creature worth avoiding in California waters is the occasional large electric ray. Jim told me that a few weeks earlier, north of La Jolla, a diver had come up under a big ray, which promptly draped its "wings" down over his head and turned on the current.

"Luckily, the diver was wearing a rubber hood against the cold," Jim explained, "and that *may* have given him some protection. But he said later, when his companion helped him out of the water, that it was like putting his head in a giant lamp socket."

That afternoon Jim took me for a dive in

CALIFORNIA

SUPERLATIVES seem almost commonplace in California: Most populous state (with 19,040,000); continent's lowest point (Death Valley, 282 feet below sea level) and highest waterfall (Yosemite, 2,425 feet); tallest of all living things (coast redwoods) and oldest known (bristlecone pines); first ranking in value of agricultural products, number of cars, and military installations, leadership in the space industry. Vulnerable to earthquake, fire, and flood, it also owns some of the world's most spectacular mountain and coastal scenery. Early explorers included Sir Francis Drake. Spanish friars seeking converts and forty-niners in search of gold helped bring civilization.

Golden State. **AREA:** 158,693 square miles, third largest state, after Alaska and Texas. **MAJOR CITIES:** Los Angeles (Nation's second most populous urban area, after New York, and third most populous incorporated city, after Chicago), San Francisco, San Diego, Sacramento (the capital). **CLIMATE:** Most of state enjoys Mediterranean-type climate, with temperature extremes in high mountains and southern desert. **ADMISSION:** 1850 as 31st state.

La Jolla Bay, and we spent a delightful half hour below. The water had an almost magic clarity, and we saw a steady but always changing procession of California marine life, including the spiny lobster.

There was a small moray as well, several varieties of crab, and endless species of small fish that hovered around us in schools like clouds of brilliant gnats. Happily, the hammerheads and electric rays were busy elsewhere that day.

Electricity Helps Protect Mothball Fleet

South of La Jolla, at the U. S. Naval Base on San Diego Bay, man has borrowed a trick from the electric ray. I learned the story while touring the Navy's mothball fleet with Comdr. Derwood Duncan.

San Diego has been a seafaring community since discovery of its great natural harbor—and thus of California—in 1542 by Juan Cabrillo, a Portuguese navigator in the employ of Spain. Curiously, California is believed to have earned its name before Juan Cabrillo ever set foot ashore. Around the year 1510, before the conquest of Mexico, a Spanish writer of romantic fiction described an island "on the right hand of the Indies . . . very near to the Terrestrial Paradise. . . ."

Carried away by his vision, the author told of a race of beautiful women, "without any men among them." Their weapons, he said, were entirely of gold, "for in all the island, there is no other metal." The queen was called Calafia, and the writer named his mythical realm California.

Nearly a quarter of a century later, so the story runs, Spanish mariners cruising the waters northwest of Mexico sighted the coast of what they fancied to be the golden realm. Word of the discovery spread, and in 1542 when Juan Cabrillo sailed into what today is San Diego Bay, the name California sailed with him.

Cabrillo and his men found little if any gold and still less in the way of beautiful women. Centuries later, however, the Spanish writer proved a prophet: California became famous for both.

In early times San Diego exported what Californians called "leather dollars"—cured hides that were hauled from the great inland cattle ranches and tumbled down San Diego's cliffs to waiting longboats.

Today the leather dollars, together with choice California beef, go east by rail and truck, while San Diego handles more formidable traffic: Many U. S. warships bound for Viet Nam waters clear through San Diego (pages 624-5).

One morning I toured half a dozen installations, including the recruit training center, the Naval Air Station on North Island, an underwater demolition unit, and an antisubmarine warfare school, all part of the Navy establishment

Firework flowers bloom over Disneyland: Sleeping Beauty's castle glows like a mirage as crowds enjoy a summer evening. More than six-and-a-half million visitors—three-quarters of them adults—revel here at Anaheim every year, a record made possible by California's gentle climate. "Sunshine built California," Walt Disney told the author. "Just about everything else followed it here."

KODACHROME BY THOMAS NEBBIA © N.G.S.

that spends more than a million dollars a day in San Diego. Finally we ended with the mothball fleet, scores of cocooned and silent ships at ghostly anchorage.

Walking beside the aircraft carrier *Philippine Sea* with Commander Duncan, the fleet's maintenance officer, I noticed a slender electrical cable running down into the water beside the hull. Commander Duncan explained that the cable helps to protect the hull against corrosion.

"Without protection," he said, waving toward the carrier, "a hull that size can lose hundreds of pounds of steel a year through corrosion. And the corrosion isn't always uniform—it attacks certain points in a hull and forms pits or craters that eventually could eat right through.

"Basically, corrosion is an electrical and chemical process. We've found we can slow it down, or even eliminate it, simply by running a current to the hull of the ship through the water from what we call anodes—bars of lead, graphite, platinum, or other metals that in a sense do the deteriorating in place of the hull, only at a much slower rate." He smiled.

"That way, if the Navy ever needs these ships in a hurry, we can get them to sea ready for a fight without having to patch them up like old inner tubes."

Market Research Aids War on Smuggling

For all its role in national defense, San Diego still finds time to enjoy itself. The possibilities are broad, for the city has one of the world's finest zoos (page 623), some of the best fishing and surfing beach in California, and a brand-new waterfront recreation area, Mission Bay Park, that draws yachtsmen and vacationers from as far away as the Atlantic coast. In addition, of course, there is San Diego's colorful next-door neighbor, the Mexican border town of Tijuana.

Tijuana, with its bull ring, its *jai alai* matches, and its slightly faded air of endless fiesta, lures Californians across the border by the scores of thousands each weekend and returns them, as a rule, happier and slightly poorer. On weekdays the human tide reverses itself, as thousands of Mexicans cross the

PHOTOGRAPHS BY LAWRENCE SCHILLER © NATIONAL GEOGRAPHIC SOCIETY

Hardy campers line Pasadena streets on New Year's Eve. Their reward for the chilly, nightlong vigil: a close-up view of the resplendent Tournament of Roses Parade. A million and a half spectators jammed the route to watch the procession last January 1; more than a hundred million saw it on television.

Blaze of blossoms on Burbank's float honors Walt Disney, 1966 grand marshal. Floral music staff and artist's palette resting on an open book represent "the three important elements in the Disney legend: story, music, and art." The float uses 5,000 orchids, 75,000 chrysanthemums, 1,000 roses, and 50 potted azaleas.

Tournament
of Roses

border northward to shop or, in some cases, to work in San Diego.

I stood by the human floodgate—the border station of San Ysidro—one weekday morning with a U. S. Customs Bureau inspector. San Ysidro is famous for its stories of smuggling, and I asked if there was any truth to them. The inspector nodded.

"We make more individual seizures of narcotics than any other United States point of entry," he said.

Marijuana and heroin, I learned, are the drugs most frequently smuggled, and the Customs Bureau has found them hidden in practically everything—salt shakers, ladies' compacts, hollowed-out vegetables, and once in a set of extremely false teeth.

"Don't get the idea that smuggling is particularly a Mexican affair," the inspector told me. "No country has a monopoly on it. Our troublemakers hail from every part of the world—and usually come to grief right here."

He sounded very sure of himself, considering that customs never sees the contraband that slips past it. The inspector smiled.

"We don't need to," he said. "We have agents all over southern California who know the going price for—let's say heroin—on the black market. If the price is high, that means the supply is low, and we're doing all right at San Ysidro. But if the price of heroin takes a dive"—the smile faded—"we spend a little more time with certain visitors."

Lawyer's Skill Overcomes Intolerance

For all the human traffic between California and Mexico—some 22,000,000 people a year pass through San Ysidro alone—influence on the Golden State from south of the border has long been declining. Mexico's brief rule over California ended more than a century ago. In 1848, after the war with Mexico, the territory was ceded to the United States by treaty.

"We gave California some of our music and architecture," Ramon Castro observed one night at dinner in San Diego. Ramon is a brilliant young lawyer whose Mexican parents immigrated to California from the State

Gardener's palette splashes color on fields of Edwin Frazee, Inc., at Oceanside. Yellow, orange, and red beds of ranunculuses contrast with more distant carpets of anemones. Frazee's 500 acres produce bulbs and cut flowers for shipment around the world.

KODACHROME BY THOMAS NEBBIA © N.G.S.

of Durango before he was born. "Luckily for all of us," he continued, "we gave you the taco and the enchilada, too.

"But those are minor contributions, and the trend is the other way. Many Mexican Americans in California today go what I call all-out 'native'—strictly U.S.

"It wasn't always that way," he added, frowning. "When I was a boy here in California, I hated the gringo with a passion. I remember excursions when we traveled in separate rail coaches—one for Mexican American kids, and the other for the 'real Americans.'

"But we've learned a lot on both sides since then. Today in San Diego I'm just another American who happens to speak a second language, Spanish."

As a successful lawyer, Ramon has helped to bring down the barriers of misunderstanding between Californians and their neighbors south of the border. Not long ago a San Diego court appointed him to defend a young man accused of murder.

"When I walked into his cell," Ramon explained, "the first thing he said was, 'I guess you ought to know I don't like Mexicans.'

"So I told him that was fine, that I didn't want his case anyway, but now that I had it, I was going to win it. We did win it, too; the jury acquitted him and he's free today.

"I receive news of him now and then, and he's changed his mind about Mexicans. That's one man whose kids will never ride in a separate coach."

East of San Diego, beyond the great rain barrier of California's coastal ranges, Mexico and the Golden State work side by side. The business is agriculture; the place, the Imperial Valley; and the result, $200,000,000 a year.

Imperial Valley, that vast larder for the Nation, is in part a happy accident of nature —silt piled as deep as 2,000 feet by former meanderings of the Colorado River. What transforms murderous desert into one of the world's richest farming areas is man's diversion of Colorado waters into the All American Canal.

Through a system of barriers upstream on

Devils Golf Course, a fossilized lake in Death Valley, holds the dry remains of a watery expanse 100 miles long and 600 feet deep. Wind and rain carved its salt into jagged pinnacles. Hottest place in the Nation, the valley once recorded 134° F in the shade.

KODACHROME BY WILLIAM BELKNAP, JR. © N.G.S.

the Colorado—the great concrete scallop shells of Imperial, Parker, Davis, Hoover, and Glen Canyon Dams—the gravity-flow canal can deliver 15,000 cubic feet of water every second to Imperial Valley's nearly fifty assorted crops. As a result, farmers on both sides of the border take a dim view of that valley rarity—rain.

"That's the last thing we want," one Imperial grower told me. "Rain drowns the plants, washes away the soil, and makes a quagmire out of everything."

He waved a hand across the green velvet of a broccoli field.

"When my crops need water, I pick up the telephone and ask the water district to open its sluice gates and send me some. Within a day I get just what I asked for—almost down

KODACHROMES BY THOMAS NEBBIA © N.G.S.

to the drop." He spread his hands. "No rainstorm on earth can do that."

I mentioned the grower's remarks later to Father Jerry Sims, the Roman Catholic pastor of a church in El Centro, Imperial Valley's major city. Father Sims nodded.

"Rain is a touchy subject in the valley," he agreed. "It's a problem even in church. Now and then the bishop of our diocese over

Magic of water conjures a lush green golf course on Palm Springs' burning desert. A score of courses in the area attract many celebrities, including former President Dwight D. Eisenhower. Dry, warm winters, elegant shops, and luxurious accommodations make the city California's best-known desert resort. Almost every home has its pool; water flows from 400-foot-deep wells and from the nearby San Jacinto Mountains (left).

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

in San Diego issues a special prayer for rain, and that's fine for San Diego—they can use it.

"But I'll tell you this: It takes a brave priest to read that prayer in the valley."

Not every part of southern California has a Colorado River to tap, or even much hope of rain. North of Imperial Valley and its great drainage sump, the Salton Sea, lies a vast stretch of seared and empty land known to Californians simply as "The Desert."

Actually, the California desert has many parts, the two largest being the Colorado and the Mojave. Together the two giants cover some 20,000 square miles—an area four times the size of Connecticut.

Maps give the Mojave a deceptively gentle look, with their blue tracery of lakes and rivers. The map maker's blue is more phantom than real—the symbol of water long vanished. The lakes and riverbeds for the most part are dried-up fossils of the great sea that drowned southern California in prehistoric times (page 615).

For all the Mojave's barren hostility to man—a soldier on desert maneuvers once called it "the proving ground for Hell"—it is a land of haunting beauty.

Like bowling balls, cantaloupes tumble into a truck as college students help with the harvest near Huron. Fringed sombreros from south of the border became rare when the Government in 1965 halted seasonal migrations of *braceros*—field workers from Mexico. Local farm hands help fill the gap, but a shortage of labor still plagues some areas despite increasing use of machinery.

Driving north from Imperial Valley, I passed ranges of jumbled rock, scorched and blackened as though by a giant blowtorch. Yet among the rocks rose the slender shafts of yucca plants, lifting their clusters of silver blossoms like candelabra against the sky.

Altimeter Unwinds to Minus 80 Feet

Loneliness enfolds the Mojave like a cerement. Often the traveler's only companions are the dust devils—miniature whirlwinds that do their ghostly dance across endless miles of sand. Sound, too, comes rarely to the desert, except for the solitary wind. Now and then against the stillness, high out of sight, a jet aircraft rips a seam across the sky.

Curiously, the desert offers a hospitable side to the aircraft that invade its silence. So endlessly flat and hardened are the dry lake beds that they make perfect auxiliary landing strips. The most famous example is the vast expanse of Rogers Lake, at Edwards Air Force Base.

One morning at the base, the Air Force's great flight-test center in the western Mojave, I sat buckled in the rear seat of a T-38 jet trainer behind a test pilot, Capt. David Livingston.

Earlier I had toured the base and learned that in today's aviation test work, all is not supersonics and the Space Age. Close beside the X-15, the bulletlike rocket plane that has flown six times the speed of sound,* I saw half a dozen familiar propeller-driven aircraft. All were vintage types that I had thought of as long since tested, yet all were obviously being readied for experimental flights by green-overalled ground crews.

"No Air Force plane ever really graduates from the test line," Dave Livingston told me. "For one thing, aircraft designers are always coming up with improvements to make their products do a better job—or even do a brand-new one.

"All the drawing boards in the world won't tell you for certain how some change may affect an airplane in flight. Our job is to find out for sure, not only with the supersonic

*Test pilot Joseph A. Walker described how it feels to fly the X-15 in the September, 1962, GEOGRAPHIC.

California gold: Sunkist oranges go into crates at Rancho Sespe, near Ventura. The Golden State provides 90 percent of the Nation's lemons, but Florida outproduces it in oranges by three to one. Groves of oranges, lemons, and grapefruit earn California $150,000,000 a year. Because of sky-rocketing land values, however, many groves have yielded to expanding cities and suburbs.

Carpet of cotton, woven with machine precision, covers a seemingly endless expanse of the San Joaquin Valley at Lemoore. Daredevil pilots leave contrails of pesticides over the fields. Scientific fertilizing, irrigation, planting, and harvesting make this valley the

state's most important farm region and California the Nation's leading agricultural producer. High cost of labor and its short supply have spurred the development of complex machinery to operate the huge factorylike farms.

types, but with what people nowadays consider the Model T's."

Our jet trainer was neither the Air Force's fastest plane nor in any sense a Model T. Dave lifted the slender nose and we streaked upward through the desert haze, leveling off in the crystal morning at 15,000 feet. The dry lake bed below us had dwindled sharply, its network of emergency strips like a scattering of arrows in the dust.

I had asked to fly over Mount Whitney in the Sierra Nevada, the United States' highest point—at 14,494 feet—until Alaska brought Mount McKinley (20,320 feet) into the Union. Afterward I hoped to see the Western Hemisphere's lowest point, near Badwater in Death Valley, at 282 feet below sea level.

Dave swung northward over the Tehachapi Mountains, long a traditional dividing line between southern and northern California. Today, with faster transportation and closer dependence between the two halves, the boundary is less easily defined.

Beyond the Tehachapis we banked eastward, and suddenly the great upturned saw blade of the Sierra flashed beneath us. Even in early summer, the grooves of the blade—the high mountain passes—were clogged with snow. Here and there among the peaks, small frozen lakes glinted like tarnished coins.

Dave circled Mount Whitney and followed the Sierra northward, along the jagged ridgeline. Clouds drifted in on the Pacific's westerly winds, striking the massive mountain barrier and coiling upward in a violent froth. Winds tipped the froth over the ridge, so that it curled and tumbled down the eastern slopes and vanished over the desert; we seemed to be flying beside an enormous waterfall.

We followed the clouds in a shallow dive, and suddenly the great, vivid scar of Death Valley opened before us.

[illegible] © NATIONAL GEOGRAPHIC SOCIETY

Oasis of wonders: Balboa Park, San Diego's chief recreational and cultural center, borders the downtown business district. Its 1,158 acres contain wild and landscaped grounds, museums, a concert bowl and theater, golf courses, and a zoo where children may feed and pet some of the animals. Amid sun-drenched gardens, students (opposite) paint beneath the Spanish-colonial California Tower, designed by Bertram Grosvenor Goodhue for the 1915-16 Panama-California International Exposition.

Tall-masted pleasure yachts share San Diego Bay with steely men of war. California possesses few good harbors; boats jam every available space such as at man-made Shelter Island. Across the water, jets line the aprons of North Island's Naval Air Station. Home of the U. S. Navy's First Fleet, San Diego serves as headquarters for a huge defense complex that includes shipyards, depots, and training installations. Viet Nam-bound troops and supplies also stage through the port.

"We'll take a close look at it," David said over the intercom and went into another shallow dive. The air-speed indicator in front of me showed 400 knots as we leveled off some 200 feet above the valley floor.

I can't say that I saw Badwater as we streaked by, but Dave assured me it was there. I was more impressed by the fact that we were flying approximately 80 feet below sea level. Dave climbed and provided a final variation, rolling the T-38 slowly on its back. For a moment I hung suspended upside down in the harness—and Death Valley streamed by overhead.

It took only minutes, right side up, to cover the 165 miles between Death Valley and the town of Mojave near Edwards—a brutal week-and-a-half trek for the 20-mule teams that hauled borax from the valley in the 19th and early 20th centuries.

Today a different sort of mule helps California harvest her underground riches. The mules—Californians sometimes call them "donkeys" or even "grasshoppers"—are mechanical pumps that operate the state's 41,000 oil wells, endlessly nodding and drawing wealth from the land (pages 656-7).

California's mechanical donkeys graze in unlikely places: on downtown streets in Los Angeles; in a Beverly Hills high school yard, in vineyards and cotton fields; even miles at sea, atop offshore wells.

I walked one day through a herd of the donkeys near Bakersfield, at the southern tip

Careening on two wheels, a sand sailor races across the dry bed of El Mirage Lake. His single-sail land boat can scoot 2½ times the speed of the wind, sometimes attaining 60 to 70 miles an hour on the hard flats.

At the feet of mighty giants, tiny humans stand in awe. Sequoia National Park in the Sierra Nevada, established through Government and private efforts, including grants from your Society, preserves forest patriarchs in their primeval splendor. Some of these *Sequoia gigantea* near Crescent Meadow first took root 3,500 years ago. Although scarred by countless forest fires, the trees' thick bark helps insulate the heartwood against flames.

of the San Joaquin Valley. The San Joaquin and its northern counterpart, the Sacramento Valley, join in a great 500-mile-long trough, called the Central Valley, running between California's Coast Ranges and the Sierra.

The San Joaquin and Sacramento are two huge greenhouses, between them producing an infinite variety of crops. Bakersfield and surrounding Kern County, while blessed with rich farmland, are equally blessed in what lies beneath. In a state whose oil production is exceeded only by that of Texas and Louisiana, Kern County contributes nearly a third of all California output, with 98,000,000 barrels a year.

Ray Arnett, a geologist with Richfield Oil Corporation, led me on review past the bobbing donkeys. Like many a stranger to the petroleum industry, I had thought of oil wells in terms of gushers that had to be restrained rather than encouraged to flow. Ray nodded agreement.

"You're partly right," he said. "When a well first comes in, underground water or natural gas usually lifts the oil up, and you may have to slow it down. But after a while the pressure drops off, and then these"—he waved at the pumps—"take over.

"Finally," he added, "the pressure gets so low that even the pumps aren't enough."

I asked if that meant the end of the well, and Ray shook his head emphatically.

"Not necessarily. The cost of discovering a field can be enormous, and the ratio of producing wells pretty low. When the pressure is really gone, you recharge the well by forcing water, gas, or nowadays even steam, back into the ground to start things moving.

"It's just like shaking a soda pop bottle to make it fizz a little more. Only this is pretty valuable fizz."

Sea Water Supports Sinking Land

Shaking the pop bottle too long and hard can lead to trouble, as Californians have learned to their dismay. In some areas of the state, so much oil has been pumped out of the ground that the land above it has actually begun to settle. In coastal regions engineers have hit on an ingenious solution—stabilize the land by pumping tons of sea water underground to replace the depleted oil.

East of Fresno, along the shoulder of the mighty Sierra, lies one of southern California's greatest treasures. Sequoia and Kings Canyon National Parks, although technically separate domains, join to form a 1,314-square-

mile federal preserve. The reason for the preserve—its spectacular mountains and gorges aside—is *Sequoia gigantea*, the big tree (preceding pages).

Many National Geographic Society members are familiar with their Society's role in preserving the world's finest stands of giant sequoias. Susan Baisden, for one, knows all about it.

I met Susan, who is ten years old, at Lost Grove, one of the roadside stops in Sequoia park, where her family had come for the weekend from their home in Bakersfield. She and I fell to discussing the great fire scars that etch the sequoia trunks as far up as the eye can reach, recording countless assaults by flames.

One of the park naturalists had told me that a healthy redwood may even withstand a "crown fire"—a forest fire that races through the tops of the tall trees. The bark of *gigantea*, like that of its cousin, *Sequoia sempervirens* —the coast redwood of northern California—has an almost asbestoslike quality. Although it can be burned, a mature redwood, because of its thick, fire-resistant bark, rarely dies as a result of a single fire.

That fact, I said, may help to account for

the sequoias' fantastic age, estimated as high as 3,500 years. Susan nodded unhappily.

"Yes, but it's sad that they aren't the oldest living thing any more," she said. "I suppose you've read about those bristlecone pine trees in the GEOGRAPHIC—the ones in the White Mountains, beyond the Sierra. We read about them in school."

I said I knew of them. One of the incredibly gnarled bristlecones has an estimated age of more than 4,600 years. And one tree across the line in Nevada has lived 4,900 years.

Susan considered matters soberly for a moment, and then brightened.

"A plane in every garage" could be the motto of Sierra Sky Park, near Fresno. The "town square" is a 3,200-foot-long grass airstrip, making this a suburb with a real difference. Planes taxi on streets that bear signs reading "Watch for Aircraft on the Roadway." Children skateboard along the driveway of their futuristic home. Their father, a lumber company owner, uses his plane for business and family recreation.

KODACHROME BY THOMAS NEBBIA © N.G.S.

"After all," she said, "it isn't so bad, really—most bristlecones are Californians, too."

For every national park and monument within its borders, California has dozens of state parks and monuments all its own. For sheer contrast with Sequoia's untouched splendor, nothing quite matches San Simeon (page 639).

Empty Bottles Return to Wine Cellar

Even the term "castle" seems scarcely adequate for the lavish former home of the late William Randolph Hearst, on the Pacific coast north of Morro Bay. Castles, as a rule, follow a single architectural style; San Simeon exuberantly follows half a dozen.

The vast mansion, with its soaring bell towers, formal gardens, and statuary, exhibits such styles as Florentine, Moorish, Roman, Greek, and Peruvian, with a dash now and then of ancient Egypt. Yet somehow the castle at San Simeon, far from being an eyesore, has unmistakable grace. It also has a very curious wine cellar.

I learned about the cellar from Barbara Sewell, an attractive member of the state historical monument's staff. She had shown me the lavish Neptune Pool, done in marble with a Roman temple on the side. Mrs. Sewell remarked that the State of California, now the mansion's proprietor, allows guides and maintenance staff to use the pool after hours. But the state, unhappily, refuses to heat the pool, as Mr. Hearst did for his guests.

Indoors, we came to the enormous Refectory, the main dining hall of the mansion. At one side of the room on a long buffet stood a magnificent silver wine bowl, more accurately called a wine cistern. Mrs. Sewell explained that San Simeon in its day had been famous for its wine cellar, part of which still remains.

Recalling the pool privileges, I asked if she were personally acquainted with the wine cellar. She shook her head.

"I made several recommendations about that," she said smiling, "but the State of California didn't agree."

Actually, I learned later, California doesn't own San Simeon's wine—it still belongs to Mr. Hearst's family. But to maintain the cellar's original appearance, California and the Hearsts have made an ingenious agreement.

The Hearsts, who no longer live in the main mansion, now and then remove a few cases of wine for their own use. Once the bottles are empty, the Hearsts return them to San Simeon's cellar to help preserve its authentic historical atmosphere.

South of San Simeon, just off California's coastal Route 1, something happens to the salt sea air. It is suddenly drowned in a fragrant wave of chocolate, followed by others of nutmeg and cinnamon. The reason is Solvang, a town of some 1,500 that would seem to have no business being in California at all.

Solvang, with its immaculate, half-timbered houses and its Hans Christian Andersen bakeries and candy shops, properly belongs on the other side of the Atlantic, in Denmark—the birthplace of about half the town's residents. Happily for California, Solvang's Danish-Americans are quite content where they are.

EKTACHROME © N.G.S.

Rainbow robes of Japanese O Bon dancers paint swirls on Fresno's city mall—and fill a child's eyes with wonder. Traffic once clogged this business district where today flowers, fountains, and a sculptured clock tower adorn an open promenade. City planners hope to convert an entire 85-acre business "superblock" to pedestrian use, erecting a convention center and other public buildings. Japanese-Americans honor their dead during the O Bon Festival; they constitute only a small proportion of Fresno's population, but represent the active and prosperous Nisei community of the entire state.

SECURITY BANK
PRICES
PRICES
BURT'S
SHOES

Solvang began more than half a century ago as a small colony of Danish-Americans from the Midwest. Over the years other Danes followed, both from the homeland and from many parts of the United States. With them they brought the magic of Danish cookery, craftsmanship, and a genius for farming.

Solvang's sidewalks are perpetually awash with non-Scandinavians—visitors drawn by the town's endless store of fresh-baked pastry, delicate cheese, and hand-blocked linen.

But the charm of Solvang and its surroundings, to me, stretches beyond the gift shops and the bakeries. North of the town in a quiet valley stands a red frame building as surprising in California as is a Danish village.

In a state whose exploding numbers demand education on a massive scale, the two-room school seems hopelessly out of place. Yet the small public school of Ballard goes unconcernedly ahead training some two dozen pupils every year, just as it has since 1882.

Gopher Umpires a Sand-lot Game

I sat one morning on the schoolhouse steps with Joan Brace, Ballard's principal and one of its two teachers until she left recently to be married. We talked of California's educational system, for all its massive size one of the best in the country. I asked how Ballard

"Queen of the Missions," Santa Barbara relives its colonial glory during the Old Spanish Days Fiesta. Padre Choristers open the August festival on the steps of the old church. Beguiling dancer twirls to the music of guitars and castanets. Established in 1786, the mission forged a link in the chain of 21 outposts—from San Diego to present-day Sonoma—that helped Spain colonize California's coast.

fitted into a network noted for such giants as the University of California, Stanford University, and Los Angeles' University of Southern California.

"Perfectly," Joan answered. "Ballard graduates have gone on to take higher degrees in those places, and a good many others. It's true that the big elementary schools outdo Ballard in the extras—music, mechanical training, and that sort of thing. But basically we all follow the same pattern." She waved around her.

"What Ballard has that the others don't is something that's precious in California because it's vanishing—space, and the wonder of natural things. Look there, for example." She pointed toward the schoolyard, at a small form investigating what appeared to be a sandwich crust.

"That gopher is a school pet, and every one of my 28 pupils knows him on personal terms. What's more, he knows them. I've seen him at baseball games, standing attentively right next to third base. If you didn't know better, you'd say he was an umpire. I'm convinced *he* thinks he is." She smiled as I stood up to go.

"You won't find that in San Francisco or Los Angeles."

Ballard, at least, has a schoolhouse with

children; lonely San Nicolas has hardly any life at all. I learned of San Nicolas during a visit to Santa Barbara, once the site of a Spanish *presidio*, or colonial garrison, as well as a Franciscan mission.

Lonely Vigil Proves Futile

Santa Barbara has an air of untroubled charm that disguises two historic ordeals—a disastrous earthquake in 1925 and a forest fire that engulfed the city's outskirts less than two years ago.

It was at Mission Santa Barbara, called "Queen of the Missions" (preceding page), that I learned of Juana Maria. Juana Maria's story goes back to the year 1835 and to remote San Nicolas, a speck of land lying some 50 miles southwest of Los Angeles in the Pacific Ocean.

During the fading years of Mexican rule over California, authorities decided to evacuate the small band of Indians living on San Nicolas. As a boatload of islanders set out for the waiting ship, one mother, Juana Maria, discovered that her child was missing. She was returned to the island, but while she searched, a fair wind sprang up and the ship set sail for the mainland. For 18 solitary years

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Juana Maria lived marooned on San Nicolas, until rescuers sent by the Franciscans at Mission Santa Barbara found her and returned her to the mainland. There she died a few weeks later and was buried by the Franciscans in their quiet cemetery.

No trace of the child has ever been discovered on the island.

Fascinated by the story, I determined to visit San Nicolas. The island today provides a link in the Pacific Missile Range, a 3,000-mile-long test corridor from the Navy's missile test complex at Point Mugu all the way to tiny Johnston Island west of Hawaii.

Whorls of light outline oil wells at Coalinga. With his camera set on a hilltop and the shutter open, NATIONAL GEOGRAPHIC photographer Thomas Nebbia drove through the maze of roads serving five wells and stopped at each pump to set off a flash. In the process, he captured his own silhouette at least once—in the circle at far left.

California wells produce nearly 11 percent of the Nation's petroleum, surpassed only by Texas and Louisiana. Yet, because of the state's huge number of motor vehicles —11,000,000 registered in 1965—it must import motor fuel.

The Navy kindly flew me to San Nicolas from range headquarters at Point Mugu. The flight took us south, past the magnificent Channel Islands National Monument to the west of Santa Catalina, Los Angeles' offshore vacation center. Finally the ten-mile-long outline of San Nicolas appeared below us through the haze.

San Nicolas is hardly a reassuring sight to passengers in an aircraft about to land. As we circled low for a final approach, I noticed a grim line of wreckage beside the runway. There were battered sections of fuselage, a crumpled tail fin or two, and the charred remains of half a dozen wings. The pilot ignored them and banked evenly into the wind, touching down and rolling to a stop beside the control shack.

Only then did I learn that San Nicolas' junkyard is a source of pride rather than shame to the Navy.

"They're target drones, brought down in practice shoots and then fished out of the water," said Comdr. Harold R. Megrew, the island's officer in charge. "Beautiful sight, aren't they?" I admitted they were breathtaking.

Commander Megrew took me for a brief tour of the island in an open jeep, and I learned why Californians speak of the "San Nicolas tilt." A constant half gale tore at our clothes and raised miniature dust devils beside the road. Old-timers who used San Nicolas as an occasional station for hunting sea otters insisted that to walk anywhere on the island, they had to maintain a constant 45-degree tilt to windward.

I found San Nicolas a bleak and forbidding spot, wind-scourged and treeless. Only the grim silhouettes of the Navy's great radar tracking antennas relieved the low line of dark hills.

My thoughts turned to Juana Maria and her years of lonely exile, gazing endlessly out on an empty sea. San Nicolas had begrudged her even the comfort of wild companions. The island proper has few natural inhabitants save for lizards and the elusive Channel Islands foxes.

Yet Juana Maria had not watched alone. To seaward of the coves where she had gathered abalone and small mussels, rise dark spires of rock—lookouts to this day for other sentinels of the lonely ocean, the cormorant and the sea lion.

Where South Ends and North Begins

Flying back toward the mainland at dusk, we passed Los Angeles' great plain of light and turned northwestward to follow the coast. Gradually the city dropped behind like some enormous incandescent cloud, drifting across the dark reach of space. At last I turned away and picked up the lights of Point Mugu before us. From there the coast lay north and west, outlined by other lights of small towns like a row of beacons set awry.

Beyond them lay another California.

* * *

La Cuesta Encantada—The Enchanted Hill—William Randolph Hearst's San Simeon estate, houses a fabulous collection of paintings, sculptures, and antiques. The palatial home towers like a Spanish cathedral over surrounding guest cottages and landscaped grounds. A colonnade flanks the outdoor pool. Donated to California by the Hearst Corporation, the property has become a state historical monument.

Newspaper editor William Randolph Hearst, Jr., rides on the family's 75,000-acre ranch surrounding the San Simeon estate.

ABOVE THE DOORWAY of a state building in Sacramento, California's capital, runs a legend carved in marble:

BRING ME MEN TO MATCH MY MOUNTAINS

Providence, it seems, having created California on a vast scale, generously answered the request. From its earliest beginnings, California history has rung with great names in discovery and achievement—Cabrillo, Serra, Drake, Frémont, Vallejo, Stanford.

Yet for all its dramatic past, California remains a land of endless challenge. In a recent speech near San Francisco, President Lyndon B. Johnson declared: "Those who believe the frontiers of America are closed should be out here today... the era of the pioneers is not over—only the area of pioneering has changed."

One of California's greatest challenges lies in binding two divergent parts into a single, smoothly working state. What distinguishes northern California above all from its southern counterpart is the ratio of men to mountains—of men to the land.

"Southern California has the people," runs a saying. "Northern California has everything they need." The saying exaggerates; yet the fact remains that two out of three Californians make their home in what is regarded as the southern part of the state, while many of the resources—timber, undeveloped land, and water—lie largely in the northern half. The result is a state divided in character, yet unified by the needs of its vast population.

Open Spaces Hold Key to Future

Northern California's wealth lies not only in its resources but in the sheer majesty of the land itself—in the great coastal ramparts that buttress the land against the sea, in the timeless grandeur of the redwood groves, in rolling grasslands and grim volcanic peaks—and in

the glitter of a stately city at night high above San Francisco Bay.

I began my tour at Big Sur, still in the southern half of the state but scenically the beginning of nature's north. Big Sur has become famous both for its dramatic confrontation with the sea and for the artists and writers who are drawn to its natural beauty (pages 650-53). I saw it first on a day when fog wrapped the great headlands in gauze, smoothing the rough contours of the coast.

At least one of Big Sur's residents, the noted architect Nathaniel Owings, believes such uncluttered beauty holds the key to California's future. "Our problem is people," he told me when I called on him. "Not just thousands or even millions of people, but *tens* of millions. California's population is expected to triple by the end of the century, and our cars even now are increasing at something like a thousand a day.

KODACHROMES BY JONATHAN S. BLAIR (BELOW) AND TED [illegible] © N.G.S.

CALIFORNIA
PART II

Nature's North

By WILLIAM GRAVES

Photographs by JAMES P. BLAIR and JONATHAN S. BLAIR

Beloved city by the bay, San Francisco dons her nighttime glitter beneath a tawny sunset sky. Double decks of the majestic Bay Bridge carry spangled streams of auto lights. The vibrant city of St. Francis blends gold-rush gusto and Nob Hill sophistication, whistle of ships and clank of cable cars (above). Queen of northern California, she reigns over a domain of farmland and forest, pleasant towns and rugged mountains—and water to nourish the state's parched south.

"Someone has said jokingly that eventually California will be entirely paved—with the possible exception of Lake Tahoe. It might almost come to that, unless we treat the land with respect. Today, instead, we treat it with contempt, sprawling all over it with suburbs.

"We have a lesson to learn from some other Americans," Mr. Owings added, "the Pueblo Indians, who were here on the continent centuries before us. They needed land for agriculture and beauty just as we do, and what did they do about it? By building early versions of high-rise apartments, they concentrated their living areas.

"That way they saved the open spaces for all the people—not to mention future generations. We would do well to consider history."

California Adds 31st Star to Flag

Californians are seldom more than a step or two from the past. Just north of Big Sur lies a city steeped in tradition, the old Spanish garrison town of Monterey.

Curiously, for all Monterey's fame as a colonial stronghold—first Spanish, later Mexican—it speaks to Californians of independence. There, on July 7, 1846, the United States flag was first raised as a permanent symbol in California, signifying a free territory. Four years later a slightly different flag followed, with a 31st star—California's.

Monterey is something more than a historic landmark, as both golfers and gourmets can testify. On Monterey Peninsula lie five famous golf courses, among them the spectacular Pebble Beach Course, beside the equally spectacular Seventeen Mile Drive. Almost within iron shot, along Monterey's waterfront, runs a street known as Cannery Row.

Cannery Row has changed surprisingly little in appearance since 1945, when John Steinbeck's novel by that name captured the bizarre life of Monterey's sardine packers. The great canning factories still line the Row in drab ranks, but the sounds and smells that once engulfed them are only memories. In

Market Street pierces downtown San Francisco like an arrow, its flaming tip the Ferry Building tower. The financial district—Wall Street of the West—stretches to the left. Wells Fargo's bank-in-the-round sits like a top hat beneath Crown Zellerbach's skyscraper; the Shell Oil Building lifts an amber crest beyond.

Early-bird brokers open the Pacific Stock Exchange at 7 a.m. to synchronize workdays with their New York counterparts.

KODACHROME BY JONATHAN S. BLAIR © N.G.S.

Dungeness crabs delight a small diner at San Francisco's Fisherman's Wharf. Each day before dawn, sturdy mariners stream out into the Pacific to net flounder, shrimp, salmon, and crabs for the wharf's renowned restaurants.

Dazzle of Chinatown bursts upon sightseers in a motorized ricksha. Grant Avenue's pagoda rooftops mark the home of 25,000 American Chinese—largest Chinese settlement outside the Orient.

1946, the sardines that formerly blackened Monterey Bay began to depart, as did eventually the jobless cannery workers.

Today new businesses restore life to the Row. In the shadow of the silent factories stand several elegant restaurants, an antique shop or two, and a mecca for alpinists—the Himalayan Pak Company, a well-known mountaineering supply firm.

Where once only Spanish commands rang through Monterey's historic presidio, or military headquarters, the sounds today are of Swahili, Turkish, Greek, and Mandarin Chinese. The reason is something called the Defense Language Institute (West Coast Branch), a school administered by the United States Army for military personnel assigned to special jobs overseas.

Sea Lions Provoke Linguistic Feud

One morning I toured the institute with Capt. Dolores Hubik, an attractive staff officer. We visited half a dozen classes out of the more than 250 that offer 25 different languages to some two thousand students.

No one took notice as we passed through the rooms on what seemed a tour of the Tower of Babel. Military rank had little place in the classroom: Officers and enlisted men treated one another on equal terms as fellow students. Later I asked Captain Hubik what sort of assignments the graduates drew.

"According to the Russians and the Communist Chinese," she answered, "we're running an espionage school. Of course we get students from all branches of the military, but," she said, "I've yet to see a cloak or a dagger here.

"The fact is," she added seriously, "that the services today in every line of work need fluent language specialists, from military attachés to combat interpreters."

She pointed to one student with his leg in a cast, whom I had taken to be a casualty of California's ski slopes.

"He got that in parachute training at the Army's Special Forces school in Fort Bragg, North Carolina. You can't jump from a plane with a broken ankle, but you can study a language while it heals. After graduation, he'll go back to jumping."

The institute's curriculum is a reasonable gauge of world tensions and United States commitments. Three years ago the average class in Vietnamese numbered roughly 50 students; today it is closer to 300. Russian and Chinese—both Cantonese and Mandarin—account for other large classes.

Courses are so concentrated that the students become deeply absorbed in their adopted languages, but the institute fortunately has its occasional lighter side.

"We had a second lieutenant here not long ago," Captain Hubik said, "who was studying for an assignment in Thailand. He took to going down on his day off to watch the sea lions in Monterey Harbor. I asked him one day why he spent so much time there, and he told me he had a theory the sea lions were speaking Thai. Apparently, he had quite an argument about it with a friend—the friend claimed they were speaking Serbo-Croatian."

With apologies to the second lieutenant and his friend, sea lions have a language all their own. I went to see them one day in a dramatic setting, Point Lobos Reserve State Park, south of Carmel-by-the-Sea. The park takes its name from a spectacular arm of land called by the early Spaniards after their term for sea lions: Punta de los Lobos Marinos—Point of the Sea Wolves.

The Spaniards, it seems, were as prone to illusion as the young lieutenant—sea lions are a far cry from wolves. To be fair to the Spaniards, one has to admit they are just as far a cry from lions.

I watched a herd of the ponderous creatures shuffling and hitching their way over the offshore rocks. Once they took to the water, clumsiness vanished; they were all grace and effortless speed.

In and out of water, the herd kept up a running commentary, a series of honks and blasts that echoed among the coves and wind-bowed cypresses. The sound reminded me of neither man nor beast; the nearest thing to it is an antique-car rally.

Fortune-seekers Build a State

If Monterey represents the birthplace of California statehood, the Mother Lode might be called the cradle. The wild and beautiful mountain region lying roughly between Sacramento and the high Sierra gave the state its first true magnet—gold.

For more than three centuries the vision of quick wealth had beckoned conquistadors and other adventurers to California's shores. Actually, James Marshall's discovery at Sutter's mill in 1848 was only one of several clues to treasure beneath the soil. Six years earlier, a small strike had been made in what is now

Reaching for the Golden Gate, Carinita-class sailboats race seaward beneath bald headlands of Marin Peninsula. Awesome currents surge through this majestic passage between the Pacific Ocean and San Francisco Bay; each tide rams an estimated one-sixth

of all the bay's waters in or out. A waterman's paradise, the bay wears a white-flecked pattern of sailing canvas the year round. Golden Gate Bridge, its roadway 246 feet above the water, points traffic northward from San Francisco toward the Redwood Empire

the Los Angeles area. The find, however, attracted little notice.

Marshall's discovery not only attracted notice; it touched off a world-wide epidemic of "Sutter's fever" and laid the foundations of modern California. During the first frenzied three years of the gold rush, the forty-niners rocketed California's population from 15,000 to close to 100,000. They also gave California a new name—Golden State.

Today the hills of the Mother Lode are virtually silent. The gold—California's harvest ultimately reached more than 2⅓ billion dollars—is not, as many believe, exhausted. Many veins still exist, but the price paid for the metal, legally fixed at $35 a fine ounce, has closed all but a handful of small mines.

Driving through the Mother Lode, I found the names of its former mining towns poignant reminders of an era both sordid and heroic. There were courage, greed, hope, and a touch of loneliness in such names as Challenge, Rescue, Smartsville, Rough and Ready, Enterprise, and Tragedy Springs. There was humor, too, in such misnomers as Drytown—the settlement, in its heyday, had 26 saloons.

Other memorials in the Mother Lode tell more personal stories, ones of nostalgia or of longing for a distant land. In a cemetery at Jamestown I came across an inscription to one Victor Belli.

A Frenchman, Belli apparently had contracted Sutter's fever and sought a cure for it thousands of miles from home. In tribute to

KODACHROMES BY THOMAS NEBBIA © NATIONAL GEOGRAPHIC SOCIETY

his attachment to France, friends had inscribed the stone in his native language:

Ici repose
VICTOR BELLI
Né à Paris, France
Décédé à Peoria Flat
Le 12 Février, 1877

To at least one town in the Mother Lode, tradition means something more than gold. When spring creeps north along the Sierras, the talk in Angels Camp turns to frogs.

The reason is Mark Twain's riotous story, "The Celebrated Jumping Frog of Calaveras County." For more than a century, readers of all ages have delighted in the tale of Jim Smiley, the gold-rush gambler who bet a

California sherry in a glass-ended cask casts a roseate halo over tour guide Sally Paolini at Almaden Vineyards, Los Gatos.

Burden borne high, seminarian Michael C. Carey hurries a pan of grapes between a vineyard's stripped rows. His white Sémillons will ferment into golden sauterne at the Novitiate of Los Gatos; thus lives the tradition of California's mission fathers, who introduced viticulture two centuries ago. Today vines by the hundreds of thousands drape hillside and valley from Shasta to San Diego, producing 80 percent of all wine drunk in the United States.

MOUNTAINS BOUND FROM MISTY SEA *as dusk etches the rock ribs of Big Sur—a storied stretch of sculptured coastline. Taillights trace a car's progress on State Highway 1, notched into the soaring slopes.*

 KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. BLAIR © N.G.S.

stranger $40 that his pet frog, Dan'l Webster, could outjump all comers.

While Smiley obligingly went in search of a frog for the stranger to match against Dan'l, the stranger prudently fed the champion a dose of quail shot, successfully ensuring his own victory.

Every spring since 1928, Angels Camp in Calaveras County has marked the tale with a county fair and a Jumping Frog Jubilee. Frog fanciers from all over the United States, and even from foreign countries, enter their favorites in the jumping tournament.

The visitor who wishes to compete but who has no frog is invited to catch one in a pool stocked for the occasion. Officials guarantee that none of their frogs has been fed a diet of quail shot.

Unfortunately, the guarantee says nothing about other handicaps. My borrowed frog, whom I hopefully christened "Paul Bunyan," thoroughly disgraced us both. In the three consecutive hops allowed by jubilee rules, he covered an embarrassing 4 feet, 7½ inches.

Later, after a frog by the less glorious name of "Hops" had swept the field with a creditable 14 feet, 8 inches, I asked a veteran frog-handler what Paul Bunyan's trouble was. He took a long look at Paul and another one at me.

"Mister," he said pityingly, "the first thing you do is get a new name for that frog. If it was me, I'd pick 'Paulette' or maybe 'Gertrude.' She's expecting, and she's carrying half a pound of eggs."

Some 40 miles to the southeast of Angels Camp lies a treasure far more dazzling and durable than gold. Yosemite National Park, another of California's great magnets, attracts more than 1,600,000 visitors each year.

Actually, Yosemite is not one magnet but hundreds of them, ranging from

On a lonely strand, a curl of kelp garnishes froth-laced Point Sur beach. Other Big Sur beaches—isolated in high-walled coves—reward beachcombers with jade, agate, jasper, iridescent bits of abalone shell, and moonstone smoothed by sand and tide. Residents value a greater treasure: privacy in a wild symphony of sea, mountain, and sky. The seafront country was the *sur*, or "south," to the Spanish settlers of old Monterey.

KODACHROME BY [illegible] © N.G.S.

the massive granite bulk of Half Dome to the lacy miracle of Bridalveil Fall (pages 662-3). Most of the park's famous features lie along seven-mile-long Yosemite Valley, although the entire preserve roughly equals Rhode Island in area—1,200 square miles.

To Californians and their countrymen, the Yosemite region has long stood for breathtaking beauty. To a handful of scientists, it has recently become a possible laboratory for studying characteristics of the moon's surface.

Volcano Offers Clue to Moon

I learned of the development from Dr. Joel S. Watkins, a member of the U. S. Geological Survey's Astrogeology Branch, with headquarters in Flagstaff, Arizona. Recently the survey has conducted studies of the lunar surface for the National Aeronautics and Space Administration, through telescopes and by examining close-up photographs taken by the Ranger lunar probes. One of the objects of the study is to determine the type of terrain the Apollo spacecraft may encounter when Americans first land on the moon.

"Last summer," Dr. Watkins told me, "we had an exciting discovery in the Mono Craters area just east of Yosemite. A geologist there found permafrost—perpetually frozen ground that usually occurs in higher latitudes than ours. But the elevation of Mono Craters—some 8,500 feet—makes for low temperatures."

I failed to see a connection with the moon. Dr. Watkins explained.

"It's a question of the type of ground," he said. "The Mono Craters area, being volcanic, contains lava and pumice. Some scientists believe that parts of the lunar surface likewise are covered with

EKTACHROMES BY JAMES P. BLAIR © NATIONAL GEOGRAPHIC SOCIETY

At home in "Wild Bird," an A-frame retreat perched high on a cliff, 600 feet above the surf (top and page 651), Mr. and Mrs. Nathaniel Owings battle to keep Big Sur unspoiled. A world-famous architect, Mr. Owings heads a Presidential commission charged with face-lifting Pennsylvania Avenue in Washington, D.C. Wood sculptor Harry Dick Ross and his wife Eve, a painter, dwell among other artists of Big Sur's Partington Ridge.

"Butterfly trees" glitter at Pacific Grove on the Monterey Peninsula. Here monarch butterflies by the millions—fluttering in from as far as Canada—brighten winter every year. Citizens greet them with a parade, and a city ordinance protects the migrants from molesters. (See "Mystery of the Monarch Butterfly," by Paul A. Zahl, NATIONAL GEOGRAPHIC, April, 1963.)

Powder-fine white sand, rimmed by cypress and pine, invites loungers at Carmel-by-the-Sea's crescent beach. But a sign warns, "Surf Unsafe. Riptides and Undertow."

Nonconformists, Carmelites ban television antennas, house numbers, mail delivery, and billboards. The community's 4,580 residents take pride in their artists, writers, restaurants, and dollhouse architecture.

PHOTOGRAPHS BY JAMES P. BLAIR (LEFT) AND THOMAS NEBBIA © N.G.S.

lava and pumice. The Russians' recent Luna 9 photographs, in fact, lend weight to that theory.

"Now, suppose there is water, too, below the lunar surface. Because of the intense cold a few centimeters down, the water would almost certainly be permanently frozen. Then what do you have? Something like permafrost in volcanic material.

"In any event, Mono Craters' rocks may be close relatives to lunar rocks. If our Apollo astronauts find permanent ice under the lunar surface, the similarity between Mono Craters and the moon could be even greater."

The Golden Gate: Heaven's Portal

While some men lay plans to invade the celestial world, others claim to have lived there for years. Nothing can shake San Franciscans' belief that heaven is located on San Francisco Bay (pages 640, 646-7). To them, it is more than mere chance that the entrance is called Golden Gate.

San Franciscans, admittedly, have a point: There is something almost celestial about their city. Seen from Marin County across the bay at evening, its hills lie embroidered with light, as if—in the words of one San Franciscan—"God dropped all His leftover stars on them."

San Francisco is hardly less spectacular by day. On early mornings when fog sifts low through the Golden Gate, filling the bay with a ghostly high tide, the city soars

into the sunlight above like some Atlantis returned from the sea.

San Francisco, however, is more than mere scenery; to begin with, it is home for some three quarters of a million people and the focus of a metropolitan area population numbering roughly three million more. The result is northern California's unofficial capital, one of the world's most beautiful cities.*

San Francisco is also the Nation's third busiest port (if one includes all waterfront cities in the bay region) after New York and New Orleans; a world center of finance and of scientific research; a lodestone for both Oriental and Western arts. Not every distinction, though, is a source of pride. For all the beauty and charm of its surroundings, San Francisco has a higher rate of suicide than any other city in the country.

City Cherishes Antique Trams

One way to risk death, or at least severe injury, in San Francisco is to criticize the cable cars (page 641). San Franciscans are fiercely protective about their antique mode of transport, so much so that the owner, the San Francisco Municipal Railway, trembles at the thought of any change.

"I remember the time we put windshield wipers on the cars," Charles Smallwood told

*See "Boom on San Francisco Bay," by Franc Shor, National Geographic, August, 1956.

me one day in the repair shop at Washington and Mason Streets. Mr. Smallwood, a large and kindly man, oversees all maintenance of the city's 39 venerable machines.

"People raised no end of fuss," he said. "One old gentleman even told me that if cable cars had needed windshield wipers, the good Lord would have built them that way."

San Franciscans are like that, slow to change where tradition and sentiment are involved. It is no accident that the city's best-loved hotels—for example, the stately Fairmont or the Huntington on Nob Hill—carefully preserve an air of bygone elegance while sparing no modern convenience.

Elsewhere San Franciscans welcome change, yet always with a protective eye on the past. The city already is hard at work on a Bay Area Rapid Transit system—BART—to link the downtown with such bay cities as Oakland, where a great Californian, Chief Justice of the United States Earl Warren, started his law career. Other plans are less easily accepted—for example, an unobtrusive second deck on the cherished Golden Gate Bridge was approved only after years of civic controversy.

San Franciscans maintain the same watchful eye on the heart of their city. Along Market Street, the traditional main artery, blocks of disheveled buildings have given way to sleek new skyscrapers (pages 642-3). Not far away, yet immune to the wrecking hammer, stands the beloved San Francisco Opera House—a monument to yesterday's elegance.

Elegance occasionally can be overdone, as with some of San Francisco's famous restaurants. The emphasis in a few seems heavier on interior decor than on the interior of the customers themselves. Other restaurants face the opposite problem of emphasizing perfectly good food amid distractions to the guests. Those on Fisherman's Wharf are in constant competition with some 200 crab and fishing boats moored beneath their windows.

At least one type of restaurant in San Francisco solves the problem of atmosphere by ignoring it. To residents of Chinatown, the sole business of restaurants is food. Atmosphere belongs outside, on Grant Avenue.

Grant Avenue, with its pagoda-type streetlamps, its neon aurora, and its garish rows of Chinese variety shops, runs like a strip of tinsel through the heart of Chinatown, luring visitors and San Franciscans alike in seemingly inexhaustible numbers (page 644).

Behind the avenue, in narrow streets of quiet row houses and apartment buildings, lives a sober community of some 25,000 American Chinese, the largest Chinese settlement outside Asia. Approximately 17,000 other American Chinese are scattered elsewhere throughout San Francisco.

With banshee howl, natural steam escapes the earth near Geyserville. Workmen protect ears from the din with muffs as they repair pipes carrying scalding vapor from The Geysers—a teakettle area of fumaroles and hot springs. The ready-made steam spins generators of Pacific Gas and Electric Company. Bores 700 to 5,000 feet deep tap ground water set boiling by heat from magma, or molten matter in earth's fiery interior.

Nation's highest dam, rising in the Feather River canyon 70 miles north of Sacramento, promises a solution to California's water problem. To be completed by 1968, Oroville Dam will impound enough water to supply every household in the state for a year. Key unit of California's farsighted State Water Project, it will supply cities as distant as San Diego through a system of rivers, aqueducts, and tunnels. Oroville's 1¼-mile-long earthen embankment will climb 770 feet above the canyon floor, to the level of the highest roadway at right. Dark streak marks a slab of impervious clay, heart of the massive dirt dam.

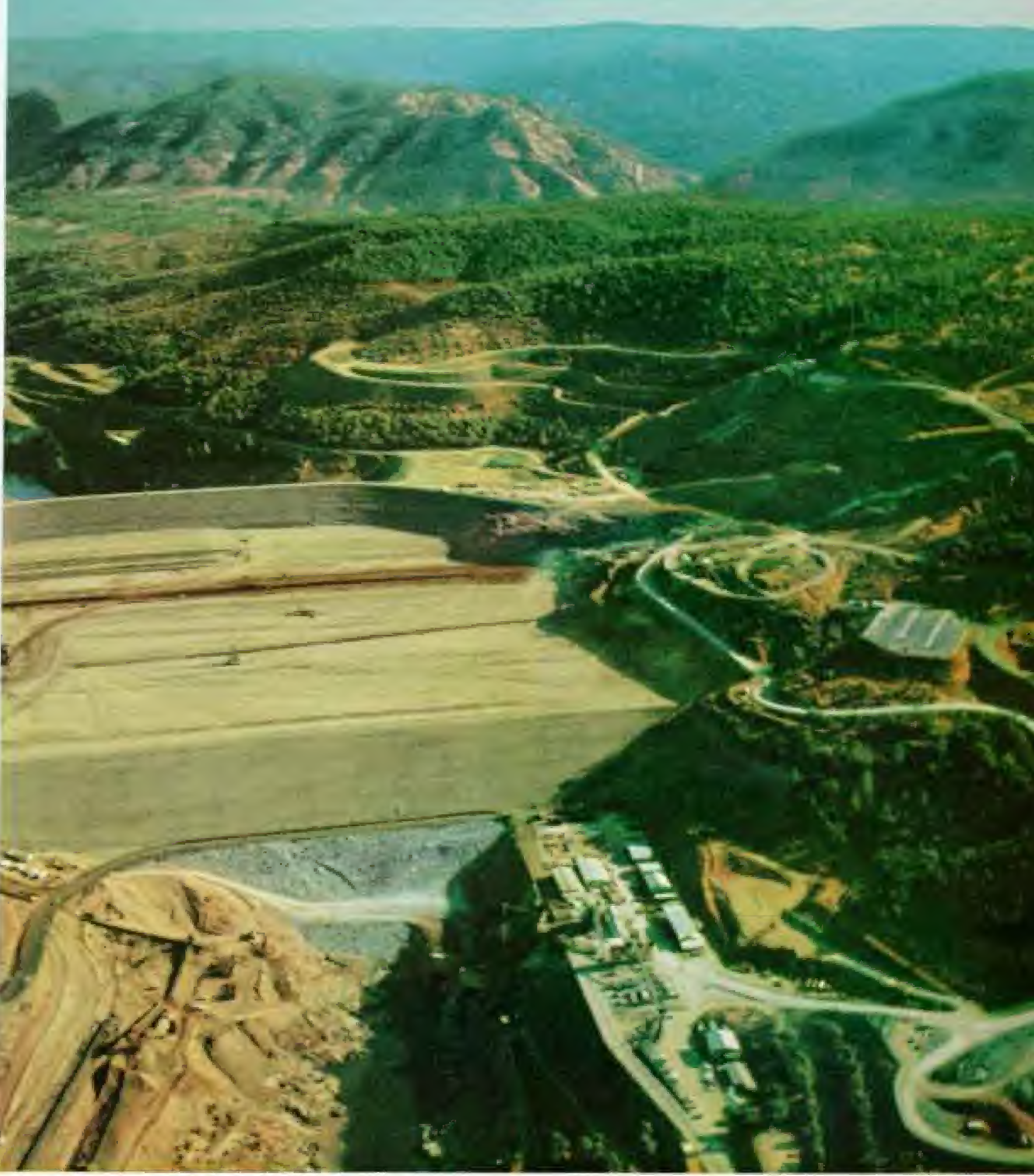
Fearsome looking but tranquilized by drugs, a chinook salmon rides an elevator of water-filled compartments from "dope pound" to tank truck for a lift past the Oroville Dam site. A hatchery below the dam will replace spawning streams disturbed by the project.

Chinatown today is neither the tinseled world of Grant Avenue nor the murky realm of the tong war and the opium den favored by fiction writers.

"Outsiders think of our tongs in terms of Murder, Incorporated," says Alan S. Wong, an energetic young worker in Chinatown's antipoverty program. "Of course it's true that at one time the tongs weren't above settling their differences with the hatchet and the cleaver, but then"—he grins—"I don't recall that the old forty-niners took many of their arguments to court, either."

The tongs of San Francisco once wielded enormous power in their roles as business cartels, courts of justice, and crime syndicates, all in one. Today, like many another traditional feature of Chinatown, they have lost a great deal of their influence. The last killing attributed to a difference between tongs occurred forty years ago.

The associations now more closely suggest



PHOTOGRAPHED BY JAMES P. BLAIR © NATIONAL GEOGRAPHIC SOCIETY

combinations of business groups and fraternal orders. I asked Alan Wong how the change in traditional patterns influenced Chinatown's younger generation.

Words of Wisdom From an Oven

"'Influence' is hardly the word," he replied. "Our children are changing the patterns themselves, just as your own children are.

"Naturally, our kids are in love with everything modern—cars, television, the way-out dances—though to them it's all strictly 'American.' You see, they think they're rebelling against outdated Chinese culture, when all they're really doing is what kids everywhere do—rebelling against their own parents."

At least one American influence in Chinatown is hardly modern; it's a book of Benjamin Franklin's sayings. The owner, an American Chinese named Ernest Louie, quotes it to millions of Orientals and Westerners alike.

Ernie Louie has an influential job: He

composes the messages that go into Chinese fortune cookies. With his brother Ed, he owns a successful firm known as the Lotus Fortune Cookie Company.

Passing their plant on Chinatown's Pacific Avenue one day, I dropped in and made Ernie's acquaintance. He showed me the ingenious machines like small carousels that pour and bake the cookies—more than 30,000 a day—in endless succession. Women tending the machines deftly scoop each finished cookie from its small oven, inserting a fortune and bending the still pliable pastry into final shape before it cools.

Ernie, I discovered, is not one for cute phrases or frivolity when it comes to fortune cookies. "People need a little philosophy, something meaningful at the end of a meal," he said. "Jokes are bad for the digestion."

I asked where he got his inspiration—the Lotus Company prints more than 4,000 different fortunes—and he waved toward a shelf of heavy books.

"I'm fond of the regulars, Confucius and Lin Yutang," he said, "and now and then I lean heavily on Plato. But my favorite is this one." He held up an incredibly battered book. "You can't beat *Franklin's Wit and Wisdom.*"

Fortune cookies, it seems, can be just as appealing to Chinese as they can to Westerners.

Ardent conservationist. Governor Edmund G. ("Pat") Brown pledges his administration will never sacrifice the state's prized groves of coast redwoods to freeways.

Crackling skies match the brilliance of a floodlighted capitol dome at Sacramento. A booming gold-rush town when it became the state capital in 1854, Sacramento served as western terminus for the Pony Express and the first transcontinental railroad. Today's city of 266,000 people prospers as a food-processing, trade, and transportation center.

"Even I can't resist them," Ernie confided sheepishly. "When I see one in a restaurant, I've got to know what's inside—even if I wrote it myself. But what kind of a fool would I look like, opening a fortune cookie, when everybody knows the business I'm in?"

I asked how he solved the problem, and Ernie blushed.

"I usually go with friends," he said. "They open my cookie for me, and then pass the fortune under the table."

Fortune and its companion, disaster, are old acquaintances of the city beside San Francisco Bay. Many San Franciscans remember, and all are aware of, the horror that overtook their city one morning 60 years ago. At 5:13 a.m. on April 18, 1906, the great San Andreas Fault, running roughly north and south beneath San Francisco Bay, split for a distance of some 270 miles, loosing a series of jackhammer blows at San Francisco and neighboring towns.

Shock and Fire Level a City

The blows themselves lasted less than a minute, but as with many major shocks in populated areas, fire took up where the heaving earth left off. The price to San Franciscans after days of anguish was some 700 lives lost and roughly half their city demolished.

EKTACHROME (OPPOSITE) BY JAMES P. BLAIR; KODACHROME BY TOM MYERS © N.G.S.

Gouged by glaciers, breathtaking Yosemite Valley dazzles 1,600,000 visitors a year to California's top scenic attraction—Rhode Island-size Yosemite National Park. El Capi-

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER B. ANTHONY STEWART © N.G.S.

tan's granite prow soars vertically at left, Bridalveil Fall plunges below Cathedral Rocks, and distant Half Dome hulks nearly two-thirds of a mile above the valley floor.

San Francisco, of course, eventually was rebuilt, together with a safeguard that remains to this day. What had cost the city cruelly in its struggle with fire was lack of water—the first shock had severed most of the mains.

Today San Francisco firemen run little risk of facing a holocaust with limp and useless hoses. At 152 points around the city, on the crests of hills and at major intersections, lie great subterranean cisterns, independent of the city's water system—precious weapons against earthquake and its aftermath.

Actually, the cisterns are nothing new to San Francisco: Smaller versions existed even before the great fire. Several were located in the notorious Barbary Coast area, near Pacific Avenue and Kearny Street, where they helped to save the Coast in 1906; it suffered scarcely a casualty or a burned-out saloon. Today enlarged cisterns safeguard the Coast's would-be successor, the dazzling but somewhat tamer North Beach entertainment district.

California's Average: Tremor a Day

Californians are constantly reminded of the terrible spasms that can seize their land. Every year some 350 tremors—an average of roughly one a day—are recorded in the northern and central parts of the state.

"Of course, those are just the ones we can locate accurately," explains Dr. Bruce Bolt, Director of the University of California's Seismographic Station at Berkeley. "Many tremors are too remote or too slight to allow our seismographs a proper fix. Of the total number of shocks, between 30 and 60 are strong enough and close enough to people in California to be felt by them. Fortunately, none so far has equaled the 1906 shock for strength and damage combined. But all of them remind us that California is a land in perpetual motion."

Dr. Bolt's town recently has earned a name for quite another type of upheaval. More than one political or academic battle has raged through the headquarters of California's vast state university.

The Berkeley campus of the University of California has about 27,000 students—a figure matched and even exceeded by several other universities in the country. Yet all together UC comprises nine separate campuses throughout the state, with 80,000 students and a faculty of 6,000.

Perhaps Berkeley's greatest fame rests on the genius of such men as Ernest O. Lawrence, the inventor of the cyclotron and founder of the great Lawrence Radiation Laboratory that stretches across the hillside behind the Berkeley campus.

Other northern California universities, notably Leland Stanford at Palo Alto, have contributed enormously to the state's role in research and academic achievement. Yet, as a Berkeley senior remarked to me, "We have more Nobel Prize winners per square inch than any other place on earth."

EKTACHROME (BELOW) AND KODACHROMES BY JAMES P. BLAIR © N.G.S.

Weird wool-knit masks, copied from those worn by Peruvian Indians, warm cheeks and noses of youngsters skiing at Squaw Valley. Spill-conscious, one youth plays it safe with a hard hat.

Streaming a rooster tail of fresh powder snow, a skier races lengthening shadows beneath a chair lift to Siberia, the highest ridge above Squaw Valley. The Sierra Nevada resort near Lake Tahoe, scene of the 1960 Winter Olympics and now a state park, lures skiers with slopes carpeted white into early summer.

One of the first states to protect its natural wonders from encroaching civilization, California maintains a system of 185 state parks and 8 state forests.

I talked one day with another senior, 21-year-old JoAnne Schwartz, who came to California from New Jersey. JoAnne went through two major crises that have recently shaken Berkeley—the so-called Free Speech Movement and the furor over United States policy in Viet Nam. I asked how it was that the scholarly world of Berkeley could erupt so suddenly into chaos. Her answer shed light not merely on Berkeley but on much of California as well.

"The Viet Nam demonstration is a poor example," she began, "because it wasn't really Berkeley. Only a few hundred students were involved out of thousands—most of the demonstrators didn't even come from here.

"But the Free Speech Movement is something else; in the end, nearly all of us got involved. I won't argue the pros and cons of it, because that's been done to death. But you asked me how it could happen." She paused.

"I guess I would answer: 'Because it's California—and California hasn't settled down yet.' In a way, I hope it never will, because I suspect it would lose something vital.

"People are new and rootless here," she said. "California attracts that kind because, in a sense, it's still a frontier. Not in the old way, of course, but in other respects: in the experimental architecture, for example, or in new sports and fashions—even in those way-out religions Los Angeles is so fond of.

"But you see, that's part of the way Californians are: Always trying for something different, always in search of the new—and not always thinking whether it's good or bad.

Crunching across ashes, hikers file past Cinder Cone in Lassen Volcanic National Park. Wracked by eruptions from 1914 through 1917, nearby Lassen Peak spat fiery columns (below) that scattered ashes as far as Reno, Nevada. The park preserves the devastation caused by this southernmost peak of the Cascade Range, the only active volcano in the United States excepting Alaska and Hawaii.

KODACHROME BY B. ANTHONY STEWART © N.G.S.; LOOMIS MUSEUM ASSOCIATION (RIGHT)

"Sometimes we come up with nothing more than a new style of bathing suit, sometimes with a campus revolt." She waved toward the laboratories behind us on the hill. "And now and then we produce an Ernest Lawrence. California pioneers come in all sizes."

Wedge of Earth Blocks Feather River

In their long and dramatic history, California pioneers have worked a succession of miracles on their land. The most massive to date is Oroville Dam, the great earthen wedge now being built across the Feather River in the Sacramento Valley (pages 658-9).

The key to California's ambitious State Water Project, Oroville Dam in 1970 will begin delivering millions of gallons to parched areas as far south as San Diego, more than 500 miles away. It may also spell the end of an age in hydraulic engineering—the age of the great concrete storage dam.

"We get visitors almost every week from the so-called underdeveloped countries," says an Oroville engineer proudly. "They can't all afford to throw great concrete slabs across their rivers, but they've sure got the manpower and materials to copy Oroville.

"What's more," he adds, "they'll have just as good a dam as the old concrete ones. Thanks to Oroville's inner core of impervious clay, we expect to measure our leakage almost with a medicine dropper."

Southwest of Oroville, across the Sacramento Valley in the heart of the Coast Ranges, another pioneer project takes shape. Amidst an infernal realm of steam clouds and sulphur

fumes, drilling crews at The Geysers puncture the earth to harness natural steam wells to waiting dynamos (pages 656-7).

Not all California miracles, however, are the work of giant machines—the dragline, the steam shovel, the bulldozer. At the foot of the Sacramento Valley, where the San Joaquin and Sacramento Rivers meet, lies a monument to the wheelbarrow and the spade.

The delta, or slough country, as northern Californians call it, represents a contradiction in the Golden State: Where men historically have struggled and even killed to preserve water, pioneers in the slough country strove to banish it. Their enemies were the Sacramento and the San Joaquin, which sought to drown rich farmland in periodic floods.

Beginning with mere farm tools in the days of the gold rush, settlers in the delta walled themselves off from the rivers. Gradually their earthen dikes encircled vast areas of marshland—and the island farms of the delta were born. The waterways, or "sloos," meandering among the islands, became the delta people's country roads. One day I traveled part of the 1,300-mile labyrinth by power boat with Wallace McCormack, a native of the quiet delta town of Rio Vista.

Only in recent years, Mr. McCormack explained, have roads and bridges begun to supplement the sloughs.

"When I was a boy here and someone got sick," he said, "you often went for the doctor in a rowboat. It meant two round trips of several miles each, and of course you didn't ask a doctor to help row. By the time you were all through and got back home, you almost needed the doctor yourself."

Like residents of another water-beleaguered land, the Netherlands, delta people cherish tales of heroism and quick action among their kind. Perhaps the most famous concerns Jesse Thomas, a farmer who was inspecting a levee on horseback. Suddenly he came on a dangerous break; even as he watched, surging water widened the gap to nearly a yard.

"It was a hard decision," Wallace McCormack explained, "but Jesse knew he could never seal the break alone. He rode his horse directly into the gap and then killed it where it stood with a blow of his hatchet. Leaping free, he scooped up dirt by hand and kept throwing it into the break. Soon others came to lend a hand, and the levee was saved."

I asked whose levee it had been, and Wallace McCormack shook his head.

"Nobody's in particular. And everybody's."

Sacramento: Seaport 91 Miles Inland

Today a new kind of flood occasionally tops the levees, although the delta people scarcely notice it. It lasts only a moment and is caused by the wake of some ocean-going ship on its way up to Sacramento.

Californians are still slightly astonished that their capital has become a deep-sea port. Dredging of the Sacramento River and construction of a new terminal, at a total cost of $55,000,000, now bring heavy freighters 91 miles inland from the Golden Gate.

At least one resident of Sacramento sees nothing surprising in such developments. California's Governor Edmund G. Brown (page 660)—known everywhere as "Pat"—already has his mind on the year 2000.

"Managing California," he told me in his office, "is a little like tuning a car going 65 miles an hour. It isn't just a problem of taking care of the engine." He grinned. "It's the running alongside while you do it."

Governor Brown does better than keep up with his state. Many of California's vast new projects for highways, water development, education, and other needs took shape in his office at the capitol. One development that did not, and that may bring change to California, is the United States Supreme Court's ruling on reapportionment.

Under the ruling, California must revise its state senatorial districts by population rather than on county lines. The prospect disturbs northern Californians, who fear domination by the more numerous southerners. I asked Governor Brown what he thought.

Vermilion shaft of light, bouncing from mirror to mirror, illuminates a new kind of three-dimensional photograph, a hologram. In ordinary white light, it would appear to be merely a piece of gray glass. But in the pure red light of a laser at Stanford University's Systems Techniques Laboratory, the hologram takes on color and lifelike depth.

In this triple exposure, the immensely powerful red pencil of light has overexposed the film, creating a yellow line. A piece of ground glass, moved along the beam almost to the picture frame, makes the light visible, and a lens flares the beam to illuminate all of the hologram. Now experimental, holography holds potential for 3-D television. This test hologram shows a stack of coins, keys on a ring, and a laboratory signboard. Engineer David Jackson adjusts one of the mirrors that show how laser light can be bounced around corners to the point of use.

KODACHROME BY THOMAS NEBBIA © N.G.S.

Students take a break between classes at the University of California's Berkeley campus. The Associated Students pennant hangs above Sproul Hall Plaza, named for famed President Robert G. Sproul. Here a coed may study in the sun (above) or a campus politico may take to the soapbox. Oldest of nine UC campuses, Berkeley enrolls a third of the system's 80,000 students. An annual budget exceeding half a billion dollars spurs growth of the "multiversity"; all California high-school graduates who meet admission standards may attend tuition-free.

Hanging like chandeliers, closed-circuit TV screens bring the blackboard to students in the 550-seat Physical Sciences Lecture Hall. Remote-controlled camera, monitored in foreground, trains on Professor of Physics Harvey White as he lectures on kinematics, the dynamics of motion. Dr. White's stage, of his own design, rotates so that aides behind it can set up experiments to be swung into view for the next class.

With nine Nobel Prize winners, the Berkeley faculty has achieved such breakthroughs as isolating viruses and building the Nation's first atom smasher.

"To begin with," he answered, "we're all Californians together—we need one another too much to become divided. But beyond that, our northern part of the state is on the verge of enormous expansion itself. If Californians are going to triple by the end of the century, where will a lot of them go? I'll tell you one place, and that's in our far north. Go take a look, and you'll discover why."

Water Jug Triggers a Holocaust

I followed the Governor's advice, and ended up in a dilemma: where to settle if I ever become a Californian.

There is the Sacramento Valley, broad and rich in the sun, its silos standing like great stacks of silver coins on the green baize of endless level fields.

There are the smaller valleys, Sonoma and Napa, famous for the gift of fine California wines and steeped in the saga of a state's struggle for birth. Here in the closing days of Mexican rule, Gen. Mariano Vallejo governed California, and here in 1846 Californians called for independence with that stirring symbol, the flag of the Bear Republic.

North of the Sacramento Valley the land sheers upward in the giant thrust of two volcanic peaks, Lassen and Mount Shasta (pages 667 and 678-9). Barely half a century ago, long-silent Lassen thundered to life, immolating thousands of acres of grassland and turning stately forests of pine and Douglas fir into enormous open-hearth furnaces.

Fire still presents California with a dreadful balance sheet, claiming an average of 300,000 acres a year and sparing little, often taking human life. Not every fire, it seems, is the result of a lightning bolt or of a carelessly dropped match.

"I've known a fire to start from a jug of cold water left in the shade by a logging crew."

one forester told me. "Gradually, the sun worked around to where it hit the jug, and then fire had everything it needed—bright sunlight, a makeshift magnifying glass, and made-to-order tinder."

Other forest fires have spread in macabre ways. A friend of mine tells of seeing a wall of flame checked by a logging road. Suddenly a rabbit, its fur ablaze, streaked across the road and doomed the forest on the other side.

Rustlers' Tools Invite Suspicion

Northeast of Lassen Peak I came to the rolling grasslands of cattle country around Alturas. California's beef cattle are valued at nearly $450,000,000, and the beef industry follows such modern techniques as diet feeding and inoculation against epidemic disease.

Charlie Demick remembers the days when the only doctoring of cattle had to do with their brands—and could get a man in serious trouble. I talked in Alturas with Charlie, a retired cattleman of 91, about early ranching in California. Gradually the subject turned to branding and to the ingenious ways rustlers had of doctoring brands.

"They used what we called a 'running iron,'" Charlie explained, "really no more than a long bar bent at one end to make a sort of 'L.' Actually, people used running irons now and then to burn legitimate brands, but a rustler could take one and doctor the brand on a calf so that even the owner couldn't tell his property.

"I remember one job they did on the old ZX brand that belonged to an outfit just across the line in Oregon. They turned the letters into the prettiest six-pointed star you ever saw in your life. Look here."

He borrowed my pencil, and with a slow but deliberate hand, traced two designs in my notebook. On the left he drew the original brand and on the right the doctored version, with the forgery shown in dotted lines.

ZX   ZX

I asked if there was any truth to the old legend that a rustler's court often consisted of the nearest tree. Charlie shook his head.

"Not for cattle rustling," he said, "though it was a serious business. The branch of a tree was for stealing horses, because a horse was your life—taking it amounted to murder.

"Still, if a stranger rode in one side of town with a running iron on his saddle, people took what you might call a special interest till he rode out the other side."

Autumn was slipping south across the Oregon border as I came to Tule Lake. The sky above the great national wildlife refuge at

BLAIR (ABOVE) AND JONATHAN S. BLAIR (BELOW, RIGHT); KODACHROMES BY JONATHAN S. BLAIR, BUREAU OF OUTDOOR RECREATION, DEPARTMENT OF INTERIOR © N.G.S.

"Suicide row" greets chinook salmon entering Smith River. Treacherous tidal currents drown some ten sportsmen a year—thus the name for their anchored formation. When an angler hooks a fish, he slips anchor and drifts to avoid snarling. Most salmon escape the gantlet.

Twenty-pound armful makes Lewis Haller beam. He dangled anchovy bait to hook his prize, average in size for a chinook. Sportsmen take a third as many as commercial fisheries.

Still fighting, a chinook rises in the net of a Yurok Indian guide at the mouth of the Klamath River, a major highway of spawning salmon.

times showed only dimly through the migrating birds, as if through some vast, threadbare canopy. Across the surface of the darkened lake, Canada and snow geese mingled with avocet, grebe, mallard, and redhead—major species among more than two hundred that use the stopover on their long winter retreat down the Pacific flyway.

Beyond the mountains west of Tule Lake I reached Crescent City, California's northernmost coastal town. Crescent City is famous among Californians for an event that had its origin 1,600 miles from the Golden State. The terrible earthquake that battered Alaska in March of 1964 set up a seismic sea wave that some six hours later wiped out almost the entire Crescent City waterfront.*

One crab- and salmon-boat owner, whose moored vessel survived the disaster, recalled the night Crescent City heard that the wave was coming. "Right then," he told me, "I would have sold you that boat for a dollar and given you 75 cents change. Then the next morning I looked out and there she was by the pier, worth all of $20,000 again."

Of some 100 boats in the harbor that night, nearly a third were sunk or badly damaged.

South of Crescent City for nearly 350 miles runs a strip of unimaginably beautiful land. Northern California's frontier with the sea is a miracle of sloping, grassy headlands, majestic stands of redwood and fir, and dark

*Author Graves reported on the Alaskan disaster in "Earthquake!" NATIONAL GEOGRAPHIC, July, 1964.

World's tallest living thing, a coast redwood towers 367.8 feet above fireside campers. Dr. Paul A. Zahl, Senior Natural Scientist of the National Geographic Society, discovered the spire in a glen of giants cupped by this question-mark curve of Redwood Creek in Humboldt County. Here also stand the third and sixth tallest trees.

Seedling about a year old (right) pokes from a stony bed in an area lumbered and reseeded by Arcata Redwood Company, owner of the giants. In another 600 years the baby *Sequoia sempervirens* could measure 12 feet thick and 350 feet high. Arcata now preserves the Redwood Creek grove. Bills before Congress seek to protect it in a national park.

KODACHROMES BY GEORGE F. MOBLEY
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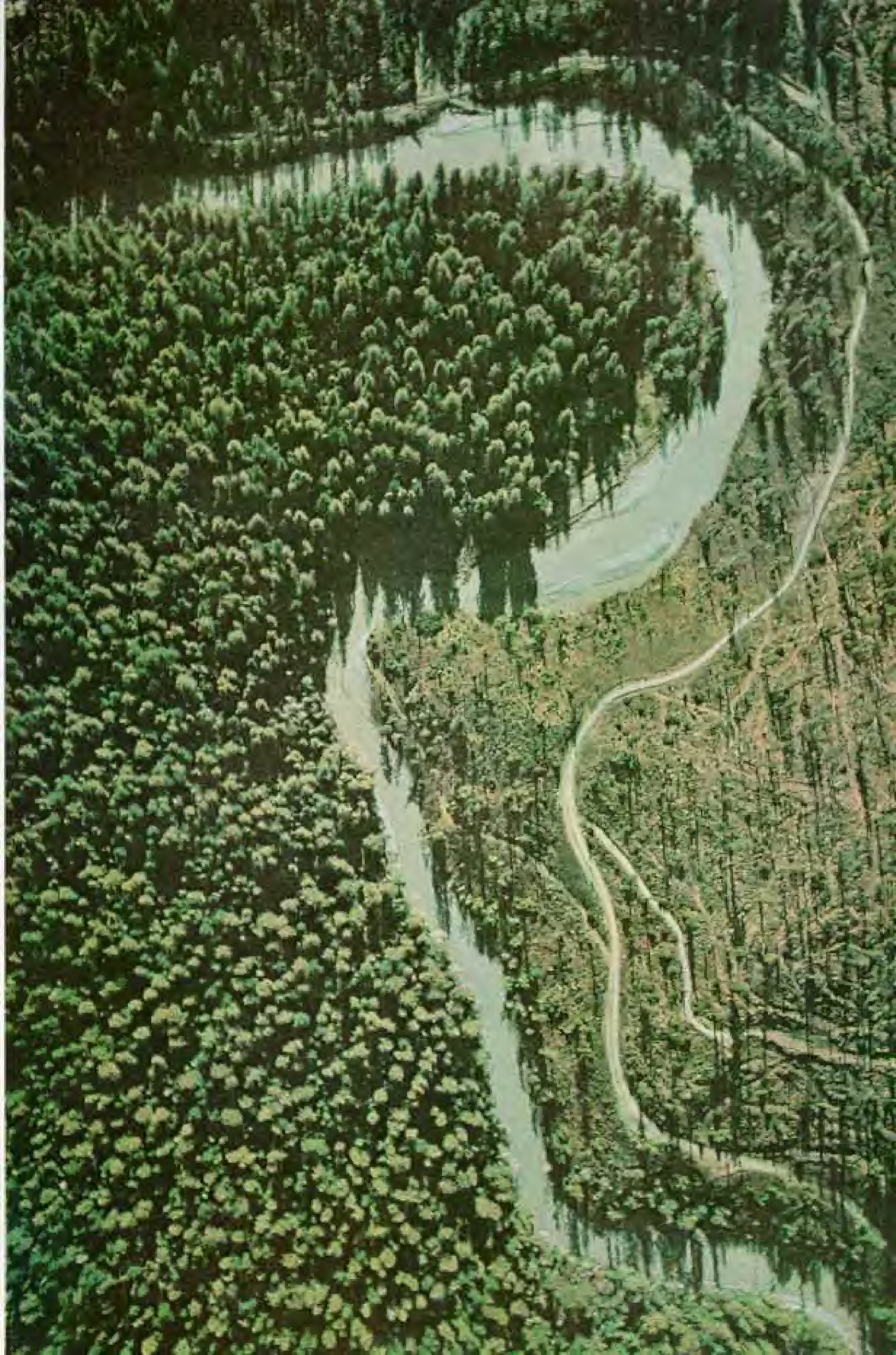

Screaming teeth of a chain saw sink into a coast redwood near Scotia. Steep slope forces the logger to make his cut high on the downhill side. Fellow worker (below) clears a cavernous notch that aims the brittle behemoth's fall toward a cushion of earth loosened by bulldozing.

Wall of redwood soars out of sight in dust kicked up by a highballing truck. From this stack, called a "cold deck," trucks relay the logs to feed band saws of the world's largest redwood mill, Pacific Lumber Company's plant at Scotia.

Decay-resistant and richly hued, redwood makes durable outdoor furniture and siding as well as striking interior paneling. A single giant such as the one at left, measuring 10 feet across its base with 170 feet of usable trunk, yields enough lumber to build and furnish three large homes.

battlements of rock fringed with offshore spires—a land alternately drenched in mist and golden sunshine.

The names of some of the counties bordering the coast are almost poetry in themselves—Sonoma, Marin, Del Norte, Mendocino.

Often the northern coast is a bright and tranquil realm, garlanded with flights of gulls on a steady northwest breeze. Occasionally, however, storm winds come up out of the southwest, building great waves before them. Then there is thunder all along the coast, and the offshore spires are besieged by spray.

Other sections of the California coast have the booming surf and tall headlands, yet none has the majesty of the coast redwoods. The immense stands and groves of *Sequoia sempervirens* extend in a scattered chain beside the Pacific from the Muir Woods National Monument area, near lonely Point Reyes, to just beyond the Oregon line.

Cathedral of Timeless Giants

From Crescent City south, I followed the coastal route that runs like a great nave between cathedral ranks of dark spires.

Some of the most famous redwood groves take the names of those who fought relentlessly to preserve them—Rockefeller Forest in Humboldt Redwoods State Park, Williams

Grove, Stephens, and Jedediah Smith. North beyond Eureka stands the tallest known living thing, a 367.8-foot-high redwood discovered in 1963 by Dr. Paul A. Zahl of the National Geographic Society (pages 674-5).*

Recently, through their dues, members of the Society financed another farsighted project—a detailed survey of the great coast redwoods belt, conducted by the National Park Service, which pointed out the need for saving one of the last stands of virgin redwoods.

*See "World's Tallest Tree Discovered," by Melville Bell Grosvenor, and "Finding the Mount Everest of All Living Things," by Paul A. Zahl, July, 1964, GEOGRAPHIC.

"Old White Lady," as pilots in northern California fondly call snow-maned Mount Shasta, looms 14,162 feet. Airmen respect her as a navigation reference point, yet keep their distance, since downdrafts created by her bulk can send small aircraft plummeting earthward. Four California summits rear higher than Shasta, but none more spectacularly. No nearby mountain competes with her stately eminence amid virgin wilderness. Seventy miles away in Oregon, the snowy heights of 9,495-foot Mount McLoughlin peek above the horizon.

Today such a park, the vision of all conservation-minded Americans, stands close to reality: President Lyndon B. Johnson, in a recent message to the Congress, has asked for its early establishment.

Reminders of Nature's Powers

In safeguarding a great and irreplaceable treasure, Americans give fresh meaning to the words of Secretary of the Interior Stewart L. Udall: "In an era when man's role in altering the face of the earth is conspicuous, we need reminders of nature's own forces, events, and ultimate powers."

On my way back to San Francisco I stopped once more in Sonoma Valley, gentle in the autumn sun. The first chill had touched the leaves of the vines, barren now of grapes after the harvest. The valley lay awash in a tide of yellow tinged with scarlet and green.

To the north, winter had brushed Mount Shasta's flanks with new snow and paved the edges of Tule Lake with ice. As I turned at last toward San Francisco and the end of my trip, I suddenly found I had company. High overhead I caught the faint chatter of Canada geese, moving south across the golden land.

THE END

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. BLAIR © N.G.S.

California: First State Map in New United States Atlas Series

SIR FRANCIS DRAKE strode ashore in 1579 near what is now San Francisco and left a name for map makers to ponder: Nova Albion, or New England. But, through the centuries, settlers flocking to this rich and beautiful land have preferred another name—one bestowed by Spaniards who fancied they had found the golden realm of a mythical queen, Calafia.

California becomes the first state to be mapped in the new National Geographic United States Atlas Series. The map is distributed to the Society's more than five million members with this issue of their magazine.*

California's 840-mile north-south span required a double map, just as the Nation's most populous state called for a two-part article to do it justice. (See "California, the Golden Magnet," by William Graves, in this issue.)

The two-sided Atlas Map outlines all 58 counties, with a color code of red and yellow tracing the state's highways and freeways. Distinctive symbols denote state parks, ski resorts, redwood groves, even notable individual trees. Insets enlarge metropolitan areas—San Francisco, the bay region, Los Angeles, and San Diego—as well as Yosemite Valley, part of Sequoia National Park, and the northern redwood forests.

On the northern California side of the 20-by-15¼-inch sheet are names to send the imagination soaring: Donner Pass, Golden Gate—and Drakes Bay, where the English sea dog may have anchored his booty-laden *Golden Hind*.

Drake saw here a "goodly country," with "some special likelihood of gold or silver." He must have had a nose for treasure. A mere 125 miles inland, while building a sawmill on the American River for Capt. John A. Sutter, James Marshall found gold in January, 1848.

Run a finger down State Route 49, and you trace the Mother Lode that by 1850 had lured 80,000 newcomers to California. To get to the promised land, easterners sailed 100 days or more around the Horn to San Francisco. Or they dragged covered wagons over the Sierra Nevada through passes such as the infamous Donner—now crossed by new Interstate 80—where 34 pioneers had perished in the deep snows of 1846–47.

Today, ocean ships can steam inland past San Francisco, via new deep-water channels, into the fertile valley heartland of a state that grows more than one-third of the Nation's fruit and vegetables. Freighters berth at Stockton, California's largest inland port, or at the capital, Sacramento, 91 miles from the Golden Gate.

From San Francisco to the Oregon border, U. S. 101 ribbons past towering forests. An inset, the Northern Redwood Corridor, pinpoints the world's tallest known tree (page 674).

At the three forks of the Feather River, 70 miles north of Sacramento, the map locates Oroville Dam, which will be the Nation's highest—770 feet—when completed in 1968. A man-made river now under construction, the 444-mile California Aqueduct, will funnel the water downstate to Los Angeles and San Diego reservoirs.

Highest Peak Loses a Foot

Half the southern California side of the map is sprinkled with the names of a thirsty land: Mojave Desert, Death Valley, Devils Playground, Sand Hills. Temperatures soar above 130° F. in Death Valley, where land sinks 282 feet below sea level, lowest on the continent.

A solid blue oval to the south marks the Salton Sea, an accident turned into a recreation area. Its waters first flowed from a break in a Colorado River levee 60 years ago. Salt leached from the soil and inadequate outlets to the sea have made the waters as briny as the ocean. But they provide a bone-dry country with water sports—boating, fishing, and water-skiing.

California's highest point, Mount Whitney, stands not as high as once believed: Official survey figures have shaved a foot off the peak, now listed on the map at 14,494 feet.

Offshore lie "certaine Ilands" where Sir Francis Drake found "plentifull and great store of Seales and birds." Sea lions and birds still frequent the Farallon Islands, lonely bits of land that the frontier never reached. THE END

*Extra copies of the map may be obtained for 50 cents each, postpaid, by writing to Dept. 305, National Geographic Society, Washington, D. C. 20036. Other state maps will be issued periodically as supplements to NATIONAL GEOGRAPHIC; members meanwhile will continue to receive World Atlas Maps until that series is completed.

Snaking subdivision entwines a mountainside south of San Francisco, shrouded by haze in the distance. Rapidly spreading cities alter the face of the Golden State.

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS NEBBIA © N.G.S.

TROPICAL RAIN lashed at the thatched roof of my hut. I sat alone at the preserving table skinning a batch of arrow-poison frogs—*kokoá*, the local Indians call them—to prepare an extract of deadly venom.

No sixth sense gave me warning that within half an hour pain would rack me and I would be fighting for my life against the effects of the powerful poison in the skins.

Through the doorway I could see the swollen San Juan River rushing past the mud-and-palm-frond village of Playa de Oro, my base for biological collecting in the Chocó jungle of Colombia (map, page 688).

Rain is the normal weather in the Chocó, one of the wettest spots on earth. Nearly twenty-five *feet* of rain drench this Pacific coastal region each year.

Kokoá Venom, an Aid to Medicine?

The hothouse climate nurtures small creatures of the forest floor, among them the black, yellow-striped frog *Phyllobates latinasus* (opposite and page 685). The jewel-like kokoá fits into a teaspoon, yet its skin exudes a venom more potent than any other known. For centuries the local Cholo Indians have smeared kokoá poison on their blowgun darts.

Similar primitive arrow and dart poisons—curare from South America and strophanthin from Africa, for example—provide drugs useful in surgery and in the treatment of heart ailments. Might kokoá venom also be of medical value? The National Institutes of Health in Bethesda, Maryland, wanted very much to know.

I picked up another moist, limp frog and opened the skinning scissors. Accidentally—incredibly—I jabbed the point of one blade into my finger! I put the finger to my mouth and sucked the blood. A strong metallic taste—then my throat began to close.

Panic sent sweat coursing down my face. *There is no antidote*, I thought. Gasping for air, I lay down on a cot, repeating to myself, "You can breathe. You can breathe." Spasms shook me for an hour. Each time my throat constricted, I forced down another swallow of the only fluid immediately at hand—canned tomato juice.

Turning my head, I saw half a dozen wet figures gathered outside the front doorway. Holding captured frogs in twists of green leaves, my hunters were waiting for me to count the day's take and pay them.

How close I came to death remains a guess.

The spasms gradually subsided. Luckily it had been raw, not concentrated venom, and I had quickly sucked it from the wound. I was not going to die.

Within two hours I was on my feet again, buying arrow-poison frogs and popping them into cages.

Indians Revealed Kokoás' Secret

As a professional collector of rare animals for scientific study, I have specialized in capturing the lesser creatures of jungle and highland: birds, monkeys, snakes, rodents, and—most memorable—the poison frogs of the Colombian swamps.

Although known to naturalists since the mid-19th century, the kokoá attracted little interest until 1961, when I learned from the Cholo Indians of the frog poison's remarkable potency. During an expedition to collect giant earthworms, my Indian hunters bagged 50 of the tiny frogs. I shipped them by air to NIAMD—the National Institute of Arthritis and Metabolic Diseases—which is part of the National Institutes of Health. These were the first live

On mist-soaked Andean ridges or in tropical forests, Indian friends help the author stalk rare species for science. Chief quarry was this tiny jungle frog, the *kokoá*, which exudes the deadliest venom known. On cloud-wreathed heights (left), she sought giant earthworms (pages 692-3).

Capturing Strange Creatures in Colombia

By MARTE LATHAM

Photographs by TOR EIGELAND

SLIGHTLY LARGER THAN LIFE-SIZE

He's got one! An Indian lad, ankle-deep in a Colombian swamp, captures a black-and-gold kokoá frog for the author. Centuries ago his Cholo tribe learned to smear blowgun darts with the frog's toxic skin secretion, which can induce paralysis, convulsions, and death in minutes. Weighing only a gram, the 1¼-inch-long kokoá yields enough poison for 50 darts.

Today, researchers study the venom, hoping to uncover medical uses. Curare—another Indian arrow poison—proved valuable as a muscle relaxant, especially in surgery.

SLIGHTLY LARGER THAN LIFE-SIZE

Deadly denizens of Colombia's wild Chocó region, these jewel-like frogs produce poison: the kokoá, *Phyllobates latinasus* (top), and the less toxic "painted" frogs, subspecies of *Dendrobates tinctorius*. Biochemists at the National Institutes of Health, Bethesda, Maryland, isolated the kokoá venom and named it batrachotoxin.

KODACHROMES (BELOW AND TOP) AND EKTACHROME © N.G.S.

FIVE TIMES LIFE-SIZE

specimens of kokoa sent beyond Colombia's borders for study.

"Of the 50 frogs you sent," Dr. Bernhard Witkop later told me, "only seven reached us alive. Of these, six died overnight and the last was moribund. Enzyme action destroys the toxic principle immediately upon death."

From that fiftieth frog, scientists extracted enough venom to want to study it further. On a subsequent expedition I sent back raw venom from 2,400 kokoá. Yet even this number yielded only 30 milligrams of the crystalline pure venom—a smidgen, but enough to kill three million mice.

Now, in the summer of 1964, I was once more in the Chocó—this time accompanied by my 14-year-old son Billy, on vacation from school, and by photographer Tor Eigeland. I had orders for more kokoá frogs, and for giant earthworms from the Andean highlands.

We traveled to our wilderness base camp at a progressively slower pace: jet to Bogotá, four-engine plane to Medellín, two-engine plane over green rain forest and muddy rivers to Condoto, then launch up the swift San Juan River to Playa de Oro.

Jungle Villagers Descend From Slaves

Young friends from my previous visits ran down the steep riverbank to greet the boat and unload our bags and boxes of gear. Playa de Oro had not changed. It was still a village of desperately poor Negroes, descendants of slaves brought to Colombia by the Spanish centuries ago. They eke out a living by tending small banana plots and working tiny gold and platinum mines with simple tools.

Adobe huts, once whitewashed, line the single muddy street; a statue of the Virgin in blue and white stands squarely in the middle of the road. Automobiles have yet to reach Playa de Oro.

Our hut was waiting for us. We swept the floor, strung the last hammock, and collapsed in sleep.

Next day we posted signs stating that we would buy giant cockroaches, monkeys, kinkajous, anteaters—and, of course, poison frogs. In no time Billy had acquired a night monkey and a blue-headed parrot. He named them Abercrombie and Fitch.

The forest Indians usually drift into Playa de Oro toward the end of the week. The Cholos have always been my best frog catchers, and I wanted to enlist them again.

It was Sunday morning when I finally heard Billy shout, "Here come the Indians!"

I looked out and was delighted to see Quimico, who had taught me to find the kokoá, with his family and several friends. Like some of the other local Cholos, they were *civilizados* now, wearing shorts, hats, and shirts.

Hunters Imitate Quarry's Call

But their world was still the jungle world, and when I said to Quimico, "Will you come with us to hunt kokoá?" I knew what the answer would be, even before the long, meditative pause, the quizzical glances exchanged, and the final abrupt nod of the proud head.

The next day we headed into the rain forest, over big round hills, toward the mountains. Quimico and his family led the way, followed by camera-laden Tor, Billy, and myself.

Hidden in the jungle, the tiny frog is hard to see, even though nature gives him poster-bright stripes, as if to warn other animals that a kokoá dinner is a dangerous venture.

How do the Indians locate the frogs? From the trail we watched Quimico at work in the black swamp. He crouched—then his hand went to his face, and with a finger vibrating his taut cheek, he whistled in imitation of the peeping of the frog (page 688). "*Chee-chee-chee-chee-chee,*" stop, then repeat. He squatted quietly for a minute, then took up the chirping call again.

"*Chee-chee-chee-chee-chee,*" answered the kokoá. But where? My civilized ear could not pinpoint its location.

Quimico did not hesitate. He hopped like his quarry, landing on all fours a yard away; his hand was a blur. He tore a leaf from a plant and swirled it into a funnel. He plugged one end with a dab of mud, dropped the frog in, and tied the top with a vine.

The hunt was on. The Indians listened intently, judging distance. Too far for a clean

Spellbound Cholo mother and sons watch the author, whom they call the "frog lady," dump their catches into a wooden cage. Indians carry kokoá in swirled leaves, since prolonged contact with the creatures can cause irritation such as that roughening Mrs. Latham's hands. These tribespeople along the San Juan River cling to the dress and the ways of jungle living. But even children puff cigarettes bought at the Playa de Oro store with frog-hunt earnings.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

EKTACHROME (ABOVE) AND KODACHROME © N.G.S.

"*Chee-chee-chee-chee-chee,*" Quimico imitates the kokoá's voice, drumming his cheek while whistling. The Cholo hunter finds frogs by listening for their answering cries.

Safely past rapids that nearly swept them from their balsa-log raft, Mrs. Latham and her Indian guides journey a swift highway, the San Juan River. They look behind to see how a trailing raft fares in the turbulence.

The San Juan curls through the Chocó, a savage region of jungled hills walled off by the Andes from the rest of Colombia. Indians roam the lush forest, while descendants of African slaves, brought by the Spanish to mine gold, populate the scattered communities. Nearly 400 inches of rain annually drench the Chocó, one of South America's—and the world's—wettest places.

catch? They crept forward, stopped, then chirped. The tiny kokoá answered, and the hunters pounced. Soon I had 25 frogs.

We had witnessed a scene as old as the Cholo culture. Once the Indians hunted kokoá in preparation for the warpath. Now they use poisoned darts only to hunt game.

I explained to Billy and Tor how they prepare the darts, as Quimico had once shown it to me. The frog exudes the poison when under the stress of heat, cold, or pain. Each kokoá is impaled alive on a stick and held over an open fire. As venom seeps from the skin, the hunter rolls the dart point over the frog's back. Spiral grooves in the tip pick up the poisonous secretion. One kokoá can poison as many as fifty blowgun darts. Dried venom has remained lethal for 15 years.

At my preserving table I extracted the venom from the morning's catch. Killing the kokoá with ether, I removed the skins with scissors and forceps. (It was a careless moment some days later, when I neglected to use the forceps, that cost me those agonizing hours and that very bad scare.) Cut into pieces, the skins were soaked in alcohol, and later the solution was poured into bottles.

This was the extract from which scientists at NIAMD—Dr. Witkop, Dr. Fritz Märki, and later Dr. John W. Daly—prepared the crystalline venom found to be about ten times as powerful as that of the Japanese globefish, or puffer, the deadliest previously known.

"There is always hope," Dr. Witkop had told me, "of developing helpful drugs from a substance with such strong action as kokoá venom. Maybe in low concentration it will have beneficial action on the heart. Related venoms are used as heart stimulants.

"Who can tell? It is truly a remarkable substance and deserves careful attention."

Day after day the Indians came into Playa de Oro carrying captured kokoá frogs in leaf cages. They brought other creatures, too: less toxic but more glamorous "painted frogs" (page 685), small mammals, and birds. Occasionally we accompanied our helpers into the jungle, where we found that even Cholo children were amazingly skillful—and enthusiastic—frog hunters (page 684).

Once we ventured by dugout canoes to the upper Tadosito River in search of frogs, returning overland to Playa de Oro. Immense hardwood trees arched the crystal-clear Tadosito. Giant white anthuriums, red-and-yellow lesser bird-of-paradise flowers, long-stemmed water lilies, and lavender orchids adorned the banks. Scattered palm-frond huts with banana plots edged the river.

"God and a Japanese gardener must have joined forces here," said awestruck Tor.

Bird-eating Toad Remains a Rumor

From the settlement of Tadosito (five thatched huts, a school, and a mission building) we plunged into the great swamp at the headwaters of the river, led by a young local Cholo chief and a group of his people. It was tropical fairyland and green hell—a wild tangle of palms and hardwoods, vines and thornbushes—through which we sometimes had to hack our way with machetes.

We skirted a waterfall of breathtaking beauty, then heard a parrot's scream followed by the coo of a dove. Almost at the same moment, from the distance, came the throbbing beat of a tom-tom.

"I expect to see Tarzan swinging down from a tree any minute," Billy remarked.

One of the creatures we sought was a giant toad rumored to eat birds as big as chickens—an animal supposedly deadly just to touch. This *sapo de loma*—toad of the hills—had been on my investigation list for years.

"Do you know where we will find the toad that eats birds?" I asked the young chief.

He shook his head, no.

"Kokoá?"

Probing secrets of the lethal frog toxin, Drs. Bernhard Witkop (in glasses), John W. Daly, and Henry Fales use a mass spectrometer at the National Institutes of Health. The machine reveals the chemical nature and molecular structure of the venom.

Make-believe matadors flap their *ruanas*—Colombian ponchos—to corner a dog-size rat. The Andean rodent, or pacarana, bit one captor but quickly submitted to kind treatment from Mrs. Latham (right). Billy, her 14-year-old son (above, left), named his unusual pet "Rodie."

Excited by a sudden lurch on its first jeep ride, Rodie leaped from Billy's arms onto the driver, sending the vehicle plunging down a steep embankment. Extricating themselves from jumbled camping gear, giant worm specimens, and cages of screaming monkeys and coatimundis, the occupants recaptured Rodie with the help of fascinated bystanders (left). For the rest of the trip the huge rat rode in a box.

Extremely rare in captivity, pacaranas, also called Branick's rats, may measure a yard from nose to tail tip.

The Indian swept his arms in an arc to indicate "many, many."

As he led us overland back toward the San Juan River, we kept a sharp lookout for a toad the size of a hat. But if the bird-hungry beast exists in that region, it eluded us.

Deep in the forest, we at last heard kokoá peeping. In a few hours, the Indians had captured as many as we could use.

These frogs were of a different coloration from those near Playa de Oro. Instead of a yellow double stripe down the back, here the markings were bright orange.

Giant rhinoceros beetles climbed over rotted logs, and golden-winged locusts sang. Finally we came to scattered houses set in small banana plots.

When, after ten hours on the trail, we stumbled into the gorge of the San Juan, my knees were shaking and my face dripped with sweat. Our legs were scratched, our clothes muddy, and we were dumb with fatigue. Playa de Oro across the San Juan had never looked so good.

Before long, I had prepared venom extract from 150 arrow-poison frogs. In cages I kept two dozen live specimens, both painted frogs and kokoá. Billy by now had a fine start on the animal collection he would take back as a science project to his school in Florida. We left the Chocó jungle feeling satisfied.

On the Trail of an Andean Giant

A week later, after a brief rest in Medellín, we were in pursuit of even stranger quarry, in a dramatically different setting.

Pre-Columbian artists, I once was told, modeled giant earthworms on pottery. But until I tracked the elusive creatures down in 1956, I could find only scattered reports and a single photograph to verify their existence. In that year, mountain people high in the Andes of southwestern Colombia found five worms, each 30 inches long, while searching on my behalf. Later I journeyed to their lofty region myself and dug up giant worms by the score.

Tor, Billy, and I now flew to the mountain-girt colonial city of Popayán, where my old friend Alfonso Valencia met us with his jeep (map, page 688).

Hour after hour we climbed long switchbacks into the blue-velvet Colombian Andes, until at last we reached our base, the *finca*, or farm, of Luzselva, at 7,800 feet elevation. The adobe house perches on a narrow plateau between two brawling streams.

In the cold morning we took to the saddle. I huddled deep in my *ruana*—a woolen poncho—against the Andean chill. As we rode up into the heights, I called out at every house we passed, *"Venga, lombrices!"* My entreaty, "Come, worms!" was a familiar call from my previous trips here, as was the response, *"Cuanto vale?*—How much?"

Where the trail climbed out of a gorge, a group of Indian men, women, and children—short, stocky, hardy people—waited for us.

Maria, Feliz, and their children welcomed me with shouts and embraces; over the years they had been the best of the worm diggers. Today they had with them another man and three of his children.

"Lombrices! This way," they shouted, and gestured up the slope.

We soon reached the place the Indians had selected for digging, and I fell to with my machete. Fifty strokes, perhaps, and little Maria pounced on a monster.

"Look, a big one!" The girl's face spread in a delighted grin.

Just another earthworm? Not exactly. This one measured an inch shy of five feet long and

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Monster worms the size of rattlesnakes tunnel Andean highlands at 13,000- to 14,000-foot elevations. Mrs. Latham heard that pre-Columbian Indians depicted the giant earthworms on pottery, but many people thought them legendary until she discovered specimens near Popayán a decade ago.

Champion digger of the hunt, an Andean girl holds her prize catch, an earthworm just under five feet long. Billy Latham admires the wiggler from a distance.

more than two inches in diameter. Deepest blue and green flashed from the moist skin. It was, I suppose, a repulsive creature, its gross accordioned sections rippling back and forth, and the snout probing blindly for the soil. But to me it was a beautiful sight, a living creature whose very being until recently had been in question.

The worms live in a quite restricted band of elevation from 13,000 to 14,000 feet, above the hardwood forests and in the high-altitude grasslands, the Andean *páramos*. Colonies of them burrow just below the surface on the crests of ridges and mounds, and in the banks along the trails.

Once you have located a worm's burrow, the trick is to excavate the tunnel and its inhabitant. The quarry will always dig inward and down when pursued, and you must uncover at least half of it. These are strong animals: The harder you pull, the tighter they grip the soil. Often they break in two.

At times we could simply pick the worms off the open ground in the early morning. Torrential rains sometimes helped us by forcing our quarry out of their flooded burrows.

When we ran out of worms at one site, we sought them elsewhere. Day after day our horses zigzagged through the forests and upward to the treeless 14,000-foot páramo. Indians whom I knew would pop out of their houses along the road, offering me worms in old cooking pots, burlap bags, tin cans.

Indians Find Dog-size Rodents

The whole area is a paradise for the hunter of strange creatures. Overhead wheeled an Isidor's crested eagle, chestnut with black breast stripes. Once the Indians brought us a pair of pacaranas—rare rodents that sometimes grow as big as a good-size dog. Here, too, I found the scarlet cock-of-the-rock, one of the most colorful of birds.

From previous efforts, I knew there was little point in trying to ship my giant worms

KODACHROME BY TED SPIEGEL © NATIONAL GEOGRAPHIC SOCIETY

home alive. Out of hundreds I have sent, only one ever survived for as long as four months. And when one of these creatures dies, within hours nothing remains but a streak of slime.

This time I would preserve my catch and ship it to a biological supply house which furnishes specimens to many American universities for dissection and study.

Preserving demands patience, rubber gloves—and protective eyeglasses. The worms, even after being anesthetized and killed, often spurt back the formalin injected into each segment. Finally I packed the worms in formalin-soaked moss and wrapped them in plastic.

Adding Up the Catch

By departure date we had preserved 250 worms to distribute in Colombia and the United States. At Medellín we picked up the preserved frogs and venom extract which we had carried out of the jungles of the Chocó.

I sent a new supply of kokoá venom extract to NIAMD, and two dozen frogs (painted and kokoá) to the Philadelphia Zoo. I also assembled a collection of Chocó snakes and lizards and "pickled" Andean worms that would find their way to universities, zoos, and other places of study.

Billy's animal collection included three coatimundis, two night monkeys, a parrot, and a silky anteater, as well as Rodie, his pet pacarana (page 690).

It had been a memorable trip. Billy and I had shared many adventures and made many new friends. It had also been most rewarding professionally: I had obtained specimens of all the odd creatures I had hoped to find. As we turned for home, I could not help but wonder what medical marvels scientists might discover in them.

THE END

Mighty monuments to Ramesses II endured for 3,200 years beside the Nile at Abu Simbel. But as waters rose behind the new Aswān High Dam, only a mammoth international campaign—spearheaded by the United Nations and United States—could enable Egypt to save the shrines. In a remarkable series of paintings and photographs, NATIONAL GEOGRAPHIC shows how skilled ancients carved the cliffside temples and how, with equal skill, modern engineers lifted them above the river's reach.

Saving the Ancient Temples at Abu Simbel

Article and photographs by
GEORG GERSTER, Ph.D.

Paintings by ROBERT W. NICHOLSON
National Geographic staff artist

THE DERRICK WHIRRED. Slowly the god-king Ramesses' face separated from his ears—a sight I shall never forget.

It had been a long, busy night. The first cut in the statue had been made at dusk. Then, with the great head bathed by floodlights, two workmen inched a ten-foot handsaw down through the rock, cutting between the god-king's cheeks and ears.

A near-full moon shone on two other colossal heads of Ramesses gazing enigmatically over the silver-plated Nile. Their turn would come later.

At midnight the crew had changed. Twice I had slipped down from the camp above the temple site. The second time, at three in the morning, lacking transport, I had walked for an hour through the haunted desert to get there. I had to make sure the event would occur on schedule.

Dawn brought a selected few to the site. The sun had barely risen when the derrick operator received the long-awaited signal. The face took to the air (above and pages

730-31). For a moment I had the wry thought that ancient Egypt's great king was being ruthlessly defaced by modern barbarians. As the face hung on the hoisting rope, it revolved. In seconds it took on all the fleeting expressions—from somber to benign—that the sun, in daily passage across the sky, normally bestowed on its immovable features only by slow degrees. Then it was gently bedded onto a specially constructed trailer for removal to a storage area.

History's Biggest Rescue Task

Lifting Ramesses' 19-ton face was only one, though the most spectacular, step in a salvage job without precedent.

The two temples of Abu Simbel on the Nile, 180 miles upstream from Aswân, are the most prominent of a priceless heritage of monuments threatened by man-made Lake Nasser behind the fast-rising Aswân High Dam (map, page 698).* Hewn out of a rock bluff 3,200 years ago, they pay perpetual homage to Ramesses II, god-king of Egypt, and his favorite consort, Queen Nefertari.

Four seated colossi of Ramesses, each 67 feet high and weighing 1,200 tons, guard the entrance to the Great Temple. The upper body of one of these has broken off and lies at the statue's feet. Before the neighboring Small Temple, six giant statues of Queen Nefertari and Ramesses stand sentinel side by side.

In the campaign to salvage the treasures of flood-threatened Nubia, the lands south of Aswân, Abu Simbel's two rock-hewn shrines have been of primary concern. Nevertheless, work got off to a late start. Now engineers from many nations race the rising Nile to cut both temples into manageable blocks and move them to safety, above the future maximum reservoir level. Just to reach the innermost rooms of the shrines, the engineers had to excavate nearly 190 feet down through the cliff above the temples (page 721).

Re-erection at the new site, 212 feet above the old and 690 feet back from the shore, started last January, and the cutting and dismantling continue. The temples must be removed by August 15, when Nile waters are expected to wash over the cofferdam, a temporary structure erected to keep Ramesses' and the engineers' feet dry (pages 724-5).

The day Ramesses lost his face, October 10, 1965, was the most exciting one for me. But for the engineers the crucial day had come

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About the paintings: How did Ramesses II's magnificent shrine look when it basked in the Egyptian sunshine of three millenniums ago? NATIONAL GEOGRAPHIC staff artist Robert W. Nicholson went to Egypt to find out. He consulted eminent scholars on three continents, including Dr. Henry G. Fischer of the Metropolitan Museum of Art in New York City. Then he commenced months of work at his easel, creating paintings based upon the theory of Louis A. Christophe, an Egyptologist intimately acquainted with the site. The resulting canvases have been hailed by historians and archeologists alike.

A graduate in architecture of Clemson University in South Carolina, Mr. Nicholson drew plans and built models as preparation for his brushwork. "I know more about Abu Simbel now than I do about my own house," he comments. The artist has undertaken similar re-creations for other GEOGRAPHIC articles: "Exploring the Drowned City of Port Royal" (February, 1960) and "Conquest of the Holy City" (December, 1963).

*Recent GEOGRAPHIC accounts of Abu Simbel appeared in "*Yankee* Cruises the Storied Nile," by Irving and Electa Johnson, May, 1965, and "Threatened Treasures of the Nile," by Georg Gerster, October, 1963.

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Sailing the sacred Nile, Rameses' royal scribes, architects, and overseers set out for Abu Simbel, proposed as the site of Pharaoh's temple. Linen sails hang limp on the windless river as oarsmen drive the vessels ahead. Finally the flotilla arrives at the imposing cliffs. Here, the learned men agree, is the perfect place to build a monument worthy of a king claiming kinship with the gods.

On their return, the overseer of works presents to the ruler diagrams for a rock-hewn temple. A scribe holds plans for a smaller temple to honor the Pharaoh's favorite queen, Nefertari.

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Pharaoh's engineers, putting their knowledge of astronomy to work, line up the axis of the Great Temple. They orient it so that twice yearly the sun will shine into the innermost chamber and bless the statues of the ruler and of Amun, god of Thebes. Egyptologist Louis Christophe believes that this may have been planned to occur first on the day of Ramesses' 30-year jubilee—about October 20 in the year 1274 B.C. (or, by another reckoning, in 1260).

Thirty-two centuries later the rising sun still streamed into the Sanctuary twice each year and bathed the seated figures (page 708).

Ramesses' domain spanned more than a thousand miles from Syria to the Sudan. Today the waters of Lake Nasser gradually submerge most of his Nubian realm. The new reservoir for irrigation and power will ultimately stretch 310 miles and average six miles wide.

four and a half months earlier—when the first block had been cut and was ready for lifting.

The scene is vivid in memory. I held my breath like everyone else, as the deafening noise of the heavy construction equipment suddenly ceased. It was a moment of heart-stopping silence—for everyone from the project manager to the humblest workman.

Karl-Fredrik Wård of Sweden, representing the consulting engineers, stretched prone on the bluff below the crest of the temple cliff. Project manager Carl Theodor Mäckel of Germany, as befits a general during battle, took a position right at the edge of the excavation pit. Pino Lucano of Italy, chief of the section directly responsible for dismantling, moved busily on the rock crest. Egyptian resident archeologist Dr. Anwar Shoukry stood on a vantage point nearby.

It was late forenoon and the weatherman would have said the temperature was 100° F. in the shade—but there was no shade. Still, neither heat nor dust had kept the sidewalk superintendents from strolling over from the

base camp. One was Stefan Lindström, aged 12, who stood next to his Swedish engineer father and trained his binoculars with tense anticipation on the north end of the cliff. There a narrow cut, barely visible to the naked eye, traversed the rock.

One of Ward's assistants had motioned aside the bulldozers that ripped gashes in the rock of the excavation pit. Seconds earlier the Egyptian workmen had silenced their pneumatic hammers. Now the only sound was the rumbling of the winch. Suddenly the fine line of the cut widened to a gaping fissure—as if the mountain were yawning silently. A large block separated. Gingerly, inch by inch, the derrick's tackle swung over. For endless minutes the load hovered motionless against the majestic Nile and Nubia's drowning palms.

"Go, baby, go," a spectator behind me said.

The "baby" was heavy. It weighed 11 tons. And it had a name: GA1A01. This designation stood for Great Temple, Treatment A, Zone 1, Row A, Block 1. The zone, row, and block symbols indicated the piece's position at the topmost section above the façade. Treatment A designated the area framing the sculptured façade. The cliff behind the Treatment A slabs had already been excavated. Now the Treatment A area projected like a vertical fin above the floor of the pit.

"Baby" also got its cradle: a sand-cushioned trailer. The tractor moved it to storage at a snail's pace to avoid vibration. There the slab would wait a year and a half until reassembly in the great jigsaw puzzle, since the first pieces removed must be the last pieces in.

Pharaonic Puzzle: Cut, Float, Lift?

This initial step in precision removal, on May 21, 1965, marked the end of five years of agonizing uncertainty. Since the first call from the United Nations Educational, Scientific and Cultural Organization (UNESCO) to save the Nile's flood-threatened treasures of antiquity, Abu Simbel's two massive shrines had been alternately rescued on paper and given up as doomed.

(Continued on page 706)

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"**His Majesty** commanded the making of a mansion in Nubia by cutting in the mountain. Never was the like done before except by the son of Amun." So reads an inscription at Abu Simbel. These paintings illustrate how the army of artisans built the temples.

Guided by the painted red line established by the rising sun's rays (preceding page), quarrymen first hacked off the rough sandstone and smoothed the surface. Draftsmen, projecting the red line onto the rock face, drew lines to help proportion the figures. Masons chipped away the background, and monolithic blocks emerged. Stairsteps representing feet, lap, and crown developed into stylized forms resembling robots. From these, master sculptors softened harsh lines into muscular legs, chests, and arms. Others delicately molded curved lips more than three feet wide with dimples at the corners.

Clambering over scaffolding, painters apply red ocher to the monarch's body. The god Re-Harakhti, who seems to stride out of the wall above the entrance, wears the same hue. A solar disk crowns the falcon-headed deity. Beneath his right hand, sculptors carved the jackal-headed staff, User; beneath his left (obscured by overseers), the figure of Maat, goddess of truth. The triumvirate represents User-maat-re, Ramesses' coronation name. The Pharaoh in bas-relief on either side therefore presents offerings not only to the god, but to himself.

Through the ages, sand and weather wore away the figures' vivid coloring, but archeologists have found that Egypt's ancient monument builders followed standardized color schemes in painting their statues.

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A living god walks the earth of Nubia as Ramesses dedicates his own monument. To the blare of trumpets, jangle of sistra, and beat of drums, the king and his queen Nefertari lead a procession from the monument in celebration of his 30-year jubilee. Ramesses II wears the blue crown associated with the New Kingdom; he carries the crook and staff, royal symbols. Nefertari holds sistra, musical instruments sacred to the goddess Hathor. Her headdress of horns, disk, and feathers also honors the female deity.

Temple priests shoulder the golden solar bark containing images of gods who preside over the Sanctuary. Linen draperies hide the hallowed figures from the common people. Priests and priestesses stream from the entrance.

What a glorious day! To reconstruct the event, all record of which is lost in antiquity, artist Nicholson followed a bas-relief in the Great Temple showing the king and queen on a ceremonial occasion. The painter faithfully copied many details, including the queen's musical instruments, leopard skins worn by the priests, ceremonial fans, and the sacred bark adorned with falcons on bow and stern.

A Nubian boy in the line of warriors peers at the god-king with mouth agape. One soldier looks sidewise in disapproval at the unmilitary intrusion into the martial rank.

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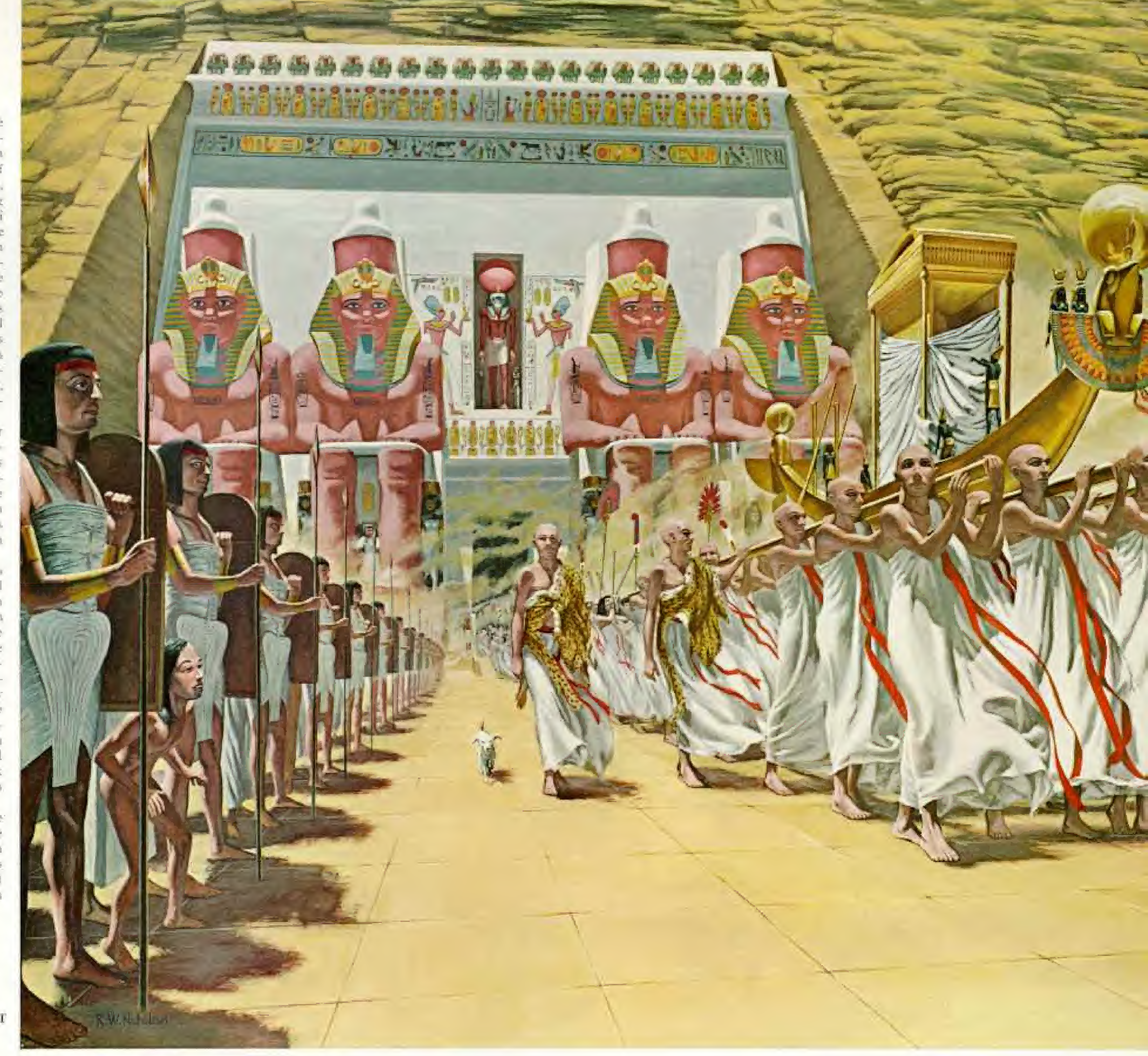

Engineers from many countries pitted their imaginations against this unparalleled challenge. The leading contenders were a French and an Italian scheme. The French plan called for a rock-and-sand-filled dam to protect the two temples. To guard the monuments against seepage would have required an elaborate pumping installation, which would have been too costly.

The Italian plan suggested freeing the temples from the rock and using jacks to raise each in a single huge mass, one weighing 291,500 tons, the other 60,500 tons.

One-piece Move Hits Cost Snag

Several other ingenious solutions were proposed. A French engineer wanted to float the shrines up to high ground on two huge rafts. He didn't propose to wait for the new lake's rise; he envisioned a mammoth concrete bathtub for each temple. Nile water would be pumped into the tubs to lift the rafts to safety.

An American construction expert proposed building barges of concrete under and around each of the two temples and allowing the rising water level of the reservoir to float them up.

A Polish engineer suggested leaving the temples under water, protected by reinforced concrete domes. Another Polish engineer would have surrounded the Great Temple with a circular reinforced concrete wall and placed the Small Temple in a smaller concrete cylinder with a glass roof.

A British film producer proposed a curved membrane to separate the muddy waters of the reservoir outside from clear, filtered water inside; the wall need not be thick, since pressure on both sides would be equal. Visitors, standing in underwater observation galleries, would then be able to admire Ramesses in a kind of aquarium within the membrane.

Inside at last! For centuries drifts of sand concealed the Great Temple. Then in 1813 Swiss traveler John Lewis Burckhardt stumbled upon "what is yet visible of four immense colossal statues." Four years later Giovanni Battista Belzoni, a bearded six-foot-six Italian who sometimes wore Arab dress, penetrated the sand barrier at the entrance. Torches illumined "one of the most magnificent of temples, enriched with beautiful intaglios, painting, colossal figures."

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GEOGRAPHIC ART DIVISION (ABOVE) AND KODACHROME © N.G.S.

Sunlight "falls like fire from heaven upon the altar at the feet of the Gods," wrote Amelia Edwards, pictured above, who visited Abu Simbel in the 1870's. "It is fine to see the sunrise on the front of the Great Temple; but something still finer takes place on certain mornings of the year, in the very heart of the mountain. As the sun comes up above the . . . hill-tops, one long, level beam strikes through the doorway, pierces the inner darkness like an arrow, penetrates to the sanctuary. . . .

"No one who has watched for the coming of that shaft of sunlight can doubt that it was a calculated effect, and that the excavation was directed at one especial angle in order to produce it."

When Ramesses' Great Temple has been reassembled beyond the river's grasp, the sun will once again shine full on the figures of the god Amun and the god-king himself each mid-February and mid-October, as it first did some 3,200 years ago.

UNESCO and the United Arab Republic once favored the Italian scheme to move each temple in one piece. But early in 1963, it became clear that the final word would come from the fund raisers, not from the engineers. UNESCO's members shrank from astronomical estimates that ranged as high as $90,000,000.

Egypt and UNESCO then decided upon a plan for dissecting the temples in as large segments as possible. This plan offered a fighting chance to win over the rising waters despite the late start. It also offered the lowest cost—$36,000,000. The Swedish consulting engineering firm of Vattenbyggnadsbyrån (VBB) drew up contract specifications. Bids were requested and received.

Egypt allocated almost one-third of the required funds. The United States, using its local currency holdings from sale of surplus agricultural commodities, pledged another third in the fall of 1963. This was decisive, making possible the signing of a contract with an international group of bidders on November 16, 1963. Other UNESCO nations partly underwrote the last third of the funds, with the remainder to be raised by private donations, about half, it is hoped, from the U.S.

The group, Joint Venture Abu Simbel, managed by the West German firm of Hochtief of Essen, includes Atlas of Cairo, Grands Travaux de Marseille of Paris, Impregilo of Milan, and two Stockholm firms, Skånska and Sentab. This group executes the VBB project under VBB and Egyptian supervision.

In addition, committees made up of internationally known engineers, archeologists, and architects act as advisers to the Egyptian authorities. The United States is represented on these advisory bodies.

Wise Crocodile Flees Bedlam

The project has been termed a "minimum program." I have heard archeologists call it a "solution of despair," and even engineers regret abandonment of the more daring proposals. Professor Walter Jurecka, Joint Venture's chief adviser and at one time acting project manager, told me: "Each and every one of us will loyally do his best for the project. But there is such a thing as keeping faith with the spirit of engineering, and I must say only the raising of the temples in one piece would have done justice to the broad vision of their builder."

My earliest recollection of Abu Simbel, as I saw it only ten years ago, approaches the idyllic: flowering acacias, a spit of golden sand flowing down from desert to river, and the giant statues of the regal deity gazing serenely across the Nile. On that occasion I shared the sandbank only with a crocodile.

A dozen visits later, in May, 1965, the salvage work had changed everything—even the crocodile had moved out. Capt. Abdel Rahman Serafi, chief pilot of the air shuttle that had brought once-remote Abu Simbel within an hour of Aswân, flew me over the sand bar from which the reptile had judiciously fled the bedlam of the relocation work.

Bustling Town Springs Up in Desert

The acacias had been chopped down, and Ramesses had been blinded under 5,000 truckloads of sand. Engineers had buried the statues of both temple façades to their crowns to protect them from falling stones during removal of the overburden of rock (pages 714-15 and 718). The cofferdam had been completed: 504,400 cubic yards of rock and sand rising 80 feet above the riverbed.

Two harbors had been roughed out for barges and supply boats. Gravel and sand pits pocked the area. There was an airstrip a mile away, although vehicles could get to it only by using four-wheel drive—but, still, a regular airfield. I was not sure I liked all this.

"What a change!" I said a little disconsolately to the receptionist in the contractor's office on the desert plateau above the temples.

"Yes, what a change," the girl echoed cheerily. "Plenty of life now!"

The new bustle struck me with special intensity, contrasting as it did with the dying land around us. Nubia had always been mostly empty space, and the Nubians had ever felt themselves to be denizens of the horizon. But after the modern Nubians were relocated to save them from the rising flood, the area lost its last trace of life. Not a soul, not a sail. Mournful palm trees foundered in the water (pages 726-7). Houses crumbled, avidly swallowed by the mounting river. Abandoned villages on the rocky heights awaited their coup de grâce. A calculated agony.

But now, how right the girl was! Abu Simbel pulsed with more life today than at any time since its construction.

On the day the first block of Treatment A swung out, nearly 3,000 persons lived around Abu Simbel. Settlements for engineers, workmen, and clerical employees, including 50

European and Egyptian families with 46 children, had been conjured out of the desert sands (pages 738-9). Front yards revealed the first timid signs of greenery. Eight miles of roads laced the area, but only the road between the operation site and the main storage yard enjoyed a hard macadam surface; it was more important to ensure a smooth ride for Abu Simbel stone than for Abu Simbel people. The community had a hospital, police station, two stores, and a bakery; a water-purification plant would soon be in operation.

The camp map even showed a Honeymoon Road—and with good reason, for several engineers had brought brides with them. But the school everyone had hoped for did not exist, frustrated by the polyglot make-up of the population. Languages spoken in Abu Simbel, besides Arabic, include English, German, Italian, Swedish, French, and Danish.

The community's international flavor reaches beyond language. At my first lunch in the mess hall, I learned where all the principal dams had been built in recent years in Africa, Asia, and South America.

Most of Abu Simbel's new residents never saw the acacias bloom before the temples. For them the record began in the autumn of 1964. I made a moonlight Nile cruise with Werner Emse, a German engineer who lived on Honeymoon Road. He was showing his young wife the sights of Abu Simbel's past, known to her only from his letters.

"Here," he pointed out, "is the former

AFTER A DRAWING BY GIOVANNI BATTISTA BELZONI

CULVER PICTURES, INC. © N.G.S.

gravel pit. . . . Here the road used to run. . . ." And, pointing to some rickety houseboats aground on the bank of the Nile, "Here we were quartered in the beginning."

Older Shrines Fixed Temple Sites

Werner's intensely personal view of Abu Simbel's past set me wondering about my own limited concept of its history. I had never reflected much on its beginnings as long as Abu Simbel was untouched. Now that men and machines had invaded the place, writing finis to the temples' three millenniums of history at the old site, I was intrigued by questions of how, when, and why.

Ancient Egypt's whole civilization, fortunately, is so well documented that we need

Glacier of sand spreads from plateau to river in an etching from an 1817 drawing by Belzoni. He distorted dimensions of the cliff and placed the Great Temple too high on its face. But he can be forgiven the overabundance of sand; it must have seemed monumental to the first man to begin removing it. "The sand ran down in a slope from one side to the other," reported Belzoni, "and to attempt to make an aperture straight through it to the door would have been like making a hole in the water."

In 1819, an expedition cleared enough sand to reveal that the statues were sitting. Diversion walls built in 1892, not seen in this turn-of-the-century photograph, kept the desert's invasion to a minimum. Sand no longer threatened the Great Temple after reinforcement of diversion walls in 1910.

not speculate entirely about the how. As for the when and why, the years during which Abu Simbel's reconstruction dossier wandered about among committees yielded much new information through an intimate study of the temples at their site. First and foremost, French Egyptologist Louis A. Christophe, UNESCO's man in Egypt for the Nubian archeological campaign, deepened our knowledge of Abu Simbel's creation.

From inscriptions at the scene Christophe concludes that the sites of the two temples were already holy ground, occupied by shrines to local divinities—the god Horus of Meha and the goddess Hathor of Ibshek. Though Ramesses appropriated the sites, he paid due homage to both by having images of them placed in his new and much larger temples.

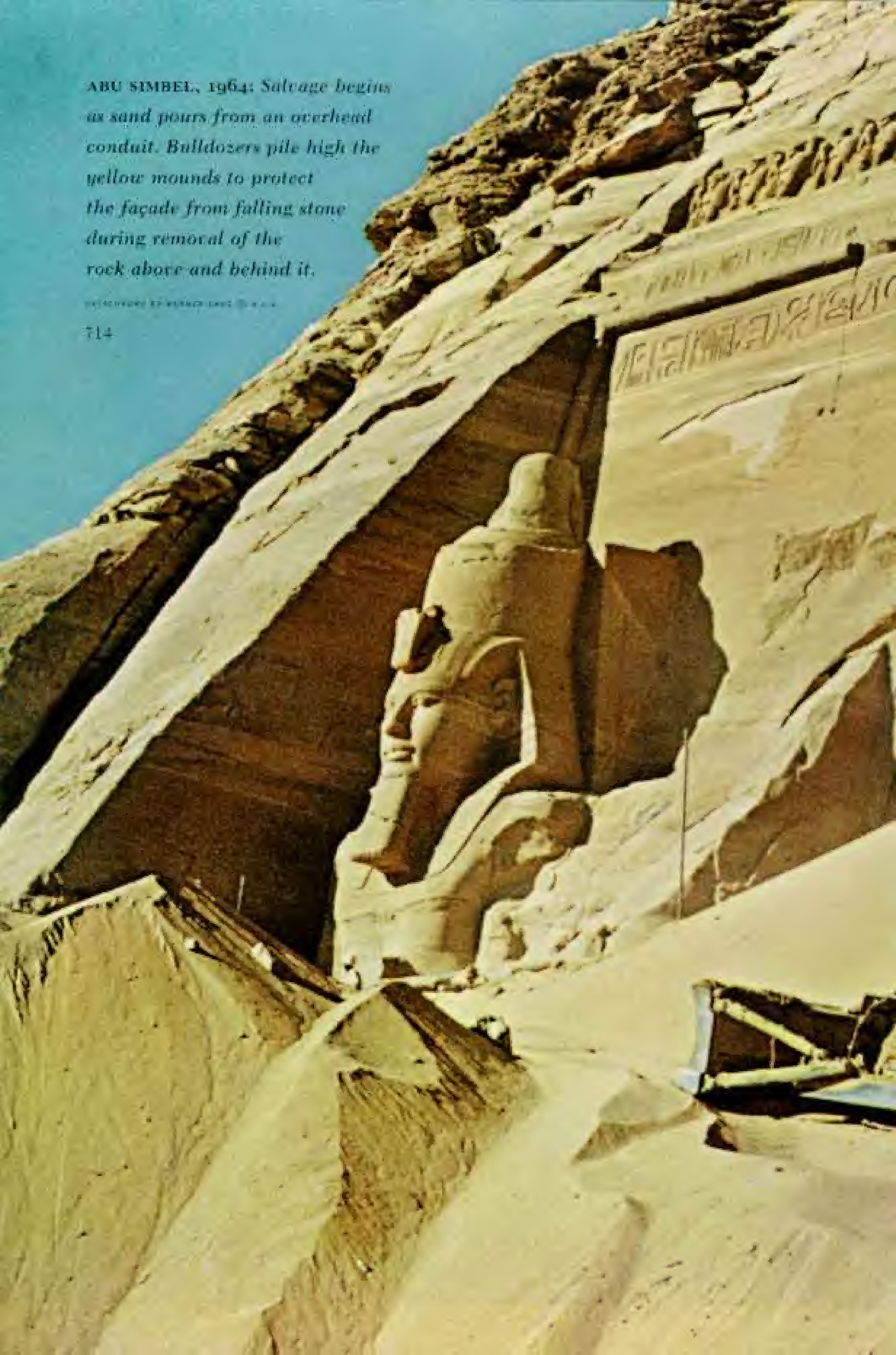
(Continued on page 717)

Gilded by sunlight, finely shaped figures of Ramesses II greet the visitor entering the Great Temple. Each holds the crook and flail, symbols common to Pharaoh and the god Osiris, king of the dead. Such statues usually flank the Great Hall, or open court, of surface temples. The four 30-foot-high figures on the north (photograph) wear the double crown of Upper and Lower Egypt; those on the south (not visible) wear only the crown of Upper Egypt.

Belzoni erred again in depicting the Great Hall; he drew double crowns on all figures (below). "The heat was so great in the interior of the temple," the Italian recalled, "that it scarcely permitted us to take any drawings, as the perspiration from our hands soon rendered the paper quite wet."

ETCHING BY A. AGLIO, AFTER A DRAWING BY GIOVANNI BATTISTA BELZONI

EKTACHROME BY HAMILTON WRIGHT ORGANIZATION © N.G.S.



ABU SIMBEL, 1964: *Salvage begins as sand pours from an overhead conduit. Bulldozers pile high the yellow mounds to protect the façade from falling stone during removal of the rock above and behind it.*

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Man and machine carve away a cliff. When plans to move the temples intact proved too expensive, Egypt and UNESCO adopted a plan to cut the monuments into movable blocks and reassemble them on the plateau above.

For bulk excavation over the temple chambers, steel rippers gouged out rock (left). When one layer of rock resisted the ripper's bite, engineers nervously resorted to dynamite. The carefully calculated blasts caused no damage to the temples.

Chain saw (right) cuts a slab immediately over the chambers. An Egyptian (above) slices sandstone with a Swedish handsaw. Workmen cut seams less than a quarter of an inch wide in the façade and interior walls.

Throughout Ramesses' reign, which began in 1304 B.C. (or, by another reckoning, in 1290 B.C.), fact and fiction tended to merge. He dreamed of restoring the Egyptian realm as far as the Euphrates, but failed. After years of striving against his Asiatic foes, the Hittites, he had to settle for little better than the status quo. Nevertheless, when he died after 67 years of rule, he had already gone down in history as a great conqueror.

A forest of obelisks and colossi from the Delta to Nubia, more gigantic than any constructed before, proclaimed his renown. In all antiquity, he was probably the most prolific builder of monuments to his own glory.

Great Temple Oriented to the Sun

The ceremonies attending the founding of an Egyptian temple centered on the placing of the four corners of the ground plan, using measuring tape and boundary stakes. This ancient and sacred ritual was no doubt enacted at Abu Simbel, even though for a rock-hewn temple it could have only symbolic meaning. Possibly animals were sacrificed to propitiate the mountain before wounding it with mallet and chisel.

We can be sure that high court officials did not shrink from the tedious journey to Nubia, on the fringe of the civilized world. But history fails to tell us when—or even if—Ramesses himself visited Abu Simbel. Our artist has assumed his presence with his queen, Nefertari; a bas-relief inside the Great Temple shows the royal couple taking part in a similar ceremony (pages 703-5).

The chief palace architect directed the construction. Surveyors laid out the axis of the Great Temple from a point on the eastern horizon. Christophe suggests that Ramesses' orders were that the rising sun's rays must strike 180 feet back into the Sanctuary on the day of his 30-year jubilee, around October 20 in 1274 B.C.—or possibly 1260 B.C.

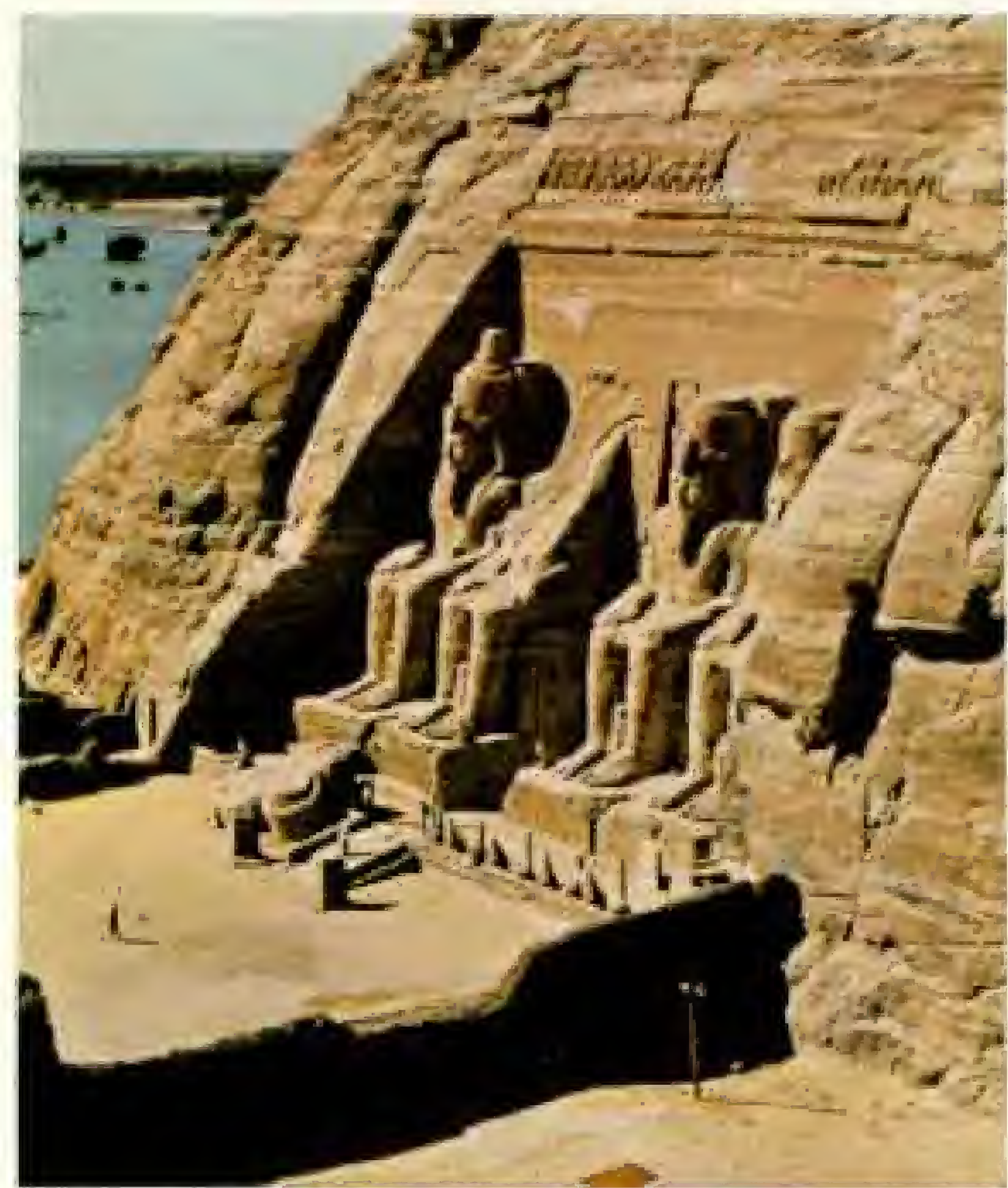
Stonecutters chiseled the façade into the mountainside, imitating the pylons of a temple in the open. Draftsmen painted guide lines on the smoothed façade to facilitate their drawing of the colossi's contours. With eyes fixed on plans sent from the court, the sculptors began the seated figures of the king with mallet and bronze chisel. At his colossal feet, they sculptured the standing figures of his family. Finally, painters swarmed over the images with fiber brushes (pages 700-702).

Specialists from the City of the Dead at Thebes drilled tunnels into the rock, at first advancing in narrow parallel galleries. Later they broke loose the rock masses that separated the tunnels. Workmen used tools of bronze and hard wood in the soft stone. They hollowed out the temple in the cliff as if it were built in the open, leaving pillars in place as ceiling supports.

How they solved the problem of lighting deep inside the mountain remains a mystery. Smudgy torches or burning wicks would have choked the workers. Did they use smudgeless alcohol-burning lanterns? But we have no evidence that distillation was a known art in ancient Egypt. Perhaps bronze mirrors reflected sunlight into the interior.

In the Great Hall of Ramesses' temple, sculptors transformed the pillars into statues holding the crook and flail, symbols common to both Ramesses and the god Osiris. In the adjoining hall they merely gave the pillars four smooth sides. In the inner sanctum they carved out of the rock four seated figures, representing Ramesses and the great gods Ptah, Amun, and Re-Harakhti. Draftsmen traced sketches on the smoothed walls, and sculptors, following these outlines, chiseled bas-reliefs. Then painters brushed on brilliant color.

Clerks in white-linen garments moved



KODACHROMES BY HAMILTON WRIGHT ORGANIZATION (ABOVE) AND GEORG GERSTER © N.G.S.

Enemy turns friend: Desert sands that once hid the wonders of the Great Temple now provide a cushion for the immense but fragile figures to protect them from falling debris during removal of the cliff top. Workmen on scaffolding covered inscriptions and stone baboons above the images with planks.

Reinforcing Ramesses' nose, Abd Es Samya of Egypt's Antiquities Department squirts polyvinyl acetate into a nostril. Where the soft sandstone threatened to crumble, this resin compound strengthened the rock surface.

"Because of the bad quality of the stone," said project manager Carl Theodor Mäckel, "Abu Simbel would have been lost long ago had it not been for the area's exceptionally dry climate."

among the artisans, checked the work against the plans, and drew up progress reports that went by express downriver. Barges brought in supplies. Dulled or broken chisels had to be recast and resharpened; club-shaped mallets needed replacement. Court executives constantly dropped in for the grand tour. Special vessels manned by high-speed rowers brought the latest instructions from the royal court. As far as we can learn, work on the Great Temple and Small Temple went on simultaneously.

Ramesses' Favorite God: Ramesses

What, I wonder, went through the minds of the artists who decorated the north wall of the Great Hall with a heroic representation of the Battle of Kadesh? They had orders to make this encounter of Ramesses with the Hittites an overwhelming victory. But the artists must have known the truth: This "victory" had been merely a successful retreat. Ramesses avoided disaster only by personal valor, inspiring his troops to fight bravely. And I would dearly like to know what these artists thought of the king's increasing self-deification.

The Great Temple actually glorifies Ramesses himself; all other deities are only invited guests. A rebus over the entrance spells out the name of the host: User-maat-re. This is the king's coronation name, his throne name. He is a deity by virtue of his office and sits in the innermost hall, a god among gods.

Christophe concludes that the king had the temple built for the feast of his *sed*, the jubilee marking 30 years of his reign and a milestone in his life. The sed was probably a symbolic survival of a prehistoric ritual: the slaying of the ruler while still in the prime of life. At the sed the Pharaoh, with great pomp, became, as it were, his own successor. The renewal

KODACHROME BY GEORG GERSTER © N.G.S.

Taking apart a mountain, workmen lay bare the Great Temple. Stonecutters moved not only the temple face but also the rock that framed it, so that the reassembled monument will appear in as natural a setting as possible.

Cutaway drawing reveals that Ramesses' architects designed his subterranean temple with a floor plan similar to that of one built in the open. Traditional entrance leads into the Great Hall (pages 706-7 and 712-13). Beyond lie Hypostyle Hall, Transverse Chamber, and Sanctuary.

A red trace on the ground shows the direction of the rising sun's beams when they penetrate twice each year into the Sanctuary and light the statues of Ramesses and Amun. Side rooms probably held ceremonial utensils or gifts to the gods.

of his rule was likened in the religious texts to the restoration of Egypt to order after a time of chaos, and also to the recapture of a fortress usurped by an enemy. On the day of Ramesses' sed, the rays of the rising sun would penetrate along the carefully aligned axis into the bowels of the mountain to flash across the statue of the king; thus the sun god himself would vouchsafe to Pharaoh the renewal of his earthly realm.

A few years later, perhaps for a celebration in the 34th year of his reign, Ramesses took the final step. As the hieroglyphs reveal, he assumed his place among the gods not only under his ceremonial

Shower of sparks cascades past an impassive Ramesses as a welder applies his torch to steel girders within the Great Hall. Because of changing stresses in the rock after removal of the cliff top, the ceilings and walls might have collapsed without these supports. The 156 tons of scaffolding will be re-erected at the new location before the chambers take shape once again.

With the skill of surgeons, bearded Egyptian Abbas Ali Ali Omar and Italian Giovanni Greco saw into the ceiling of the Great Temple. Slender steel pins driven through the slit enable chain-saw operators, slicing down from above, to locate the cut and meet it.

PHOTOGRAPHED BY GEORG GERSTER © N.G.S.

name but also as Ramesses, his name at birth. The man as well as the king was now a god.

A sculpture in the Great Temple strikingly documents the king's audacity. This relief originally showed Ramesses standing before the seated god Amun and goddess Mut, offering them Nubian captives. Then, obviously on orders from the palace, artists recut the relief to seat the deified Ramesses between the two deities. To make room for this divine latecomer, the artists moved Mut to the right and made her smaller. A touch-up with plaster and paint, abetted by the chamber's gloom, concealed Ramesses' earlier status as a mere mortal.

Royal Shrine Rises in Hinterland

Why did Ramesses choose Abu Simbel as the place to create the most spectacular of his works?

The answer must lie in the nature of Abu Simbel's setting, at once a stimulus and a challenge to Egyptian artists. Since the beginning of their civilization, Egyptians had responded to the inherent possibilities of the materials at hand. The greatness of Abu Simbel springs from the combination of superb architecture with a dynamic setting, and the completed monument is truly worthy of the grandeur of a god-king.

But Ramesses built half a dozen other temples in Nubia, four of them partly rock-hewn, and made numerous additions to existing shrines in Egypt. He also deified himself in other temples. Does it seem illogical from a religious or political point of view that he should make the overwhelming display of his power and majesty in such an isolated part of his realm?

To us it would appear that these colossi were raised by a megalomaniac to impress his subjects and the mammoth shrines to accommodate vast hordes of worshipers, but this is not true. To the Egyptian mind the colossi were living things, a mystical extension and enlargement of Pharaoh's being. They needed no worshipers to give them meaning.

Temples to the Egyptians were simply redoubts of the gods, represented by their living statues, standing guard between chaos and an ordered world. That is why at Abu Simbel small statues of the gods were borne out of the Sanctuary on a ceremonial bark to greet the sun. Abu Simbel was no subterranean cathedral with a congregation, but more like a military installation, a secret command post obsessed with problems of security and clearance of its selected personnel, the priests.

Inscription's Position Gives Clue to Date

The two temples, many years in building, were completed before Ramesses' 34th year of reign. Christophe deduces this from the fact that a happy communique announcing the reception of the daughter of Hittite King Khattusilis into the royal harem in that year had to be placed outside rather than within the Great Temple. No space remained for the

inscription inside, for the walls were covered with painted reliefs.

"But bad news had also reached Abu Simbel," Louis Christophe told me. "Ramesses' first chief consort, Iset-nefert, presumably died shortly before or after construction got under way. Bent-Anta, Ramesses' and Iset-nefert's first-born daughter, is portrayed in the Great Temple's Great Hall, sometimes as a princess, sometimes as the queen of her father-husband. As long as Iset-nefert was alive, Ramesses would hardly have elevated her daughter to a position equaling that of Nefertari, his other famous royal spouse."

The Small Temple is believed to have been completed ahead of the Great Temple, and was decorated in Nefertari's honor. It pays homage to the queen and the goddess Hathor, and in contrast to the solemnity of the larger shrine, it displays a boudoirlike intimacy and charm. Here, as in the Great Temple, Nefertari's lovely face and figure appear repeatedly, usually near her royal spouse, as in our painting (pages 703-5).

Buried Temple Sleeps Away the Ages

While Ramesses yet lived, Christophe believes, the upper portion of the second colossus from the south side fell to the sands, where it lay through the centuries. Pharaoh's experts had underestimated the fissures and stresses in the rock. A second seated figure and the temple interior required extensive repairs.

For a while after Ramesses' death, the priests continued to maintain the temples. But by 1000 B.C. Lower Nubia had begun to fade from the pages of history, and the sands of the Western Desert started to invade the Great Temple.

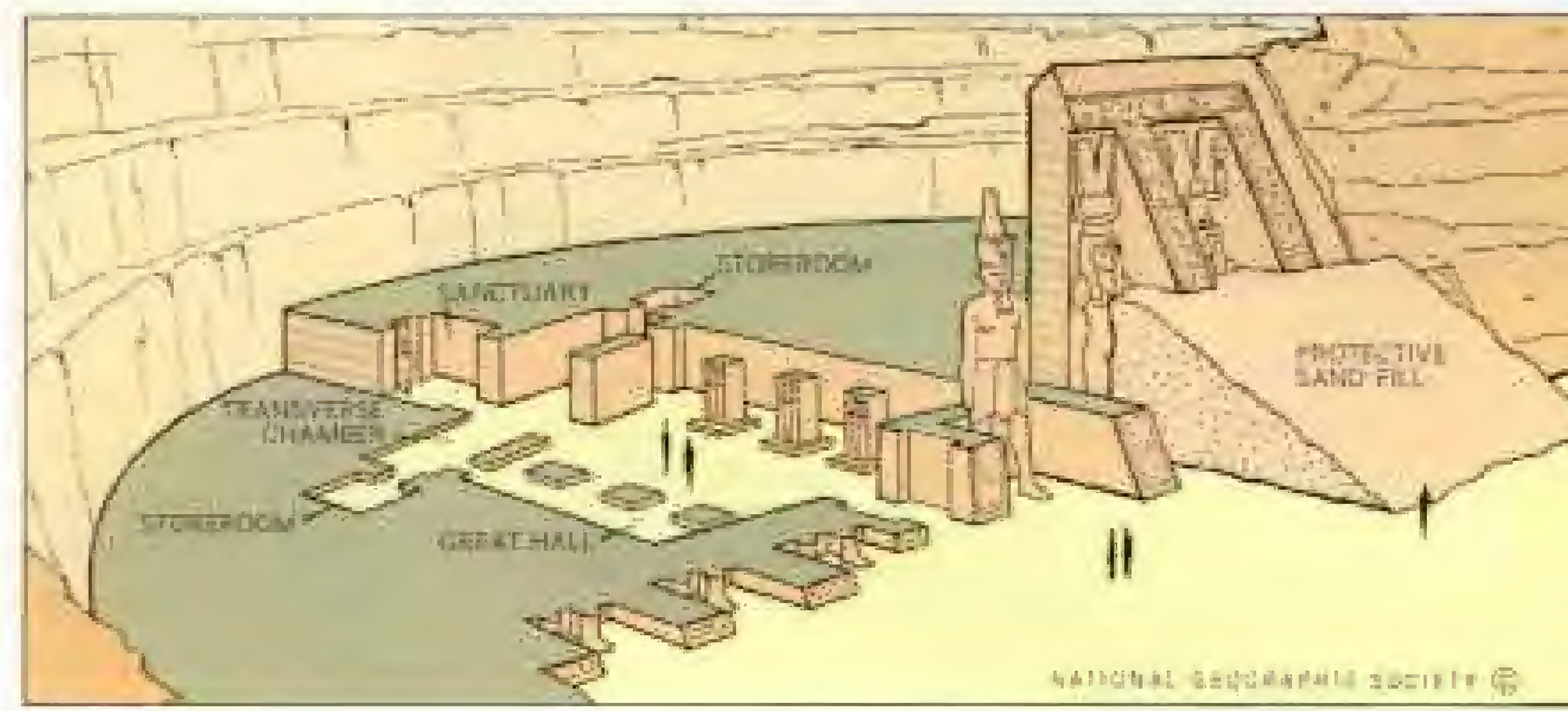
In the sixth century B.C., Greek and Phoenician mercenaries marching against Nubia climbed the heaped-up sand to carve their names on the seated colossi. Two of the

Before salvagers began their task, statues fronting the temples gazed on a serene riverscape (top). As work began, a wall of steel pilings—core for a shielding cofferdam—fenced the monuments from the Nile (center). Men labored night and day in 1964 to complete the dam to its 80-foot height when the annual Nile flood rose higher than expected. Corrugated metal conduits formed tunnels into both temples, providing access through the rising sand cover. With protective measures completed by 1965, Abu Simbel wore a new face (bottom).

Drowned forest of date palms spikes the waters of growing Lake Nasser. Soon the trees will vanish forever. Passing boatmen pick a few clusters of the last harvest. A deserted Nubian village, two miles downstream from Abu Simbel, awaits inundation. The United Arab Republic has resettled more than 60,000 Nubians of the area in new villages in the Kôm Ombo region, north of Aswân.

"Ramesses II made . . . a mansion and great and mighty monuments for the great royal wife Nefertari," reads an inscription on the Small Temple. Two statues of Ramesses and one of Nefertari stand on each side of the doorway (see cutaway drawing). Laborers remove the shielding of sand from the 33-foot-high figures. In the Tranverse Chamber, artisans carved one of the most beautiful reliefs (lower photograph), in which the goddesses Hathor and Isis crown Nefertari.

"On every pillar . . . we find the names of Rameses and Nefertari 'coupled and inseparable,'" wrote Amelia Edwards. "We see that the Queen was fair . . . the King was in his prime. We divine the rest; and the poetry of the place at all events is ours. Even in these barren solitudes there is wafted to us a breath from the shores of old romance."



soldiers, not content with a simple "Kilroy was here," scratched across Ramesses' shin this military communique:

"King Psammetichus having come to Elephantine, those who were with Psammetichus, son of Theocles, beyond Kerkis as far as the river permitted, have written this: Potasimto led the foreigners and Amasis the Egyptians. We have written this, Arkhon, son of Amoibikhos, and Pelekos, son of Oudamos."

These two soldiers bequeathed us one of the older texts in Greek, and never has science defended more staunchly the mischievous habit of decorating other people's shins and walls with signatures.

"Colossal Statues" Astound a Daring Traveler

The Hellenistic period listed among the Seven Wonders of the World Egypt's Pyramids and the Pharos, or lighthouse, of Alexandria. Not a word about Abu Simbel. Its Great Temple slumbered on in a cocoon of sand, not to be rediscovered until 1813.

John Lewis Burckhardt, traveling as a Moslem, was one of the first in modern times to follow the Nile almost to the Third Cataract, about 210 miles upriver from Ramesses' temple (map, page 698). On his return downriver he looked for the "temple of Ebsambal," of which he had "heard many magnificent descriptions."

This was the Small Temple, which had not been buried and served villagers in Burckhardt's time as a refuge from marauding Bedouin. As Burckhardt was leaving the site of the Small Temple, he suddenly espied "what is yet visible of four immense colossal statues." He saw little—only the double crown, head, and part of the torso of the most southerly statue and the "bonnets" of the two northerly ones projecting from the sand.

I had always found it hard to visualize the circumstances of this

First face lifting: Pharaoh's head glows under floodlights as work continues into the night. Guido Roncaglia severs block 120, as marked on the blueprint (below), with a six-foot saw. Sponge rubber protects the forehead. In clear morning light, a staff member with arms outstretched (opposite), guides the 19-ton face to a sand-filled trailer bound for storage.

Curved lines of the blueprint, like a contour map, show the shape and dimensions of the rock as taken from stereoscopic photographs.

discovery. No longer—for I myself have now seen the Great Temple purposely engulfed in a protective mass of sand.

Burckhardt surmised that sand hid the entrance to a temple hewn from the rock, but he could not even tell whether the colossi were seated or standing.

Giovanni Battista Belzoni journeyed to Abu Simbel in 1817 and gained entrance to the Great Temple. The British consul general in Egypt had turned to this adventurous Italian to collect antiquities for the British Museum.

After weeks of digging, the six-and-a-half-foot Belzoni and his helpers pushed aside enough sand to slide into the cavernous hall (pages 706-7). He and his companions marveled at the work of Ramesses' artists, unseen since ancient times. They attempted to make drawings, but it was so hot inside that perspiration ruined their sketchbooks.

The southernmost colossus was dug out in 1819 and the general sand level reduced, revealing the four seated statues of the façade. This revelation set off a rush of tourists, just as did news of Abu Simbel's imminent flooding 150 years later.

Excavation Betrays a Slayer

The creation of Abu Simbel in the 13th century B.C. was a story of struggle and triumph, of pride, and perhaps of strife and murder. And so has been the story of its rediscovery.

Belzoni's success for the British roiled French competitors. As the Italian left Abu Simbel after one visit, a Turkish soldier on a dromedary overtook him to deliver two threatening letters written in Arabic and signed, Belzoni reported, with fictitious names. Later a French agent warned him that if he continued his activities in Nubia, his throat might be slit. At one heated confrontation, Latin tempers rose over French and English claims; a pistol was fired, luckily missing Belzoni.

Murder was actually committed in the modern-day relocation of the temples. After a planned blasting in a quarry was abruptly postponed in October, 1964, a Swedish engineer noticed an arm projecting from the rubble. An Egyptian had killed a fellow workman, counting on the explosion to make the murder look like an accident. Before the

murderer was caught, a hundred workers from his village quit their Abu Simbel jobs, fearing the vengeance of the slain man's kin.

In the evening, when men relax, many stories make the rounds: stories of horror, of poisonous scorpions, or of the scourge of Abu Simbel—the horned viper. Or the talk may be of the visitors who take sand as a souvenir, some of them almost piously.

Today the sand is blanketed by flourlike white dust from the sawing and excavating. Phase No. 1 of the salvage operation was aimed at protection. Engineers, after building the cofferdam and shielding temple façades with sand, shored up the interiors with prestressed scaffolding (page 722). Test borings in the sandstone and measurements of its strength and stresses had revealed that the ceiling not only rested on the rock pillars but also was kept in place by lateral thrusts. The scaffolding would prevent ceiling slabs from falling when, during removal of the mountain above the temples, changes in stress occurred within the rock.

The rising waters of the Nile posed the chief problem of protection. The cofferdam helps to keep the construction site dry. A drainage system collects unavoidable seepage. Tunnels intercept any water filtering through the cliff's sandstone from the river. Deep wells help lower the water table around the site to prevent its rising higher than 40 inches below the sill of the Small Temple. Beyond that level, water drawn up into the stone by capillary action would wet the monuments. Pumps supporting this complex drainage system can siphon off as much as 200 gallons a second.

The cost of the cofferdam and drainage system is about a sixth of the estimated salvage cost—a $6,000,000 price tag for delay. If the work had started two years earlier, this costly rear-guard action against the Nile would have been unnecessary.

Phase No. 2 comprised removal of the cliff and excavation behind the façade to reach

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

Bare bones of the Great Temple lie exposed after the cutters take off the cliff top (page 720). Slab by slab, the roof and walls move by trailer from their age-old home to storage areas. Dismantling continues simultaneously on rooms and the façade.

For the first time, daylight streams into the innermost rooms from above (right). Ceiling gone, decorated walls await removal. The thin cable of this wire saw, running over grooved wheels, makes a fine cut.

the temple ceilings. The engineers planned to do this without blasting, to avoid risk to the temples. But they struck a massive layer of iron-rich sandstone that fouled the teeth of the ground-ripping equipment. Dynamiting was the only way out. The echoes of the explosions resounded in UNESCO's Paris headquarters, but the vibrations, as measured in the temple, were smaller than those caused by the bulldozers.

Pino Lucano, chief of the section superintending excavation and dismantling, told me that bulk excavation around the Great Temple involved 142,000 cubic yards of rock. Another 29,200 cubic yards had to be painstakingly excavated by hand, using pneumatic hammers only. This careful excavation included removal of the sandstone to within less than a yard behind the façade, above the ceiling, and along the side walls.

Relics Excite Dreams of Treasure

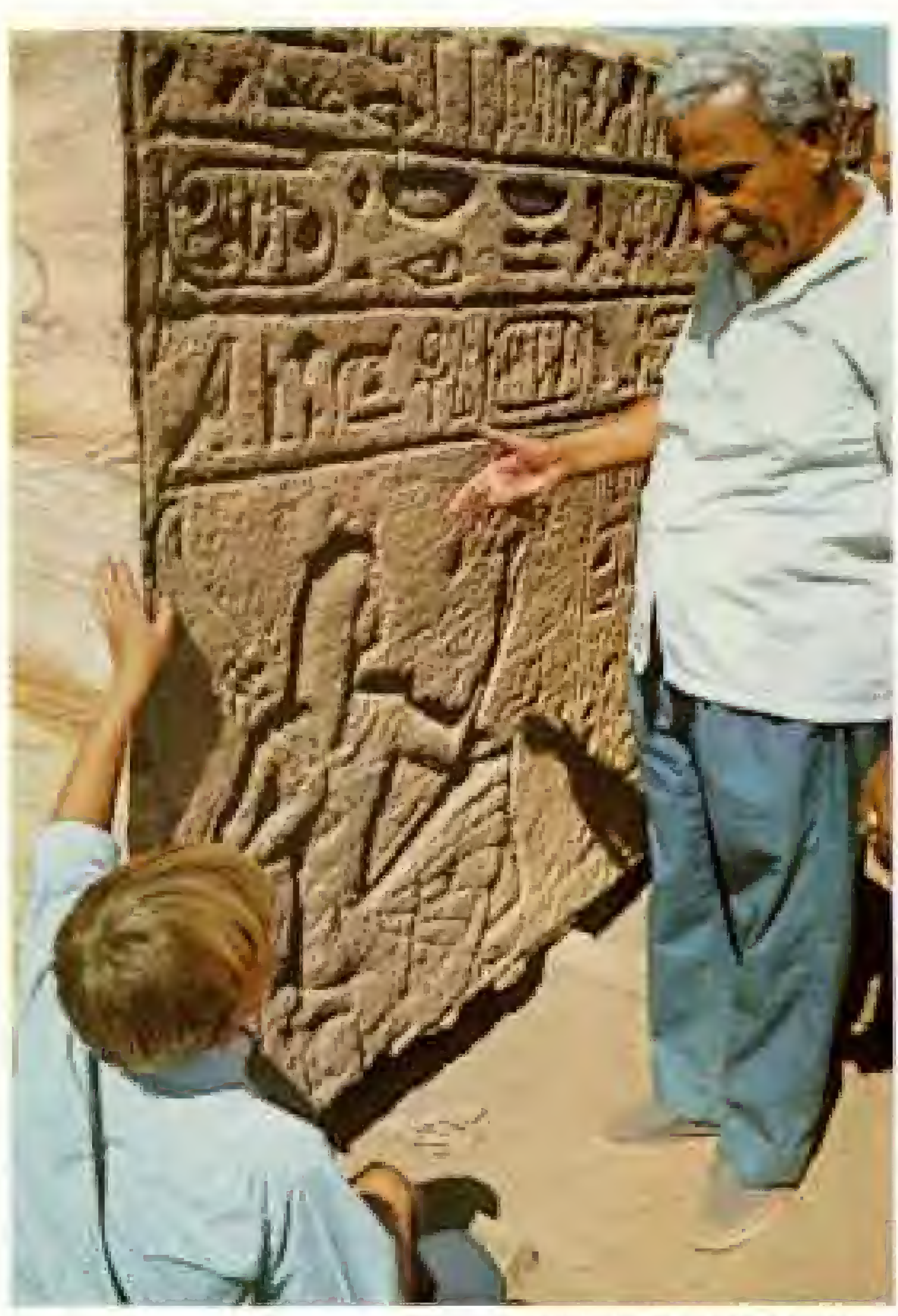
Pino showed me what looked like pieces of petrified palm tree found embedded in the sandstone. Paleontologists are still analyzing these, but if they are true fossils, they must have been washed in at least a million years ago as the sandstone formed.

Finding these relics spurred the instincts of treasure hunters. One of the Nubians on the site, a dark, fine-featured workman, confessed to me, "Never would I take a job at the High Dam; but Abu Simbel, that's something else again."

No one could fool him: he knew exactly why men and machines were driving into the cliff. He intended to be there when the gold hoard was brought to light. He had to shout his confession above the noise of the pneumatic hammers; obviously, he would have preferred to whisper it.

Even Pino Lucano's fellow countrymen, the *marmisti*, stonecutters from northern Italy's marble quarries, cling to dreams of finding treasure—"a mummy, a scarab, anything," as one said to me almost pleadingly.

The engineers, however, are too busy to give the possibility of treasure much thought. Diether Fuchs, superintendent of the civil engineering works, reviewing Phases 1 and 2 with me, said: "I do not think that management at any other construction site has ever had to coordinate so many operations. On some days we have several hundred operations going at the same time. And everything, of course, is complicated by the multiplicity



Lesson in Egyptology: Resident archeologist Dr. Anwar Shoukry explains to Stefan Lindström, a Swedish engineer's son, an inscription in the cliff near the Great Temple. The stela, showing Rameses' viceroy Setau, proclaims the sovereign's might in the 38th year of his reign.

"Watchers for the dawn," sacred baboons squat in a storage area, awaiting return to a high perch above the entrance of the reconstructed temple.

Gauze bandages cover the feet of painted figures on pillars from the Great Temple. Wrapping prevents brittle edges from crumbling away.

of languages. Then, what trouble to procure spare parts! It takes at least three months to get them from Europe. No matter how large a stock we have on hand, the part you want is always missing. Just go over to the workshops and ask them what working at Abu Simbel means: Improvise, improvise!"

Boy Becomes Expert on Abu Simbel

I asked in many places how it felt to be at Abu Simbel, and I received many answers. The most enthusiastic was, "The time of my life!" This came from 12-year-old Stefan Lindström (preceding page).

Although I often trudged the site with the engineers, I soon found that there was no better guide than Stefan. Before he came to Abu Simbel, he had watched his father build a port in Liberia. This new faster-paced project enchanted him. Any free time he had—when his mother, who was his teacher, let him escape from his studies—he roamed among men and machines.

He knew the intricacies of each piece of machinery, and all the men knew young Lindström and his field glasses. He had a grasp of details. For instance, he could differentiate scrupulously between a D-8 bulldozer and a D-9. He could also expertly distinguish between Hathor and Isis in the Small Temple's bas-reliefs. He knew when the iceman was due, and he was an authority on the quality of the fish peddled at noon among the Egyptian workmen.

He and I watched as the workmen blasted to level a storage lot and then set up the gantry crane. We stood in the excavation pit above the temples, amid the rumbling of bulldozers with steel rippers that looked like the stingers of giant angry scorpions as they struck into the rock (page 716).

Through a steel conduit piercing the sand

EKTACHROMES (OPPOSITE) AND KODACHROME BY GEORG GERSTER © N.G.S.

Rebuilding begins: In January, 1966, laborers ease the first stone of the Great Temple into place at the new site high above the rising Nile. Special mortar will attach the block to the foundation. Resin paint, shining at the base, prevents water in the mortar from discoloring the sandstone. So carefully were measurements computed that blocks fit into place with a precision of 1/25 of an inch or less—like parts of a three-dimensional jigsaw puzzle.

King-size manicure: Dismantling continues down to the finger tips as workmen slice Ramesses' extremities into neat blocks. Crane cables will attach to the steel lifting bars. Engineers expect to complete the dismantling and reconstruction of both temples late this year—two years earlier than predicted. Completion of the setting will require another year and a half.

before the façade, we ventured into the Great Temple. We could hardly move between the uprights and struts of the scaffolding. Above us, through layers of stone, the pneumatic hammers throbbed like a summer rain on a tin roof. To protect himself against the infernal dust, Stefan donned a mask.

"Now I look like a pig. Or like a spaceman," he commented happily.

Phase No. 3, dismantling and removing of the temples, was in full swing. Outside earlier, Stefan and I had seen the derrick lift the first block of the Treatment A series. Inside now, we watched skilled marmisti wield their saws, some tailor-made for this unique job.

These men had spent their working lives in cutting and moving stone. "We know rocks like hearts," one of them quipped. "We know when they break."

Soon their chain saws had bitten four feet deep into the rock on the bias, where ceiling and walls met. These cuts would prevent splintering of the temple ceiling when the mountain readjusted itself after removal of the rock overburden.

Other marmisti, working in two-man teams, cut vertical four-inch-deep grooves into the painted ceiling at regular intervals. To manipulate their saws, they crouched on a scaffold beneath the ceiling in a painfully cramped posture (page 723). I thought of the tortures suffered by Michelangelo while painting the ceiling of the Sistine Chapel.

The men, however, showed little concern for their physical discomfort. They were interested only in the width of their cuts. If they made a finer cut—by a hairline or perhaps a full millimeter (.039 of an inch)—than the maximum six-millimeter width stipulated in the contract, they felt well rewarded.

Diether Fuchs joined Stefan and me, and he explained: "The joints in all painted or

sculptured surfaces must be as thin as is humanly possible. This is true for the façades as well as the interiors of the temples. With saws we cut only an inch or so deep into the sculptured side of the slabs, then drill holes through which we drive steel pins. When by careful excavation we have approached from the outside to within 80 centimeters—31 inches—of ceiling or walls, we begin to cut from that side. Using power saws, we make a much wider cut but work faster. The steel pins tell us where to run the cuts from the outside so that they coincide with the thin cuts made from inside."

At the time of our conversation, Diether did not know yet how they would work a slab loose when the cuts approached each other. "One possibility," he told me, "is to use wedges" —the method finally adopted.

Many people believe the ancient Egyptians split granite with moistened wooden wedges. I recalled this to Diether. Half seriously, he answered: "If you want to stay around, you better banish the word 'water' in connection with the temples, even in your dreams."

The temples are sandstone, and archeologists fear not only the damage but also the discoloration that water can cause. That is why special care must be exercised in any use of reinforcing cement.

When the two temples of Abu Simbel are completely dismantled, they will form a jigsaw puzzle of 950 pieces. Of

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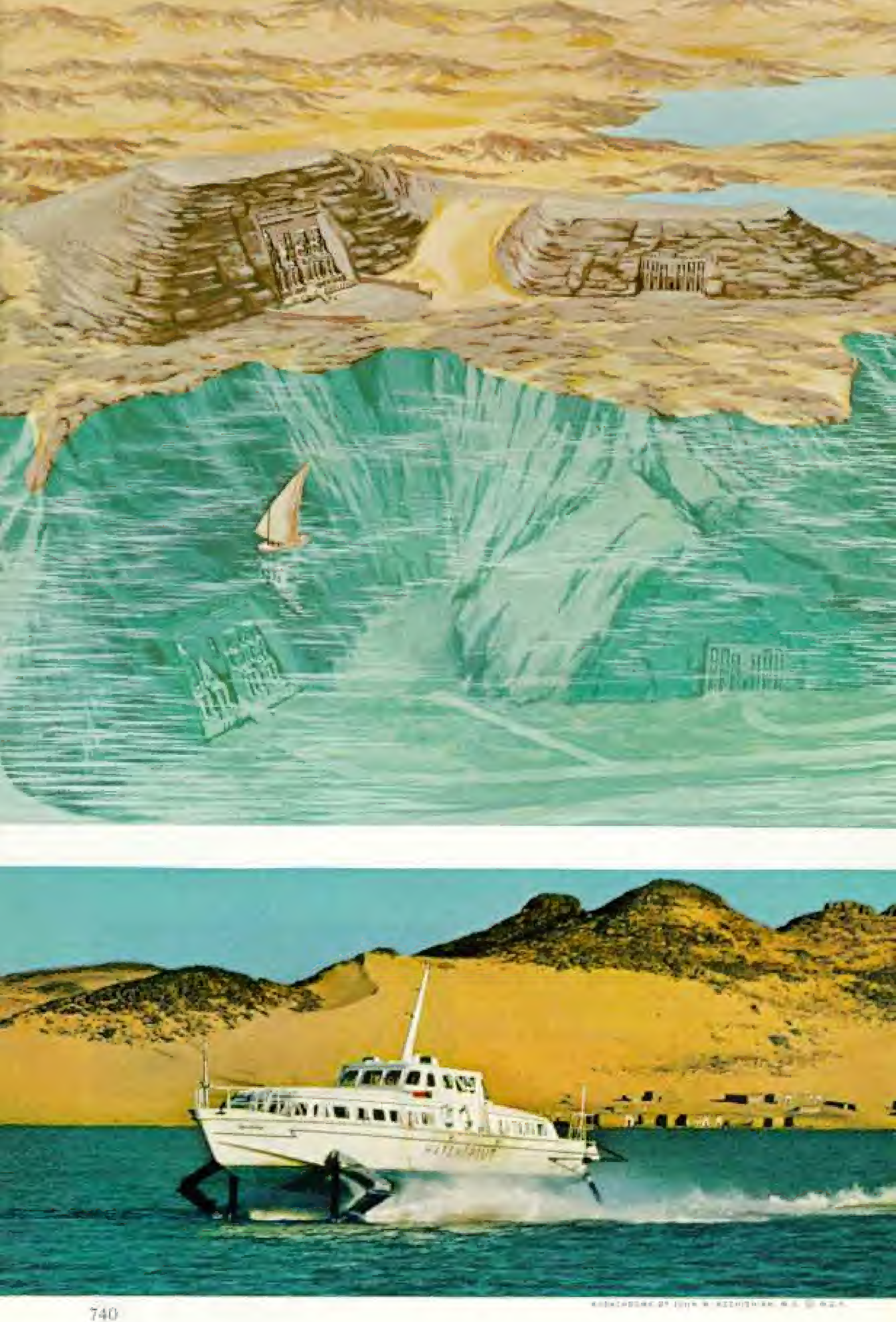
ORIGINAL SITE OF SMALL TEMPLE
COFFERDAM

New town blooms on the desert waste. Homes for engineers and workmen dot the plateau. The complex at left will become a tourist facility upon completion of the project. Resembling a race track, the main storage area stretches the length of a small promontory. A gantry crane, moving along the track, deposits each block in its preassigned place. Later, the crane will pick each one out again when its turn comes in the reassembly. Three faces of the colossi (opposite) rest in the area's soft sand.

German engineer Wolfgang Heyder concentrates on the problems of reconstruction. Working with a gypsum model of the Great Temple and a simulated derrick, he seeks the best places to set up cranes so that they can reach all parts of the monument in reassembling the blocks 212 feet above their original location.



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Reassembled for new dawns, the Great and Small Temples of Abu Simbel rest high and dry in this artist's reconstruction, which also shows the old site, now ghostly beneath the waters. On certain mornings of the year the sun will again strike the statue of Ramesses seated in the Sanctuary of the Great Temple. The fallen head of one colossus lies in its age-old tumbled position.

Speedy hydrofoils like the *Hatshepsut* will carry wondering visitors to see the reassembled temples.

FINAL RESTORATION OF ABU SIMBEL MAY DEPEND ON YOUR HELP

UNLESS an additional $7,000,000 is raised, work on Abu Simbel may stop short of complete restoration. Present funds do not cover all costs of the reassembly, which includes reconstruction of the adjacent cliffs to complete the setting. If you wish to help with this historic project, send tax-deductible gifts to the American Committee to Preserve Abu Simbel, Box 3456, Grand Central Station, New York City, New York 10022.

these, 750 make up the Great Temple. Maximum weight for ceiling or wall slabs is 20 tons; for façade slabs, 30 tons. By hollowing out some blocks from behind, a maximum surface can be obtained within weight limits.

Derricks hoist the slabs, and low-bed trailers move them to the main storage yard. There the gantry crane picks them up and carries each to its preassigned position. While in storage, interior slabs are covered with straw mats; the water archeologists fear can also come from the heavens, even in parched Abu Simbel. In 1962 a cloudburst struck the surrounding villages and melted down many mud-brick houses. Just last September a severe rainstorm lashed the site, raising Nile waves that nibbled at the cofferdam.

Each slab gets the red-carpet treatment. Cracks and fissures riddle Abu Simbel's ailing rock, and its grains of quartz are only feebly cemented together. Before the slightest cut is made in any decorated surface, workers apply a coating of synthetic resin, except on the saw line, to guard against crumbling (page 719). Deeply injected resin must not spread near a future line of cut since it would stop the saw blades. Once a block is cut, it may need further strengthening.

Rods Anchored in Stone Aid Lift

Surveyors measure each slab and compute its center of gravity in order to place drilled holes for the lifting bars. Engineers fix the bars with epoxy resin. When the resin hardens, the engineers screw these anchoring bars to a yoke attached to the derrick hook. At first they lift the block only a finger's breadth, so that the load indicator in the derrick hook can register the weight. Then hydraulic pressure is put on the slab to create a 10- to 20-percent overload; if the slab shows signs of cracking, it will be strengthened or subdivided.

When Joint Venture Abu Simbel signed its contract, none of the participating firms knew exactly how to make the quarter-inch cuts they had agreed to make or how to hold together the weak sandstone (sometimes more sand than stone) without arousing the archeologists' ire. Though Hochtief had successfully removed and relocated the Temple of Kalâbsha, near the Aswân High Dam, the project had yielded little pertinent experience, since Kalâbsha was built of blocks in the open, not hewn from rock.

VBB had supervised the removal of three small rock temples in Nubia. But these were mere finger exercises, for no block exceeded seven tons.

While engineers feverishly built the cofferdam, others conducted tests with all kinds of saws—wire saws, chain saws, disk saws, specially hardened handsaws. Chemists ran hundreds of tests to determine the proper synthetic resins and their admixtures.

VBB's towering Karl-Fredrik Wård told me, "Most outsiders, and even many insiders, overlook the key technological principle of our salvage scheme. In a negative sense, it means doing entirely without hydraulic jacks, ropes, slings, cables, and similar hoisting equipment; in a positive sense, it means the use of lifting bars.

"With the bars' help we can handle big slabs and still keep the cutting lines to a minimum width. We do not have to make room in the cut for a bulky sling. And also we do not need to move the block first to get a sling around it. That's why lifting bars are the safest solution; they minimize risk of damage."

Even so, because of the poor quality of the sandstone, some breakage must be anticipated. Early in the work a stela broke. Carl Theodor Mäckel, the project manager, explained: "That accident brought the problem of risk up for discussion. Everyone concerned should know this is an experiment. We take every possible precaution, within the time available. We could perform the dismantling work virtually free of risk, but to do this we would need two or three years. That would mean we might as well pack up right now. By August 15, 1966, we must clear the site."

Impossible to Set Insurance Value

Although Egypt obtained nominal insurance against monument damage, the coverage by no means reflected esthetic value. For what is the value of Ramesses' legs? How much is his nose worth in dollars and cents? The archeologists despaired of setting price tags on this priceless legacy of history.

Pharaoh's move is one of the most daring in history. Certainly it is the most costly. It will take at least five years from signing of contract to completion of landscaping.

In the final phase the temples are being re-erected with utmost precision over the same scaffolding system that shored up their interiors during removal. The blocks from the ceilings, walls, and façades are anchored to a structure of reinforced concrete. The rock framing the façades, consisting of 970 Treatment A blocks and some 5,500 blocks even farther out (called Treatment B), will also be returned to place. Artificial hills heaped atop the monuments will restore the original aspect of the whole (preceding pages). Concrete domes above the temples will relieve them from all pressure of this overburden.

Survey work (300,000 theodolite readings for the two temples) guarantees the repositioning of the slabs down to a millimeter of accuracy. The precision of the watchmaker applied to colossi!

Will Pharaoh Ever Be the Same?

One day soon, perhaps by the end of 1966, Pharaoh will again smile serenely on a considerably wider Nile. And on certain days of the year the rays of the rising sun will once more penetrate past the colossal guardians into the Sanctuary.

Will these "million-year temples," as a contemporary inscription describes them, look the same after reassembly? At times when the reservoir is at its maximum of 597 feet above sea level, they will appear unchanged. They will be less so when the Aswân reservoir is at low ebb. Then visitors will have to climb about 120 feet to the sill of the temples.

The temptation will be strong to restore the fallen second colossus to its original splendor. Around 1910 an engineer commissioned by the Egyptian Antiquities Department deemed the project unfeasible. Today its feasibility is no problem, but many would question its desirability.

What about the wounds inflicted on Pharaoh by the move? I took the question to resident archeologist Shoukry, who also is retired director-general of Egypt's Antiquities Department (page 735).

In giving his answer, he posed a question: "Pharaoh's injuries will be healed. The joints will be treated with a filler up to a few millimeters of the surface. It would be easy to go further—not only to heal these wounds but to conceal them. But would this be honest toward our forebears, ourselves, and those who come after us?"

SIX-MONTH INDEX

As one of the privileges of membership in the National Geographic Society, members who bind their GEOGRAPHICS as works of reference will receive upon request an index for each six-month volume. The index to Volume 128 (July-December, 1965) is now available.

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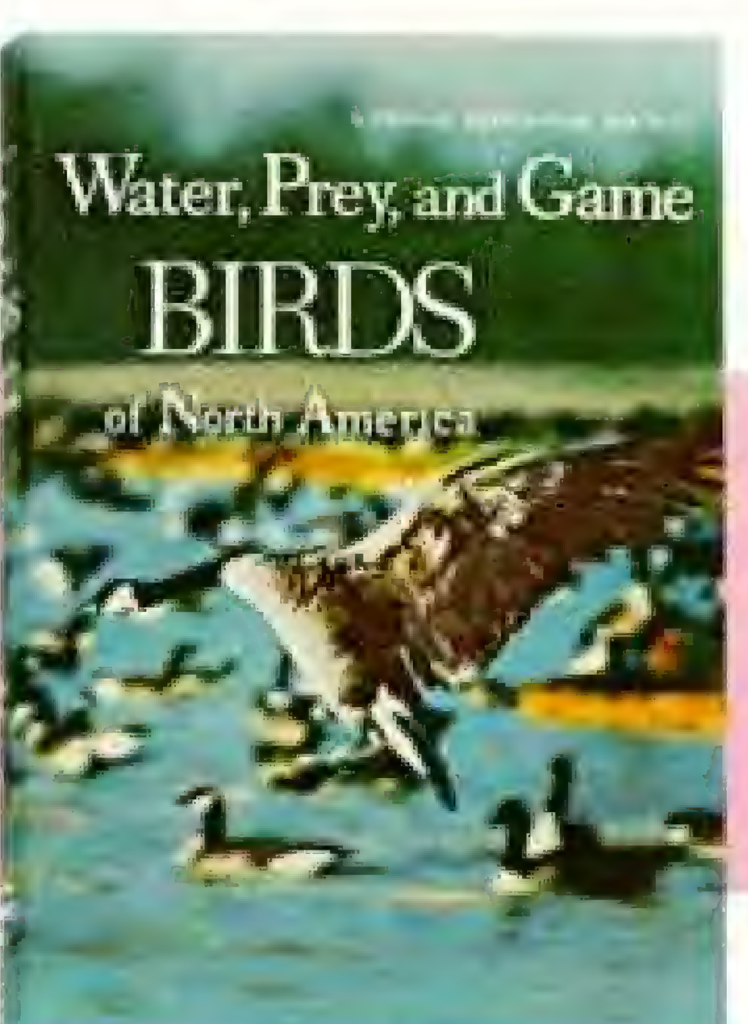

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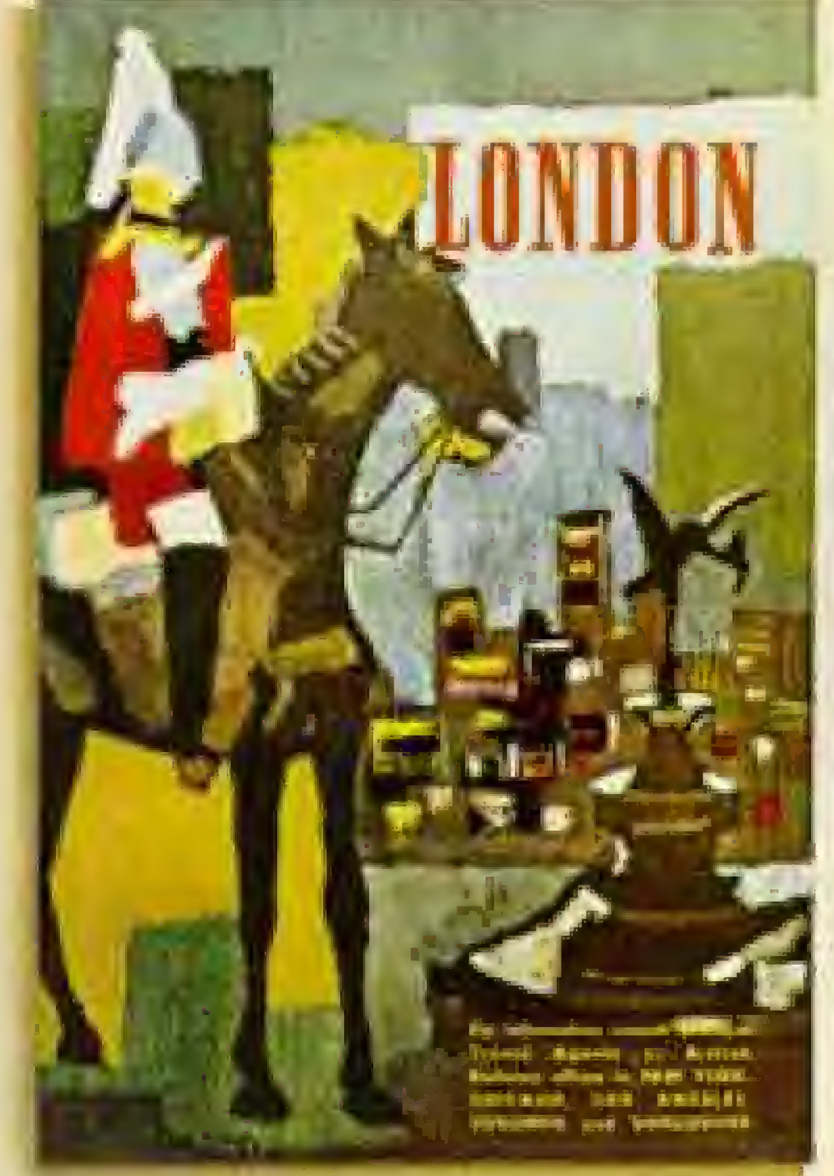

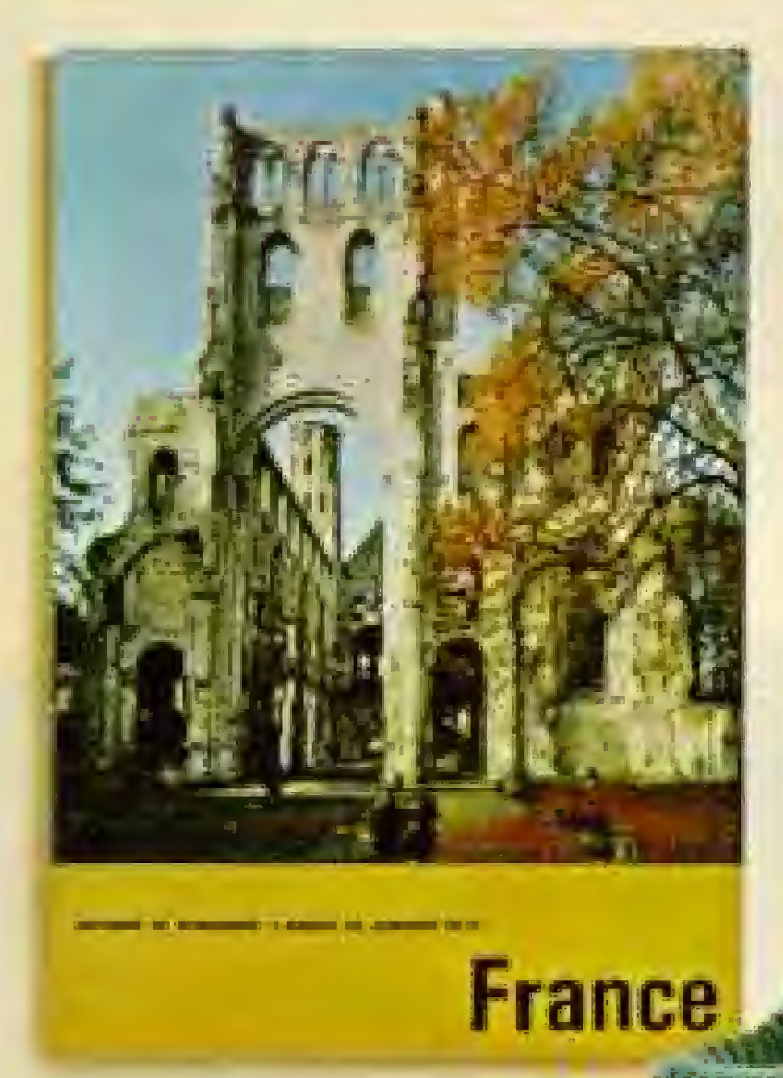

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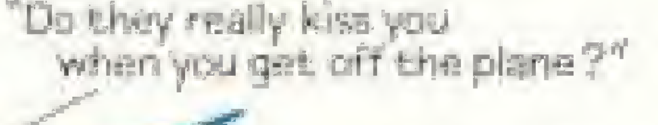

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